Maharashtra State Board Of Technical Education, Mumbai

Learning and Assessment Scheme for Post S.S.C Diploma Courses

Programme Name : Diploma In Automobile Engineering. / Chemical Engineering / Electrical Engineering / Electrical Power System / Food Technology / Mechanical Engineering / Mechatronics / Production Engineering / Printing Technology / Polymer Technology

Programme Code : AE / CH / EE / EP / FC / ME / MK / PG / PN / PO **With Effect From Academic Year** : 2023-24

Duration Of Programme : 6 Semester **Duration** : 16 WEEKS

Semester : First **NCrF Entry Level : 3.0** **Scheme** : K

Sr No	Course Title	Abbrevation	Course Type	Course Code	Total IKS Hrs for Sem.	Learning Scheme					Credits	Assessment Scheme												
						Actual Contact Hrs./Week			Self Learning (Activity/ Assignment /Micro Project)	Notional Learning Hrs /Week		Paper Duration (hrs.)	Theory				Based on LL & TL				Based on Self Learning		Total Marks
																	Practical						
						CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
													Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
(All Compulsory)																								
1	BASIC MATHEMATICS	BMS	AEC	311302	6	4	2	-	2	8	4	3	30	70	100	40	-	-	-	-	25	10	125
2	COMMUNICATION SKILLS (ENGLISH)	ENG	AEC	311303	-	3	-	2	1	6	3	3	30	70	100	40	25	10	-	-	25	10	150
3	BASIC SCIENCE — PHYSICS	BSC	DSC	311305	4	2	-	2	1	10	5	1.5	30	70*#	100	40	25	10	25@	10	25	20	250
	BASIC SCIENCE — CHEMISTRY					2	-	2	1								25	10	25@	10	25		
4	FUNDAMENTALS OF ICT	ICT	SEC	311001	-	1	-	2	1	4	2	-	-	-	-	-	25	10	25@	10	25	10	75
5	YOGA AND MEDITATION	YAM	VEC	311003	1	-	-	1	1	2	1	-	-	-	-	-	25	10	-	-	25	10	50
6	ENGINEERING WORKSHOP PRACTICES (Mechanical, Electrical and allied branches)	EWP	SEC	311005	2	-	-	4	-	4	2	-	-	-	-	-	50	20	50@	20	-	-	100
7	ENGINEERING GRAPHICS (Civil, Electrical, Mechanical and allied branches)	EGR	DSC	311006	2	2	-	4	-	6	3	-	-	-	-	-	50	20	50@	20	-	-	100
Total					**15**	**14**	**2**	**17**	**7**		**20**		**90**	**210**	**300**		**225**		**175**		**150**		**850**

Sr No	Course Title	Abbrevation	Course Type	Course Code	Total IKS Hrs for Sem.	Learning Scheme					Credits	Assessment Scheme										
						Actual Contact Hrs./Week			Self Learning (Activity/ Assignment /Micro Project)	Notional Learning Hrs /Week		Paper Duration (hrs.)	Theory				Based on LL & TL				Based on Self Learning		Total Marks
																	Practical						
						CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
													Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	

Abbreviations : CL- Classroom Learning , TL- Tutorial Learning, LL-Laboratory Learning, FA - Formative Assessment,SA -Summative Assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends : @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

Course Category : Discipline Specific Course Core (DSC) , Discipline Specific Elective (DSE) , Value Education Course (VEC) , Intern./Apprenti./Project./Community (INP) , AbilityEnhancement Course (AEC) , Skill Enhancement Course (SEC) , GenericElective (GE)

♦ For the course Basic Science - candidate will have to appear for pre-examination of both physics & chemistry. If absent in any one section (physics / chemistry) student will be declared as absent & fail for the course and marks will not be processed or carried forward.

Programme Name/s	**: Architecture Assistantship/ Automobile Engineering./ Artificial Intelligence/ Agricultural Engineering/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Architecture/ Cloud Computing and Bi Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Fashion & Clothing Te Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Food Technology/ Computer Hardware & Maintenance/ Instrumentation & Control/ Industrial Electronics/ Information Technolo Computer Science & Information Technology/ Instrumentation/ Interior Design & Decoration/ Interior Design/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Medical Electronics/ Production Engineering/ Printing Technology/ Polymer Technology/ Textile Technology/ Electronics & Computer Engg./ Textile Manufactures**
Programme: Code	**AA/AE/AI/AL/AN/AO/AT/BD/CE/CH/CM/CO/CR/CS/CW/DC/DE/DS/EE/EJ/EP/ET/EX/FC/HA/IC/IE/IF/IH/I**
Semester	**: First**
Course Title	**: BASIC MATHEMATICS**
Course Code	**: 311302**

I. RATIONALE

Basic Mathematics plays a crucial role in diploma programmes as it fosters the development of critical thinking skills, enhances quantitative literacy, prepares students for higher education, promotes problem-solving abilities, cultivates logical and abstract thinking and fosters mathematical literacy. By engaging with Mathematics, students acquire logical reasoning, problem-solving techniques and analytical thinking, which are valuable for lifelong learning and professional growth. Calculus is a branch of Mathematics that calculates how matter, particles and heavenly bodies actually move. Derivatives are useful to find maxima and minima of the function, velocity and acceleration are also useful for many engineering optimization problems. Statistics can be defined as a type of mathematical analysis which involves the method of collecting and analyzing data and then summing up the data into a numerical form for a given set of factual data or real-world observations. It equips individuals with the ability to interpret numerical information, make informed decisions and navigate real-world situations. Moreover, Mathematics provides a foundation for further studies in various disciplines and prepares students to tackle complex challenges. By exploring abstract concepts and logical structures, students develop their ability to reason, make connections, and approach problems with clarity and precision. Furthermore, studying Mathematics helps students appreciate the historical and cultural significance of Mathematics and its applications in diverse fields, thereby fostering mathematical literacy and a deeper understanding of the world. Hence the course provides the insight to analyze engineering problems scientifically using logarithms, matrices, trigonometry, straight line, differential calculus and statistics. By incorporating these topics, students comprehend to approach engineering problems from a mathematical perspective, enabling them to devise efficient and effective solutions and this leads to preparing Diploma graduates well-rounded, adaptable and capable of making significant contributions to the branch-specific problems.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Apply the concept of Mathematics to solve industry-based technology problems.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Apply the concepts of algebra to solve engineering (discipline) related problems.
- CO2 - Utilize trigonometry to solve branch specific engineering problems.
- CO3 - Solve area specific engineering problems under given conditions of straight lines.
- CO4 - Apply differential calculus to solve discipline specific problems.
- CO5 - Use techniques and methods of statistics to crack discipline specific problems.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TSL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
311302	BASIC MATHEMATICS	BMS	AEC	4	2	-	2	8	4	3	30	70	100	40	25	10	-	-	25	10	150

IKS Content : 6 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

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2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
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4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Solve the given simple problem based on laws of logarithm. TLO 1.2 Solve given system of linear equations using matrix inversion method. TLO 1.3 Obtain the proper and improper partial fraction for the given simple rational function. TLO 1.4 Solve simultaneous equations by using concept given in Ancient Indian Mathematics.	**Unit - I Algebra** 1.1 Logarithm: Concept and laws of logarithm. 1.2 Matrices: Matrices, algebra of matrices, transpose, value of determinant of matrix of order 3x3, adjoint and inverse of matrices. 1.3 Matrices: Solution of simultaneous equations by matrix inversion method. 1.4 Partial Fractions: Types of partial fraction based on nature of factors and related Problems. 1.5 Algebra in Indian Knowledge System: Solution of simultaneous equations (Indian Mathematics)..	Improved Lecture Tutorial Assignment Demonstration Simulation
2	TLO 2.1 Apply the concept of Compound angle, allied angle and multiple angles to solve the given simple engineering problem(s). TLO 2.2 Apply the concept of Sub- multiple angle to solve the given simple engineering related problem(s). TLO 2.3 Apply concept of factorization and de-factorization formulae to solve the given simple engineering problem(s). TLO 2.4 Investigate given simple problems by utilizing inverse trigonometric ratios. TLO 2.5 Use concept given in Ancient Indian Mathematics for trigonometry to solve given problems.	**Unit - II Trigonometry** 2.1 Trigonometric ratios of allied angles, compound angles, multiple angles (2A, 3A), submultiples angles. (without proof) 2.2 Factorization and De factorization formulae. (without proof). 2.3 Inverse Trigonometric Ratios and related problems. 2.4 Principle values and relation between trigonometric and inverse trigonometric ratios. 2.5 Trigonometry in Indian Knowledge System: The Evolution of Sine Function in India. 2.6 Indian Trigonometry: Basic Indian Trigonometry- Introduction and Terminology (From Ancient Beginnings to Nilakantha). 2.7 Trigonometry in Indian Knowledge System: Pythagorean triples in Sulabasutras.	Improved Lecture Tutorial Assignment Demonstration Simulation Flipped Classroom approach

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Calculate angle between given two straight lines. TLO 3.2 Formulate equation of straight lines related to given engineering problems. TLO 3.3 Identify perpendicular distance from the given point to the line. TLO 3.4 Calculate perpendicular distance between the given two parallel lines. TLO 3.5 Use geometry given in Sulabasutras to solve the given problems.	**Unit - III Straight Line** 3.1 Straight line and slope of straight line: Angle between two lines, Condition of parallel and perpendicular lines. 3.2 Various forms of straight lines: Slope point form, two-point form, Double intercept form, General form. 3.3 Perpendicular distance from a point on the line. 3.4 Perpendicular distance between two parallel lines. 3.5 Geometry in Sulabasutras in Indian Knowledge System (construction of square, circling the square). (Indian Mathematics).	Improved Lecture Tutorial Assignment Demonstration Simulation
4	TLO 4.1 Solve the given simple problems based on functions. TLO 4.2 Solve the given simple problems based on rules of differentiation. TLO 4.3 Obtain the derivatives of composite, implicit, parametric, inverse, logarithmic, exponential functions. TLO 4.4 Apply the concept of differentiation to find given equation of tangent and normal. TLO 4.5 Apply the concept of differentiation to calculate maxima, minima and radius of curvature for given function. TLO 4.6 Familiar with concept of calculus given in Indian Mathematics.	**Unit - IV Differential Calculus** 4.1 Functions and Limits: Concept of function and simple examples. 4.2 Functions and Limits: Concept of limits without examples. 4.3 Derivatives: Rules of derivatives such as sum, Product, Quotient of functions. 4.4 Derivatives: Derivative of composite functions (chain Rule), implicit and parametric functions. 4.5 Derivatives: Derivatives of inverse, logarithmic and exponential functions. 4.6 Applications of derivative: Second order derivative without examples, Equation of tangent and normal, Maxima and minima, Radius of curvature. 4.7 Calculus in Indian Knowledge System: The Discovery of Calculus by Indian Astronomers. (Indian Mathematics).	Improved Lecture Tutorial Assignment Demonstration Simulation
5	TLO 5.1 Obtain the range and coefficient of range of the given grouped and ungrouped data. TLO 5.2 Calculate mean and standard deviation of ungrouped and grouped data related to the given simple engineering problem(s). TLO 5.3 Determine the variance and coefficient of variance of given grouped and ungrouped data. TLO 5.4 Justify the consistency of given simple sets of data.	**Unit - V Statistics** 5.1 Range, coefficient of range of discrete and grouped data. 5.2 Mean deviation and standard deviation from mean of grouped and ungrouped data. 5.3 Variance and coefficient of variance. 5.4 Comparison of two sets of observation.	Improved Lecture Tutorial Assignment Demonstration Simulation Flipped Classroom approach

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Solve simple problems of Logarithms based on given applications.	1	Solve simple problems of Logarithms based on given applications.	2	CO1
LLO 2.1 Solve elementary problems on Algebra of matrices for branch specific engineering related applications.	2	Solve elementary problems on Algebra of matrices for branch specific engineering related applications.	2	CO1
LLO 3.1 Apply the concept of matrix to solve engineering problems.	3	Solve solution of Simultaneous Equation using inversion method.	2	CO1
LLO 4.1 Apply the concept of matrix to solve engineering problems.	4	Apply Matrix Inversion method to determine currents through various branches of given electrical networks.	2	CO1
LLO 5.1 Apply the concept of matrix to solve engineering problems.	5	Determine inverse of a non-singular matrix by using open source software.	2	CO1
LLO 6.1 Apply the concept of partial fraction to solve engineering problems.	6	Resolve into partial fraction using linear non-repeated, repeated, and irreducible quadratic factors.	2	CO1
LLO 7.1 Solve problems on Compound, Allied, multiple and sub multiple angles for related shapes.	7	Solve problems on Compound, Allied, multiple and sub multiple angles for related shapes.	2	CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 8.1 Utilize the concept of trigonometry to solve engineering problems.	8	Practice problems on factorization and de factorization.	2	CO2
LLO 9.1 Utilize the concept of trigonometry to solve engineering problems.	9	Solve problems on inverse trigonometric ratios based on applications.	2	CO2
LLO 10.1 Solve branch specific engineering problems under given conditions of straight lines.	10	Practice problems on equation of straight lines using different forms.	2	CO3
LLO 11.1 Solve branch specific engineering problems under given conditions of straight lines.	11	Solve problems on perpendicular distance, distance between two parallel lines and angle between two lines.	2	CO3
LLO 12.1 Solve branch specific engineering problems under given conditions of straight lines.	12	Use given form of straight line to calculate the speed, distance and time of moving object.	2	CO3
LLO 13.1 Apply the concept of derivative to solve engineering problems.	13	Solve problems to find derivatives of implicit function and parametric function.	2	CO4
LLO 14.1 Apply the concept of derivative to solve engineering problems.	14	Solve problems to find derivative of logarithmic and exponential functions for engineering applications.	2	CO4
LLO 15.1 Apply the concept of equation of tangent and normal to solve engineering problems.	15	Solve problems based on finding equation of tangent and normal for engineering applications.	2	CO4
LLO 16.1 Apply the concept of maxima, minima and radius of curvature to solve engineering problems.	16	Solve problems based on finding maxima, minima of function and radius of curvature at a given point for engineering applications.	2	CO4
LLO 17.1 Apply the concept of equation of tangent and normal to solve engineering problems.	17	Use the concept of tangent and normal to solve the given problem of Engineering Drawing.	2	CO4
LLO 18.1 Apply the concept of Maxima and Minima to solve engineering problems.	18	Use the concept of Maxima and Minima to obtain optimum value for given engineering problem.	2	CO4
LLO 19.1 Apply the concept of radius of curvature to solve engineering problems.	19	Use the concept of radius of curvature to solve given branch specific engineering problem.	2	CO4
LLO 20.1 Utilize the concept of derivative to solve engineering problems.	20	Use the concept of derivative to find the slope of a bending curve for given engineering problem.	2	CO4
LLO 21.1 Use concept of range and mean deviation to crack branch specific problems.	21	Solve problems on finding range, coefficient of range and mean deviation for given applications.	2	CO5
LLO 22.1 Use concept of standard deviation and coefficient of variance to crack branch specific problems.	22	Solve problems on standard deviation, coefficient of variation and comparison of two sets.	2	CO5
LLO 23.1 Use concept of standard deviation to crack branch specific problems.	23	Calculate the Standard Deviation for Concrete with the given data for given engineering applications.	2	CO5
Note : Note: 1. Take any 15 tutorials out of 23 and ensured that all the units are covered. 2. Take tutorial in the batch size of 20 to 30 students. 3. Give students at least 10 problems to solve in each tutorial.				

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Create a function that takes a matrix as input and returns its inverse matrix if it exists. Also Implement a program that finds the inverse of a square matrix.
- Collect the Data of Marks obtained by your class in mid sem test. Compute the variance and coefficient of variance of the data and interpret the result using the free open source software ORANGE.
- Prepare models using matrices to solve simple problems based on cryptography.
- Collect Model on quality control analysis, energy efficiency assessment, environmental monitoring, and process optimization, for these models, analyze data and calculate variance and standard deviation, make a presentation including short videos.
- Prepare the model using the concept of tangent and normal bending of roads in case of sliding of a vehicle, express geometrically the same through any open source software.
- Prepare the model using the concept of radius of curvature to bending of railway tracks, express geometrically the same through any open source software.
- A window in the form of a rectangle surmounted by a semicircular opening. The total perimeter of the window to admit maximum light through the whole opening, prepare a model using concept of Maxima and Minima for the above problem and verify the result.
- Visualize trigonometric waveforms and create animations utilizing sine or cosine functions and make a presentation.

- Develop a program of trigonometric function calculator that computes sine, cosine, and tangent values.
- Collect applications of the radius of curvature on lens design and optics, mirror and reflective surface properties, road and highway design, structural behavior, roller coaster track design, and composite material manufacturing and make a video of 5-minutes duration.
- Prepare models using trigonometry based on at least 10 engineering problems.
- Apply trigonometric principles to calculate angles, distances, forces, and dimensions relevant to the chosen area and make a poster presentation.
- Prepare charts using determinant to find area of regular shapes.
- Design a puzzle based on matrices. Create a grid of numbers and operations.
- Develop a math game based on operations of matrices.
- Use matrices as a tool for music composition. Assign different musical elements (e.g., notes, chords, rhythms) to matrix elements, and experiment with combining and transforming the matrices to create unique musical compositions. You can use musical notation open software or even traditional instruments to bring your compositions to life.
- Attempt any 10-12 Micro Projects, out of the given list.

Assignment

- Collect examples based on real world applications of logarithm and prepare a pdf file.
- Solve the simultaneous system of equation in two variables by Matrix Inversion Method. Write down a Mathematical programming using any open source software to verify the result.
- Collect an examples on coding theory using applications of matrices and prepare a pdf file.
- Represent the Graph of Trigonometric function, Logarithmic function on Geogebra and interpret the nature of graph and Make a pdf file.
- Measure height of trees in surrounding locations using trigonometry and prepare presentation.
- Find the derivative of y= x^sinx and visualize the graph of the function and its derivative using any open source software geometrically.
- Find height of room or distance between two pillars by using concept of straight line.
- Collect at least 10 examples based on real world applications of standard deviation/variance.
- Collect at least 10 examples based on real world uses of applications of derivative.
- Attempt any 5-7 Assignment, out of the given list.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Open-source software like SageMaths, MATHS3D, GeoGebra, Graph, DPLOT, and Graphing Calculator (Graph Eq 2.13), ORANGE can be used for Algebra, Calculus, Trigonometry, and Statistics respectively.	All

IX. SUGGESTED FOR WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Algebra	CO1	12	2	6	6	14
2	II	Trigonometry	CO2	16	2	6	6	14
3	III	Straight Line	CO3	6	2	2	4	8
4	IV	Differential Calculus	CO4	16	2	8	10	20
5	V	Statistics	CO5	10	2	6	6	14
Grand Total				**60**	**10**	**28**	**32**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Tests
- Rubrics for COs Assignment
- Midterm Exam
- Self-learning
- Term Work
- Seminar/Presentation

Summative Assessment (Assessment of Learning)

- End Term Exam
- Micro-project
- Tutorial Performance

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	-	1	-	1	1			
CO2	3	1	-	-	1	1	1			
CO3	3	-	-	-	-	-	-			
CO4	3	1	1	1	-	1	-			
CO5	3	2	1	1	1	1	1			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher
1	Grewal B. S.	Higher Engineering Mathematics	Khanna publication New Delhi , 2013 ISBN: 8174091955
2	Dutta. D	A text book of Engineering Mathematics	New age publication New Delhi, 2006 ISBN: 978-81-224-1689-3
3	Kreysizg, Ervin	Advance Engineering Mathematics	Wiley publication New Delhi 2016 ISBN: 978-81-265-5423-2
4	Das H.K.	Advance Engineering Mathematics	S Chand publication New Delhi 2008 ISBN: 9788121903455
5	Marvin L. Bittinger David J. Ellenbogen Scott A. Surgent	Calculus and Its Applications	Addison-Wesley 10th Edition ISBN-13: 978-0-321-69433-1
6	C. S. Seshadri	Studies in the History of Indian Mathematics	Hindustan Book Agency, New Delhi 110016. ISBN 978-93-80250-06-9
7	George Gheverghese Joseph	Indian Mathematics Engaging with the World from Ancient to Modern Times	World Scientific Publishing Europe Ltd. 57 ISBN 978-17-86340-61-0
8	Deepak Singh	Mathematics-I	Khanna Book Publishing Co. (P) Ltd. ISBN: 978-93-91505-42-4
9	Garima Singh	Mathematics-II	Khanna Book Publishing Co. (P) Ltd. ISBN: 978-93-91505-52-3
10	Gareth James, Daniela Witten, Trevor Hastie Robert and Tibshirani	An Introduction to Statistical Learning with Applications in R	Springer New York Heidelberg Dordrecht London ISBN 978-1-4614-7137-0 ISBN 978-1-4614-7138-7 (eBook)
11	Gunakar Muley	Sansar Ke Mahan Ganitagya	First Edition, Rajkamal Prakashan, ISBN-10. 8126703571, ISBN-13. 978-8126703579.
12	T.S. Bhanumurthy	A Modern introduction to Ancient Indian Mathematics	New Age International Private Limited, 1 January 2008 ISBN- 10. 812242600X, ISBN- 13. 978-8122426007
13	M.P. Trivedi and P.Y. Trivedi	Consider Dimension and Replace Pi	Notion Press; 1st edition (2018), ISBN-978-1644291795

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	http://nptel.ac.in/courses/106102064/1	Online Learning Initiatives by IITs and IISc
2	www.scilab.org/ -SCI Lab	Signal processing, statistical analysis, image enhancement.
3	www.mathworks.com/product/matlab/ -MATLAB	Applications of concepts of Mathematics to coding.

Sr.No	Link / Portal	Description
4	Spreadsheet Applications	Use of Microsoft Excel, Apple Numbers, Google Sheets.
5	https://ocw.mit.edu/	MIT Course ware
6	https://www.khanacademy.org/math?gclid=CNqHuabCys4CFdOJaddHoPig	Concept of Mathematics through video lectures and notes
7	http://ocw.abu.edu.ng/courses/mathematics/	List of Mathematical Courses.
8	https://libguides.furman.edu/oer/subject/mathematics	Open Education Resources (OER) in Mathematics.
9	https://phet.colorado.edu/en/simulations/filter?subjects=math&type=html,prototype	Phet Simulation for Mathematics.
10	https://libguides.cmich.edu/OER/mathematics	Mathematics with OER.

Programme Name/s : **Architecture Assistantship/ Automobile Engineering./ Artificial Intelligence/ Agricultural Engineering/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Architecture/ Cloud Computing and Bi Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Fashion & Clothing Te Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Food Technology/ Computer Hardware & Maintenance/ Instrumentation & Control/ Industrial Electronics/ Information Technolo Computer Science & Information Technology/ Instrumentation/ Interior Design & Decoration/ Interior Design/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Medical Electronics/ Production Engineering/ Printing Technology/ Polymer Technology/ Textile Technology/ Electronics & Computer Engg./ Textile Manufactures**

Programme Code : **AA/AE/AI/AL/AN/AO/AT/BD/CE/CH/CM/CO/CR/CS/CW/DC/DE/DS/EE/EJ/EP/ET/EX/FC/HA/IC/IE/IF/IH/I**

Semester : **First**

Course Title : **BASIC SCIENCE**

Course Code : **311305**

I. RATIONALE

Diploma engineers have to deal with various materials and machines. This course is designed with fundamental information to help the diploma engineering students to apply the basic concepts and principles of physics and chemistry to solve broad- based engineering problems. The basic concepts and principles of sciences related to heat, electricity, magnetism, optics, semiconductors, engineering materials will help in understanding the technology courses where emphasis is on the applications of these in various technology domain applications

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

This course is to be taught and implemented with the aim to develop in the student, the course outcomes (COs) leading to the attainment of following industry identified outcome expected from this course: Apply principles of physics and chemistry to solve broad based relevant engineering problems.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Use basic instruments to measure the physical quantities in various engineering situations.
- CO2 - Apply the basic principles of electromagnetics to solve given engineering problems.
- CO3 - Apply basic principles of thermometry and fibre optics to solve engineering problems.
- CO4 - Predict the structure, properties and behaviour of molecules and compounds based on the types of che
- CO5 - Apply the concepts of electrochemistry and corrosion preventive measures in industry.
- CO6 - Use the appropriate engineering material and catalyst appropriately.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TSL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
311305	BASIC SCIENCE	BSC	DSC	4	-	4	2	10	5	1.5	30	70*#	100	40	50	20	50@	20	50	20	250

IKS Content : 4 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Explain physical quantities and its types with examples. TLO 1.2 Differentiate between scalar and vector quantities with examples. TLO 1.3 Apply dimensional analysis to check correctness of equation and conversion of units in different systems . TLO 1.4 Estimate the errors in the measurement for the give problem. TLO 1.5 Explain the working of ancient astronomical instruments to measure distance , time and hour angle . TLO 1.6 Explain the procedure of measuring the dimension of a given object by using vernier calipers and screw gauge .	**Unit - I Units and Measurements** 1.1 Unit, physical quantities: fundamental and derived quantities and their units Systems of units: CGS, MKS and SI . 1.2 Scalar and Vector Physical Quantities. 1.3 Dimensions, dimensional formula ,Applications of dimensional analysis; correctness of physical equations ,conversion factor for interconversion of units in different systems of units. 1.4 Errors, types of errors: instrumental, systematic and random error, estimation of errors: absolute, relative and percentage error, significant figures. 1.5 Ancient astronomical instruments:Chakra, Dhanuryatra , Yasti and Phalaka yantra . 1.6 Applications of Vernier calipers , Screw gauge .	Chalk and board Improved lecture, Tutorial Assignment Demonstration
2	TLO 2.1 Explain electric field, potential and potential difference. TLO 2.2 Explain magnetic intensity and flux with their units. TLO 2.3 Apply laws of series and parallel combination to the given electrical circuits.Explain the heating effect of electric current. TLO 2.4 Distinguish between conductors, semiconductors and insulators on the basis of energy bands. TLO 2.5 Explain the I-V characteristics and applications of p-n junction diode.	**Unit - II Electricity, Magnetism and Semiconductors** 2.1 Concept of charge, Coulomb's inverse square law, Electric field, Electric field intensity, potential and potential difference. 2.2 Magnetic field and magnetic field intensity and its units, magnetic lines of force, magnetic flux . 2.3 Electric current, Ohm's law, specific resistance, laws of series and parallel combination of resistance, conversion of galvanometer into ammeter and voltmeter, Heating effect of electric current . 2.4 Conductors, Insulators and Semiconductors, Energy bands, intrinsic and extrinsic semiconductors, minority and majority charge carriers. 2.5 p-n junction diode, Depletion layer I-V characteristics of p-n junction, static and dynamic resistance, applications of p-n junction diode ,: Half wave rectifier.	Chalk and board Improved lecture, Tutorial Assignment Demonstration Educational Games

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Convert temperature in different temperature scales. TLO 3.2 Compare different modes of heat transfer with examples. TLO 3.3 Inter-relate the characteristics of the three gas laws. TLO 3.4 Inter-relate the characteristics of the three gas laws. TLO 3.5 Explain total internal reflection in optical fiber. TLO 3.6 Differentiate between types optical fibber with applications.	**Unit - III Thermometry and Fiber Optics** 3.1 Heat, temperature, temperature scale: Degree Celsius, degree Kelvin, degree Fahrenheit. 3.2 Modes of heat transfer: Conduction , Convection and Radiation , Applications in daily life . 3.3 Boyle's law, Charle's law, Gay Lussac's law, perfect gas statements equations and simple numerical. 3.4 Law of thermal conductivity ,Newton's law of cooling. 3.5 Law of refraction, total internal reflection. 3.6 Optical fibber: Principle, construction and working Types of Optical fibers;Single mode step index, Multimode step index, Multimode graded index Applications of optical fibers.	Chalk and board Improved lecture, Tutorial Assignment Demonstration Flip classroom Educational Games
4	TLO 4.1 Explain the properties of given material based on the bond formation. TLO 4.2 Describe the molecular structure of given solid, liquid and gases. TLO 4.3 Describe the crystal structure of the given solids. TLO 4.4 Explain Properties of metallic solid.	**Unit - IV Chemical bonding** 4.1 Indian Chemistry:-Philosophy of atom by Acharya Kanad. 4.2 Electronic theory of valency: Assumptions , Chemical bonds: Types and characteristics of electrovalent bond, covalent bond, coordinate bond, hydrogen bond, metallic bond and Intermolecular forces of attraction. 4.3 Molecular arrangement in solid, liquid and gases. 4.4 Structure of solids: crystalline and amorphous solids ,Properties of metallic solid, Unit cell: simple cubic, body center cubic (BCC) , face centre cubic (FCC), hexagonal close pack crystals.	Simulation, Model Display, Demonstration Chalk and board , PPT, ect
5	TLO 5.1 Describe mechanism of electrolysis of CuSO4 solution by using cu and pt rods TLO 5.2 Solve numerical based on Faraday's first and second law of electrolysis. TLO 5.3 Distinguish between primary and secondary cell TLO 5.4 Describe the phenomenon of the given type of corrosion and its prevention. TLO 5.5 Identify the different factors affecting rate of corrosion for the given type of material. TLO 5.6 Select the protective measures to prevent the corrosion in the given corrosive medium.	**Unit - V Electro chemistry and Metal Corrosion, its prevent ion** 5.1 Electrolyte- Types of electrolyte, ionization and dissociation ,Cathode, Anode, Electrode potential: oxidation and reduction, Mechanism of electrolysis :Electrolysis, Electrochemical series for cations and anions. Mechanism of electrolysis of CuSO4 solution 5.2 Faraday's laws of electrolysis: Faraday's first and second law, relation between electrochemical equivalent and chemical equivalent, Numerical. Applications of electrolysis: Electro-refining of copper and Electroplating. 5.3 Difference between primary and secondary cell. 5.4 Corrosion: Definition and Types of corrosion Dry corrosion: Mechanism, Types of oxide film, Wet corrosion :Mechanism hydrogen evolution in acidic medium, oxygen absorption in neutral or alkaline medium ,Galvanic cell action by Daniel cell. 5.5 Factors affecting the rate of corrosion. 5.6 Corrosion control: Modification of environment, Use of protective coatings, coating of less active metal like Tin (Tinning), coating of more active metal like Zinc (Galvanizing), Anodic and cathodic protection, Choice of material-using pure metal and using metal alloy	Simulation, Demonstration, Flipped Classroom, Collaborative Learning, Case Study, On-site/Industrial Visit ,chalk and board etc.

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
6	TLO 6.1 Identify the ingredients of the given paints. TLO 6.2 List out salient properties of the given paint and varnish. TLO 6.3 Describe the properties of insulating materials for the given application. TLO 6.4 Differentiate the given types of structural polymers. TLO 6.5 Describe the polymerization process of the given polymer. TLO 6.6 Explain the properties and uses of the given polymer, elastomer and adhesive. TLO 6.7 Describe the application of relevant adhesives required for the given material. TLO 6.8 Suggest the lubricant for various types of machines in industry. TLO 6.9 Select the relevant catalyst for given application.	**Unit - VI Engineering Materials and Catalysis** 6.1 Paints: Purposes of applying paint, Characteristics of paints, Ingredients of paints, Function and examples of each ingredient. 6.2 Varnish: Types, Difference between paint and varnishes. 6.3 Insulators: Characteristics, Classification,Properties and Application of Glass wool Thermocol. 6.4 Polymer and Monomer : Classification on the basis of Molecular structure, on the basis of monomers (homo polymer and copolymer), on the basis of Thermal behavior(Thermoplastics and Thermosetting). 6.5 Types Polymerization Reaction, Addition Polymerization, Condensation Polymerization, Synthesis, properties and application of Polyethylene, Polyvinyl chloride, Teflon, Polystyrene, Phenol formaldehyde, Epoxy Resin. 6.6 Adhesives: Characteristics, Classification and their uses 6.7 Lubricants: Classification, properties and Applications. 6.8 Catalysis: Types of catalysis homocatalysis ,heterocatalysis . 6.9 Catalyst: Types of Catalyst Positive, Negative and Auto-catalyst, Catalytic Promoter and Catalytic inhibitor, Industrial application of catalyst.	Simulation, Demonstration, On-site Visit ,Chalk and Board, etc.

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Use Vernier caliper to : Measure dimensions of given objects. Measure the dimensions of objects of known dimensions. LLO 1.2 Estimate the errors in measurement.	1	Measurements of dimensions of given object by Vernier caliper.	2	CO1
LLO 2.1 Use Micrometer Screw gauge to: Measure dimensions of given objects. Measure the dimensions of objects of known dimensions. LLO 2.2 Estimate the errors in measurement.	2	Measurements of dimensions of given objects by micrometer screw gauge.	2	CO1
LLO 3.1 Apply Ohm’s law to solve circuit problems.	3	Determination of resistance by Ohm’s law.	2	CO2
LLO 4.1 Determine the specific resistance of given wire.	4	Determination of specific resistance of given wire.	2	CO2
LLO 5.1 Verify law of series connection of resistors.	5	Determination of equivalent resistance in series connection of resistors.	2	CO2
LLO 6.1 Verify law of parallel connection of resistors.	6	Determination of equivalent resistance in parallel connection of resistors.	2	CO2
LLO 7.1 Use magnetic compass to draw the magnetic lines of forces of magnet of different shapes and determine neutral points.	7	Determination of neutral points by magnetic compass.	2	CO2
LLO 8.1 Use P -N junction diode to draw forward bias and reverse bias I-V characteristics LLO 8.2 Find out static and dynamic resistance of given P N junction diode	8	Determination of static and dynamic resistance of given P N junction diode.	2	CO2
LLO 9.1 Determine forbidden energy band gap in semiconductors	9	Determination of forbidden energy band gap in semiconductors.	2	CO2
LLO 10.1 Use Joule’s calorimeter to determine Joule’s mechanical equivalent of heat	10	Determination of Joule’s mechanical equivalent of heat by Joule’s law.	2	CO3
LLO 11.1 Determine the pressure-volume relation using Boyle’s law	11	Determination of pressure-volume relation using Boyle’s law.	2	CO3
LLO 12.1 Use Newton”s law of cooling to determine the rate of heat loss due to convection phenomena	12	Determination of the rate of heat loss due to convection by Newton's law of cooling.	2	CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 13.1 Use Searle's thermal conductivity apparatus to find coefficient of thermal conductivity of given material (Virtual Lab)	13	Determination of Coefficient of thermal conductivity.	2	CO3
LLO 14.1 Determine the refractive index of glass slab using TIR phenomenon.	14	Determination of the refractive index of glass slab.	2	CO3
LLO 15.1 Determine the Numerical Aperture (NA) of a given step index optical fibre	15	Determination of the Numerical Aperture (NA) of a given step index optical fiber.	2	CO3
LLO 16.1 Identify cation in given ionic solutions by performing selective test	16	Identification of cation in given ionic solutions.	2	CO4
LLO 17.1 Identify anion in given ionic solutions by performing selective test	17	Identification of anion in given ionic solutions.	2	CO4
LLO 18.1 Identify states of matter of materials by using simulation. by Appling heating and cooling Techniques. LLO 18.2 Relate temperature-pressure diagram	18	Identification of states of matter.	2	CO4
LLO 19.1 Determine the electrode potential of copper metal. by setting Electrochemical Cell LLO 19.2 Measure electrode potential of Cu Using Voltmeter. LLO 19.3 Measure the cell potential for various conditions.	19	Determination of electrode potential of copper.	2	CO5
LLO 20.1 Determine the electrode potential of Iron metal. by setting Electrochemical Cell LLO 20.2 Measure electrode potential of Fe Using Voltmeter LLO 20.3 Measure the cell potential for various conditions.	20	Determination of electrode potential of Iron metal.	2	CO5
LLO 21.1 Determine the voltage generated from chemical reaction using Daniel Cell. LLO 21.2 Set up Daniel Cell. Prepare Electrolyte Solution LLO 21.3 Measure voltage accurately	21	Determination of the voltage generated from chemical reaction using Daniel Cell.	2	CO5
LLO 22.1 Prepare Electrolyte Solution of CuSO 4 of known concentration LLO 22.2 Set up electrolysis apparatus LLO 22.3 Control various parameters of electrolysis. LLO 22.4 Determine electrochemical equivalent of Cu metal using Faraday's first law.	22	Determination of electrochemical equivalent of Cu metal using Faraday's first law.	2	CO5
LLO 23.1 Prepare Electrolyte Solution of the given metal of known concentration LLO 23.2 Set up electrolysis apparatus LLO 23.3 Control various parameters of electrolysis LLO 23.4 Analyze the data obtained from the experiment. LLO 23.5 Verify Faraday second law	23	Determination of equivalent weight of metal using Faraday's second law.	2	CO5
LLO 24.1 Prepare corrosive solutions LLO 24.2 Determine the extent of corrosion.	24	Preparation of corrosive medium for Aluminium at different temperature.	2	CO5
LLO 25.1 Prepare corrosive solutions. LLO 25.2 Determine the extent of corrosion LLO 25.3 Compare the corrosion behaviour of Aluminum at different temperatures.	25	Determination of rate of corrosion at different temperatures for Aluminium.	2	CO5
LLO 26.1 Determine the effect of temperature on viscosity for given lubricating oil using Redwood viscometer-	26	Determination of effect of temperature on viscosity for given lubricating oil using Redwood viscometer-I.	2	CO6
LLO 27.1 Determine the steam emulsification number of given lubricating oil. LLO 27.2 Measure the steam flow duration	27	Determination of the steam emulsification number of given lubricating oil.	2	CO6
LLO 28.1 Calculate the flash and fire point of given lubricating oils using Cleveland open cup apparatus	28	Determination of flash and fire point of given lubricating oils using Cleveland open cup apparatus.	2	CO6
LLO 29.1 Determine the flash point of given lubricating oil using Abel's closed cup apparatus.	29	Determination of flash point of given lubricating oil using Abel's closed cup apparatus.	2	CO6

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 30.1 Determine thinner content in oil paint. using electric oven	30	Determination of thinner content in oil paint.	2	CO6

Note :

i. A suggestive list of practical LLOs is given in the table, more such practical LLOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more for physics and minimum 12 or more for chemistry practical LLOs need to be performed, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry. ii. Hence, the 'Process' and 'Product' related skills associated with each LLOs of the laboratory work are to be assessed according to a suggested sample of Performance Indicators (Weightage in %) as follows: 1) Preparation of experimental set up 20% 2) Setting and operation 20% 3) Safety measures 10% 4) Observations and Recording 10% 5) Interpretation of result and Conclusion 20% 6) Answer to sample questions 10% 7) Submission of report in time 10%.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Series and parallel resistances: Prepare models for combination of series and parallel resistances u
- Magnetic flux: Prepare models to demonstrate magnetic lines of lines of forces of different types of
- Vernier Calipers: Prepare prototype vernier caliper of desired least count using card sheet
- Conductivity: Collect different materials such as metal, plastics, glass etc. and prepare models to
- Gas laws: Prepare models to demonstrate Boyle's laws, Charle's Law and Gay Lussac's law using househ
- Carbon resistors: Determine the resistance and tolerance of carbon resistors using color codes and m
- Thermal conductivity: Take different metallic plates of various metals and calculate rate of flow of
- Temperature sensor : Use Temperature sensor IC LM 35 to measure temperature of given body in vario
- Mobile applications : Use mobile applications for measurements of different physical quantities For
- Optical Fiber and TIR: Prepare model to demonstrate total internal reflection and the propagation of
- Convert given galvanometer into ammeter of desired range.
- Convert given galvanometer into voltmeter of desired range
- LDR: Use Light dependent resistor for measuring the intensity of light.
- Types of bonds: Prepare chart and models displaying different types of bonds with examples.
- Prepare a chart for showing different types of bonds or molecules.
- Crystal Structure: Prepare Models of SC,FCC,HCP,BCC
- Ionization: Prepare chart displaying ionization phenomenon.
- Corrosion-Prepare Chart displaying images of observed corrosion processes in the surrounding.
- Adhesives: Prepare chart or model to demonstrate the applications of various adhesives.
- Polymer: Collect the samples of different polymers and list their uses.
- Collect information based on market survey of different Polymer and compare the following points. i) Structure ii) Properties.
- Collect information by library survey regarding engineering material used in various industries.

Assignment

- Convert the units of a given physical quantity from one system of units to another.
- Measure room temperature of hot baths / bodies by using mercury thermometer and convert it into diff
- Prepare a chart to summarize units and measurements
- Enlist information like band gap, material used, dimension etc about different semiconductor device
- Give details about the explanation of concept like electrostatics, magnetic domain, current elect
- Demonstrate the variation of angle of refraction with respect to refractive index using online too
- Use a digital vernier caliper and micrometer screw gauge for measurements.(lab- based).
- Applications of optical fibers in civil, mechanical , electrical engineering etc.
- Applications of semiconductors in civil, mechanical , electrical engineering etc.
- Explain covalent bond, ionic bond, coordinate bond, hydrogen bond, intermolecular forces
- Draw Crystal structures of SC,BCC, FCC,HCP.
- Distinguish between paints and varnishes.
- Solve numerical based on Faraday's first and second law of electrolysis.
- Enlist various Adhesives with properties and applications.
- Compare between Thermoplastics and Thermosetting.
- State properties and applications thermocol and glass wool.
- Differentiate the given types of structural polymers and list out their applications.
- Demonstrate Mechanism of wet corrosion by waterline corrosion.
- Prepare chart showing mechanism of electrolysis of CuSO4 solution by using Cu and Pt electrodes.
- Write properties and applications of solid, semisolid and liquid lubricant.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Vernier Calipers: Range : 0-150mm , Resolution: 0.1mm	1
2	Micrometer screw gauge : Range : 0-25mm, Resolution: 0.01mm, Accuracy ±0.02mm or better	2
3	Digital multimeter : 3 1/2 digit display, 9999 counts, digital multimeter measures: Vac, Vdc (1000V max) , DC A, AC A(10 amp max), Resistance (0 - 100 MOhm	3,4,5,6
4	Resistance Box: 4 decade ranges from 1 ohm to 1K,accuracy 0.1 % - 1 %	3,4,5,6
5	Battery eliminator : 0- 12 V ,2A	3,4,5,6,8,9,10,12
6	Boyle's apparatus: U tube manometer , barometer	11
7	Joule's calorimeter : well insulated "mechanical equivalent of heat apparatus" in wooden box, , digital / analog thermometer,	10,12
8	Electronic balance, with the scale range of 0.001g to 500gm pan size 100 mm; response time 3-5 sec.: power requirement 90-250 V, 10 watt	19,20,21,22,23,24,25,30
9	Electric oven inner size 18''x18''x18''; temperature range 100 to 2500 C. with the capacity of 40 lt.	30
10	Ammeter 0-2 amp voltmeter-0-5v DC	19,20,21,22,23
11	Redwood viscometer-I	26
12	Cleveland open cup apparatus	28
13	Abel's close cup apparatus	29

IX. SUGGESTED FOR WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Units and Measurements	CO1	7	2	3	4	9
2	II	Electricity, Magnetism and Semiconductors	CO2	13	3	5	6	14
3	III	Thermometry and Fiber Optics	CO3	10	2	4	6	12
4	IV	Chemical bonding	CO4	6	2	3	4	9
5	V	Electro chemistry and Metal Corrosion, its prevent ion	CO5	12	3	4	5	12
6	VI	Engineering Materials and Catalysis	CO6	12	3	5	6	14
Grand Total				**60**	**15**	**24**	**31**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two unit tests of 30 marks (Physics 15 marks,Chemistry-15 marks) and average of two unit tests.
- For laboratory learning 50 marks (Physics 25 marks,Chemistry-25 marks).

Summative Assessment (Assessment of Learning)

- End semester assessment of 50 marks for laboratory learning (Physics 25 marks,Chemistry-25 marks).
- End semester assessment of 70 marks through online MCQ examination.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1		2	1	1	1			
CO2	3	1	1	2	1	1	1			
CO3	3	1	1	2	1	1	1			
CO4	3	2			2		1			
CO5	3	2	1	1	2		1			

CO6	3	2			2	1	1			
Legends :- High:03, Medium:02,Low:01, No Mapping: - *PSOs are to be formulated at institute level										

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher
1	Narlikar J. V. ;Joshi , A. W.; Mathur , Anuradha ; et al	Physics Textbook Part I - Class XI	National Council of Education Research and Training, New Delhi, 2010, ISBN : 8174505083
2	Narlikar, J.V.;Joshi , A. W.; Mathur , Anuradha ; et al	Physics Textbook Part II - Class XI	National Council of Education Research and Training, New Delhi, 2015, ISBN : 8174505660
3	Narlikar J.V.;Joshi , A. W.; Ghatak A.K. et al	Physics Textbook Part I - Class XII	National Council of Education Research and Training, New Delhi, 2013, ISBN : 8174506314
4	Narlikar, J.V.;Joshi , A. W.; Ghatak A.K. et al	Physics Textbook Part II - Class XII	National Council of Education Research and Training, New Delhi, 2013, ISBN : 8174506713
5	Haliday, David; Resnik, Robert and Walker, Jearl	Fundamentals of Physics	John Wiley & sons, Hoboken, USA, 2014 ISBN : 812650823X
6	Jain and Jain	Engineering Chemistry	National Council of Education Research and Training, New Delhi, 2010, ISBN : 8174505083
7	Dara S. S.	Engineering Chemistry	National Council of Education Research and Training, New Delhi, 2015, ISBN : 8174505660
8	Bagotsky V.S.	Fundamental of electrochemistry	National Council of Education Research and Training, New Delhi, 2013, ISBN : 8174506314
9	Jain and Jain	Engineering Chemistry	National Council of Education Research and Training, New Delhi, 2013, ISBN : 8174506713
10	Aryabhatta.	The Surya Siddhanta	Baptist Mission press ,Calcutta
11	Steeramula Rajeswara Sarma	The Archaic And The Exotic : Studies In The History Of Indian Astronomical Instruments	Published by Manohar Book Service, 2008 ISBN 10: 8173045712 / ISBN 13: 9788173045714
12	Anju Rawlley,Devdatta V. Saraf	Applied Chemistry with Lab Manual	Khanna Book Publishing Co. (P) Ltd. New Delhi, 2021, ISBN- 978-93-91505-44-8
13	Dr. Hussain Jeevakhan	Applied Physics - II	Khanna Book Publishing, (2021), ISBN: 978-93-91505-57-8

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	www.sciencejoywagon.com/physicszone	Electricity, Magnetism and Semiconductors , basic of fiber optics
2	https://phet.colorado.edu	Electricity, Magnetism and Semiconductors ,Thermometry and basic of fiber optics
3	www.physicsclassroom.com	concepts of basic physics
4	http://nptel.ac.in/course.php?disciplineId=104	concepts of basic physics
5	http://hperphysics.phy-astr.gsu.edu/hbase/hph.html	concepts of basic physics
6	https://www.youtube.com/results?search_query=amruta+university+physics+expts	concepts of basic physics
7	k. https://www.youtube.com/results?search_query=physics+class+11+chapter+1	concepts of basic physics
8	l. https://www.youtube.com/watch?v=zRGh9_a1J7s	concepts of basic physics
9	https://iksindia.org	IKS physics
10	www.chem1.com	Chemistry instruction and education
11	ww.onlinelibrary.wiley.com	Materials and corrosion
12	www.rsc.org	Catalysis
13	www.chemcollective.org	Virtual Labs, simulation

Sr.No	Link / Portal	Description
14	https://www.ancient-origins.net/history-famous-people/indian-sage-acharya-kanad-001399	IKS Philosophy of atom by Acharya Kanad.
15	https://phet.colorado.edu/en/simulations/filter?subjects=chemistry&type=html,prototype	Identify states of matter of materials by using simulation.

Programme Name/s	**: Architecture Assistantship/ Automobile Engineering./ Agricultural Engineering/ Architecture/ Civil Engineering/ Chemical Engineering/ Civil & Rural Engineering/ Construction Technology/ Fashion & Clothing Technology/ Electrical Engineering/ Electrical Power System/ Food Technology/ Interior Design & Decoration/ Interior Design/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Production Engineering/ Printing Technology/ Polymer Technology/ Textile Technology/ Textile Manufactures**
Programme Code	**: AA/AE/AL/AT/CE/CH/CR/CS/DC/EE/EP/FC/IX/IZ/LE/ME/MK/PG/PN/PO/TC/TX**
Semester	**: First**
Course Title	**: ENGINEERING GRAPHICS (Civil, Electrical, Mechanical and allied branches)**
Course Code	**: 311006**

I. RATIONALE

Engineering graphics is the language of engineers. The concepts of graphical language are used in expressing the ideas, conveying the instructions, which are used in carrying out the jobs on the sites, shop floor etc. This course is useful in developing drafting and sketching skills in the student. It covers the knowledge & application of drawing instruments & also familiarizes the learner about Bureau of Indian Standards related to engineering drawing. The curriculum aims at developing the ability to draw and read various engineering curves, projections and dimensioning styles. The subject mainly focuses on use of drawing instruments, developing imagination and translating ideas into sketches. The course also helps to develop the idea of visualizing the actual object or part on the basis of drawings and blue prints. This preliminary course aims at building a foundation for the further courses related to engineering drawing and other allied courses in coming semesters

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Prepare engineering drawing manually using prevailing drawing instruments.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Draw geometrical figures and engineering curves.
- CO2 - Apply principles of orthographic projections for drawing given pictorial views.
- CO3 - Draw isometric views of given component or from orthographic projections.
- CO4 - Use various drawing codes, conventions and symbols as per IS SP-46 in engineering drawing.
- CO5 - Draw free hand sketches of given engineering elements.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TSL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
311006	ENGINEERING GRAPHICS (Civil, Electrical, Mechanical and allied branches)	EGR	DSC	2	-	4	-	6	3		-	-	-	-	50	20	50@	20	-	-	100

IKS Content : 2 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Prepare drawing using drawing instruments. TLO 1.2 Use IS SP-46 for dimensioning TLO 1.3 Use different types of lines. TLO 1.4 Draw regular geometrical figures. TLO 1.5 Draw figures having tangency constructions.	**Unit - I Basic Elements of Drawing** 1.1 Drawing Instruments and supporting material: method to use them with applications. 1.2 Standard sizes of drawing sheets (ISO-A series) 1.3 I.S. codes for planning and layout. 1.4 Letters and numbers (single stroke vertical) 1.5 Convention of lines and their applications. 1.6 Scale - reduced, enlarged & full size 1.7 Dimensioning techniques as per SP-46 (Latest edition) – types and applications of chain, parallel and coordinate dimensioning 1.8 Geometrical constructions.	Model Demonstration
2	TLO 2.1 Explain different engineering curves with areas of application. TLO 2.2 Draw different conic sections. TLO 2.3 Draw involute and cycloidal curves. TLO 2.4 Draw helix and spiral curves from given data TLO 2.5 Plot Loci of points from given data.	**Unit - II Engineering curves & Loci of Points.** 2.1 Concept and understanding of focus, directrix, vertex and eccentricity. Conic sections. 2.2 Methods to draw an ellipse by Arcs of circle method & Concentric circles method. 2.3 Methods to draw a parabola by Directrix-Focus method & Rectangle method 2.4 Methods to draw a hyperbola by Directrix-Focus method. 2.5 Methods to draw involutes: circle & pentagon 2.6 Methods to draw Cycloidal curve: cycloid, epicycloid and hypocycloid 2.7 Methods to draw Helix & Archimedean spiral. 2.8 Loci of points on Single slider crank mechanism with given specifications.	Demonstration

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Explain methods of Orthographic Projections. TLO 3.2 Draw orthographic views of simple 2D entities containing lines, circles and arcs only. TLO 3.3 Draw the orthographic views from given pictorial views. TLO 3.4 Use of IS code IS SP-46 for dimensioning technique.	**Unit - III Orthographic Projections** 3.1 Introduction of projections-orthographic, perspective, isometric and oblique: concept and applications.(No question to be asked in examination) 3.2 Introduction to orthographic projection, First angle and Third angle method, their symbols. Conversion of pictorial view into Orthographic Views – object containing plain surfaces, slanting surfaces, slots, ribs, cylindrical surfaces. (use First Angle Pr	Model Demonstration Video Demonstrations
4	TLO 4.1 Prepare isometric scale. TLO 4.2 Draw isometric views of simple 2D entities containing lines, circles and arcs only. TLO 4.3 Interpret the given orthographic views. TLO 4.4 Draw Isometric views from given orthographic views	**Unit - IV Isometric Projections** 4.1 Introduction to Isometric projection. 4.2 Isometric scale and Natural Scale. 4.3 Isometric view and isometric projection. 4.4 Ilustrative problems related to simple objects having plain, slanting, cylindrical surfaces and slots on slanting surfaces. 4.5 Conversion of orthographic views into isometric View/projection. (For branches other than mechanical Engineering, the teacher should select branch specific elements)	Model Demonstration Video Demonstrations
5	TLO 5.1 Sketch proportionate freehand sketches of given machine elements. TLO 5.2 Select proper fasteners and locking arrangement.	**Unit - V Free Hand Sketches of Engineering Elements** 5.1 5.1 Free hand sketches of machine elements: Thread profiles, nuts, bolts, studs, set screws, washers, Locking arrangements. (For branches other than mechanical Engineering, the teacher should select branch specific elements for free hand sketching)	Model Demonstration

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Use of drawing instruments	1	Draw horizontal, vertical, 30 degree, 45 degree, 60 & 75 degrees lines using Tee and Set squares/ drafter. (Sketch Book).	2	CO1
LLO 2.1 Use of IS code related to dimensioning standard	2	Draw different types of lines, dimensioning styles (Sketch Book)	2	CO1
LLO 3.1 Practice of drawing as per given sketch	3	Draw one figure showing dimensioning techniques, two problems on redraw the figures and one problem on loci of points - slider crank mechanism. (Sketch Book)	2	CO1
LLO 4.1 Use IS Standard for drawing different figures	4	Draw one figure showing dimensioning techniques, two problems on redraw the figures and one problem on loci of points - slider crank mechanism. (01 Sheet)	4	CO1
LLO 5.1 Identify different Engineering curves	5	Draw any four Engineering Curves (Sketchbook)	2	CO1
LLO 6.1 Identify different Engineering curves	6	Draw any four Engineering Curves – (01 Sheet)	4	CO1

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 7.1 Apply method of projection for drawing simple orthographic views	7	Draw two problems on orthographic projections using first angle method of projection having plain surfaces, slanting surfaces and slots etc.- (Sketchbook)	2	CO2 CO4
LLO 8.1 Apply method of projection for drawing simple orthographic views	8	Draw two problems on orthographic projections using first angle method of projection having plain surfaces, slanting surfaces and slots etc.- (01 Sheet)	4	CO2 CO4
LLO 9.1 Apply method of projection for drawing complex orthographic views	9	Draw two problems on orthographic projections using first angle method of projection having cylindrical surfaces, ribs etc. (Sketchbook)	2	CO2 CO4
LLO 10.1 Apply method of projection for drawing complex orthographic views	10	Draw two problems on orthographic projections using first angle method of projection having cylindrical surfaces, ribs etc.- (01 Sheet)	4	CO2 CO4
LLO 11.1 Draw simple isometric projections	11	Draw two problems on Isometric view of simple objects having plain and slanting surfaces by using natural scale. (Sketchbook)	2	CO3 CO4
LLO 12.1 Apply different scales for drawing isometric projections.	12	Draw two problems on Isometric view of simple objects having plain and slanting surfaces by using natural scale. (01 sheet)	4	CO3 CO4
LLO 13.1 Draw simple isometric projections	13	Draw two problems on Isometric Projection of objects having cylindrical surfaces and slots on slanting surfaces by using isometric scale.(Sketchbook)	2	CO3 CO4
LLO 14.1 Apply different scales for drawing isometric projections	14	Draw two problems on Isometric Projection of objects having cylindrical surfaces and slots on slanting surfaces by using isometric scale. (01 sheet)	4	CO3 CO4
LLO 15.1 Draw Orthographic views of a given object.	15	Problem Based Learning: Given the orthographic views of at least three objects with few missing lines, the student will try to imagine the corresponding objects, complete the views and draw these views (sketch book).	2	CO2 CO4
LLO 16.1 Draw standard discipline oriented components using free hand .	16	Draw freehand Sketches of 12 different standard components (Sketch book)	2	CO5
LLO 17.1 Draw standard discipline oriented components using free hand .	17	Draw freehand Sketches of 12 different standard components (1 Sheet)	2	CO5
LLO 18.1 Collect information of an ancient Indian culture related to engineering graphics	18	Correlate ancient Indian sculptures, Indian temples, Monuments, etc. with Engineering Graphics	2	CO1 CO2 CO3 CO4 CO5

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

-

- not Applicable

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Drawing Table with Drawing Board of Full Imperial/ A1 size.	All
2	Models of objects for orthographic / isometric projections	7,8,9,10,11,12,13,14,15

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
3	Models/ Charts of objects mentioned in unit no. 5	16,17
4	Set of various industrial drawings being used by industries.	All
5	Set of drawings sheets mentioned in section 6.0 could be developed by experienced teachers and made used available on the MSBTE portal to be used as reference/standards.	All
6	Drawing equipment and instruments for class room teaching-large size: a. T-square or drafter (Drafting Machine). b. Set squires (450 and 300-600) c. Protector. d. Drawing instrument box (containing set of compasses and dividers). Drawing sheets, Drawing pencils, Eraser, Drawing pins / clips	All

IX. SUGGESTED FOR WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Basic Elements of Drawing	CO1	3	0	0	6	6
2	II	Engineering curves & Loci of Points.	CO1	6	0	0	6	6
3	III	Orthographic Projections	CO2,CO4	7	0	0	14	14
4	IV	Isometric Projections	CO3,CO4	8	0	0	14	14
5	V	Free Hand Sketches of Engineering Elements	CO4,CO5	6	0	0	10	10
Grand Total				**30**	**0**	**0**	**50**	**50**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Term work

Summative Assessment (Assessment of Learning)

- Practical

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	-	-	2	-	2	-			
CO2	3	-	-	2	-	2	-			
CO3	3	-	-	2	-	2	-			
CO4	3	-	-	2	-	2	-			
CO5	3	-	-	2	-	2	-			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher
1	Bureau of Indian Standards.	Engineering Drawing Practice for Schools and Colleges IS: SP-46	Third Reprint, October 1998 ISBN No. 81-7061-091-2
2	Bhatt, N.D.	Engineering Drawing	Charotar Publishing House, 2010 ISBN No. 978-93-80358-17-8
3	Bhatt, N.D.; Panchal, V. M	Machine Drawing	Charotar Publishing House, 2010 ISBN No. 978-93-80358-11-6
4	Jolhe, D.A.	Engineering Drawing	Tata McGraw Hill Edu. New Delhi, 2010, ISBN No. 978-0-07-064837-1
5	Dhawan, R. K.	Engineering Drawing	S. Chand and Company New Delhi, ISBN No. 81-219-1431-0
6	Pradhan, S.K Jain, K.K	Engineering Graphics	Khanna Book Publishing CO(P) LTD, New Delhi, ISBN No. 978-93-91505-50-9

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=dmt6_n7Sgcg	Free Hand Sketches
2	https://www.youtube.com/watch?v=_MQScnLXL0M	Orthographic Projection
3	https://www.youtube.com/watch?v=3WXPanCq9LI	Basics of Projection
4	https://www.youtube.com/watch?v=fvjk7PlxAuo	Introduction to Engineering Graphics
5	https://www.youtube.com/watch?v=8j7l1OWhMlE	Isometric Projection

Programme Name/s : Architecture Assistantship/ Automobile Engineering./ Artificial Intelligence/ Agricultural Engineering/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Architecture/ Cloud Computing and Bi Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Fashion & Clothing Te Dress Designing & Garment Manufacturing/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical Power System/ Electronics & Communication Engg./ Electr Food Technology/ Computer Hardware & Maintenance/ Instrumentation & Control/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Instrumentation/ Interior Design & Dec Interior Design/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Medical Laboratory Technology/ Medical Electronics/ Production Engineering/ Printing Technology/ Polymer Technology/ Surface Coating Technology/ Textile Technology/ Electronics & Computer Engg./ Travel and Tourism/ Textile Manufactures

Programme: Code : AA/AE/AI/AL/AN/AO/AT/BD/CE/CH/CM/CO/CR/CS/CW/DC/DD/DE/DS/EE/EJ/EP/ET/EX/FC/HA/IC/IE/IF/I

Semester : First

Course Title : COMMUNICATION SKILLS (ENGLISH)

Course Code : 311303

I. RATIONALE

The most commonly used medium to express oneself is language. English being a global language is used in all spheres of human life i.e. personal, professional and social. English Language proficiency focuses on strong reading, writing, speaking and listening skills. It will include grammar, vocabulary, comprehension and describing skills to enhance overall language proficiency. English for professional purposes aim to equip the students with necessary language skills required for Public Speaking, presentation and negotiation. English for academic purposes will include academic writing skills and critical thinking considering the need of students to communicate in engineering domain.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to achieve the following industry identified outcome through various learning experiences: "Communicate in written and oral form of English effectively at workplace".

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Construct grammatically correct sentences in English.
- CO2 - Comprehend passages correctly.
- CO3 - Compose paragraphs and dialogues on given situations
- CO4 - Use contextual words in English appropriately
- CO5 - Deliver effective presentations in English using appropriate body language

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TSL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
311303	COMMUNICATION SKILLS (ENGLISH)	ENG	AEC	3	-	2	1	6	3	3	30	70	100	40	25	10	-	-	25	10	150

IKS Content : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Use transcription to pronounce words correctly. TLO 1.2 Use prefix and suffix for flexibility and precision in language TLO 1.3 Employ synonyms and antonyms to express similarity and contrast between words. TLO 1.4 Use Homophones to expand their vocabulary TLO 1.5 Make use of the collocations correctly	**Unit - I Vocabulary** 1.1 Phonetics :Vowels(12) Consonants (24) Diphthongs (8) 1.2 Prefix & Suffix : . Definition & Examples , List of common prefixes and suffixes 1.3 Synonyms & Antonyms : Vocabulary expansion , Context & Usage 1.4 Homophones : Identifying Homophones , Meaning & Context , Vocabulary Expansion 1.5 Collocations : Definition & identification , Types of collocations	Language Lab Drill Classroom learning Reference Books NPTEL
2	TLO 2.1 Formulate paragraphs with synchronized sentence structure on the given situation / topic TLO 2.2 Develop dialogues to practice language skill in a structured and meaningful way.	**Unit - II Paragraph and Dialogue Writing** 2.1 Types of paragraphs: Technical , Descriptive , Narrative 2.2 Dialogue Writing: i Greetings ii. Development iii. Closing Sentence	Classroom learning Skit Language Lab YouTube videos
3	TLO 3.1 Respond to the given questions of the specified passage. TLO 3.2 Formulate sentences using new words TLO 3.3 Use correct syntax to construct meaningful sentences for the given situation. TLO 3.4 Respond to the questions on the given seen & unseen passages.	**Unit - III Comprehension (Seen and Unseen Passages)** 3.1 1 Passages from MSBTE workbook 1.Say No to Plastic bags 2.Interview of Dr. APJ Abdul Kalam 3.Maximum Achievements 4.Be Remarkable 5.Arunima Sinha: A Biography 6.Roses of Gratitude 3.2 Importance of Comprehension 3.3 Unseen Passages 3.4 Interpretation of passages in written and Spoken form	Classroom learning interactive session Discussion
4	TLO 4.1 Describe technical objects with specifications TLO 4.2 Explain the given picture in grammatically correct language. TLO 4.3 Diary Entry on situations TLO 4.4 Translate from English to Marathi/Hindi- vice versa	**Unit - IV Communicative Language** 4.1 Technical objects : i. Heading ii. Description of technical objects 4.2 Picture Description : i. Situational picture ii. Describe in your own words 4.3 Diary Entry : i. Date ii. Content iii. Name of the writer 4.4 Translation of paragraph from English to Marathi/Hindi-Vice versa (Question not to be asked on Translation in Theory Examination)	Language Lab Pictures on situations Classroom learning

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Cultivate/Develop habit of being presentable TLO 5.2 Formulate speeches for occasions TLO 5.3 Prepare power point presentation TLO 5.4 Use appropriate body language for effective communication	**Unit - V Presentation Skills** 5.1 Dressing & Grooming : i. Dressing for the occasion ii. Proper grooming 5.2 Speech Writing : i. Situation ii. Salutations iii. Introduction of the topic iv. Description/Body v. Conclusion 5.3 Power Point Presentation : i. Layout ii. Font size iii. Color combination 5.4 Kinesics : i. Facial expressions ii Eye contact iii Postures iv Gestures	Classroom learning Language Lab

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Use transcription in correct form LLO 1.2 Learn to differentiate vowel, diphthong and consonants	1	Write 20 words using phonetic transcription	2	CO1
LLO 2.1 Learn correct pronunciation by using headphones in language lab	2	Practice pronunciation as per IPA using language lab	2	CO1
LLO 3.1 Enhance the understanding of word formation LLO 3.2 Enrich word power LLO 3.3 Construct words with the specific meanings	3	Formulate 20 words using Prefix and Suffix	2	CO1
LLO 4.1 Use words and phrases effectively LLO 4.2 Enrich vocabulary LLO 4.3 Develop overall language skills	4	Construct sentences using 20 collocations	2	CO1
LLO 5.1 Articulate ideas clearly and effectively LLO 5.2 Improve grammar, punctuation	5	Write two paragraphs of 75 words each	2	CO3
LLO 6.1 Add depth to narratives LLO 6.2 Form grammatically correct sentences	6	Compose situational dialogues (Any Two)	2	CO3
LLO 7.1 Promote the development of effective communication skills LLO 7.2 .Improve non -verbal communication Skills LLO 7.3 Enhance interpersonal skills LLO 7.4 Build confidence	7	Enact Role Plays as per situation and context	2	CO5
LLO 8.1 Acquire the ability to convey complex ideas in clear and concise manner LLO 8.2 Expand technical vocabulary LLO 8.3 Enhance the written communication Skills	8	Describe any three technical objects using correct grammar	2	CO1 CO3
LLO 9.1 Develop skills in story telling LLO 9.2 Connect with the audience	9	Narrate anecdotes of various situations in English	2	CO5
LLO 10.1 Notice and articulate specific elements, colors, shapes, & other visual aids LLO 10.2 Express observations & interpretations clearly and concisely LLO 10.3 Enhance vocabulary	10	Describe a given picture (Any Two)	2	CO1 CO4
LLO 11.1 Express information in coherent and engaging manner LLO 11.2 Build confidence	11	Introduce oneself and others	2	CO5
LLO 12.1 Present complex information in a clear & concise manner LLO 12.2 Develop public speaking skills and presentation skills	12	Prepare a Power point presentation on a given topic	2	CO5
LLO 13.1 Improve language skills &expand vocabulary	13	Translate paragraph --English to Marathi/Hindi (vice -Versa) (Any4)	2	CO1 CO3
LLO 14.1 Reflect on thoughts, feelings, and experiences	14	Write your experience in 50 words on (Four) given situations (Diary Entry)	2	CO3 CO5
LLO 15.1 Develop language acquisition	15	Respond to the questions based on the given passages	2	CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 16.1 Build confidence in public speaking LLO 16.2 Enhance the skills in planning and prioritization	16	Deliver oral presentations using correct grammar and appropriate body language	2	CO5
Note : Any 12 out of 16 practicals are compulsory				

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Report different types of episodes/anecdotes
- Seminar preparation and presentations
- Make a Podcast episode based on Indian Freedom Fighters
- Summarize the editorial columns of English newspapers
- Summarize the content of an Eminent person’s biography / autobiography
- Write a review on the following: Short stories ,Novels ,Films.
- Prepare a booklet on the contribution of eminent Indian scientists
- Prepare a podcast referring ancient literature.
- Prepare blogs, podcast, vlogs
- Prepare a questionnaire & conduct the interview of Industry Personnel, social worker, entrepreneur
- Prepare and participate in debates and extempore speeches

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Language Lab with relevant software and Computer system with all necessary components like; motherboard, random access memory (RAM), read-only memory (ROM), Graphics cards, sound cards, internal hard disk drives, DVD drive, network interface card	All
2	LCD Projector with document reader	All
3	Smart Board with networking	All

IX. SUGGESTED FOR WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Vocabulary	CO1	10	2	4	6	12
2	II	Paragraph and Dialogue Writing	CO2	6	2	4	6	12
3	III	Comprehension (Seen and Unseen Passages)	CO3	16	5	6	13	24
4	IV	Communicative Language	CO4	7	2	4	8	14
5	V	Presentation Skills	CO5	6	2	2	4	8
Grand Total				**45**	**13**	**20**	**37**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- -

Summative Assessment (Assessment of Learning)

- -

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	1	1				2	1			
CO2	1	1				2	1			
CO3	1	1				2	1			
CO4	1	1				2	1			
CO5	1	1				2	1			
Legends :- High:03, Medium:02,Low:01, No Mapping: - *PSOs are to be formulated at institute level										

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher
1	MSBTE	Spectrum, G Scheme and I- Scheme	MSBTE
2	Kumar, E. Suresh, Sreehari, P Savitri	Effective English with CD	Pearson Education
3	Gnanamurli	English Grammar at a Glance	S. Chand
4	CBSE	English Communicative (class X)	Golden
5	Dr. Anjana Tiwari	Communication Skills in English	Khanna Publishers, New Delhi

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.britishcouncil.in/english/learn-online	Website link is given to refer Unit 1
2	Vocabulary.com	Refer this website for interactive vocabulary quizzes, word lists
3	International Phonetic Association (IPA) Website	It offers audio examples and charts to help understand and transcribe sounds
4	grammarly.com/blog	For constructing effective paragraphs and improving clarity
5	www.newagegolden.com	Refer this website for speech writing, diary entry and paragraph writing

Programme Name/s	**: Automobile Engineering./ Chemical Engineering/ Electrical Engineering/ Electrical Power System/ Food Technology/ Mechanical Engineering/ Mechatronics/ Production Engineering/ Printing Technology/ Polymer Technology**
Programme Code	**: AE/CH/EE/EP/FC/ME/MK/PG/PN/PO**
Semester	**: First**
Course Title	**: ENGINEERING WORKSHOP PRACTICES (Mechanical, Electrical and allied branches)**
Course Code	**: 311005**

I. RATIONALE

Workshop Practice is a basic engineering course. The knowledge of basic shops like wood working, fitting, welding, plumbing and sheet metal shop is essential for technician to perform his/her duties in industries. Students are able to perform various operations using hand tool equipment and machineries in various shops. Working in workshop develops the attitude of group working and safety awareness. This course provides industrial environment in the educational institute.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Use different engineering tools for performing shop floor activities.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Use firefighting tools and equipment.
- CO2 - Prepare job using different tools in fitting shop.
- CO3 - Perform various operations using plumbing and carpentry tools.
- CO4 - Prepare various welding joints.
- CO5 - Produce simple job using different sheet metal operations.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TSL				Based on SL		Total Marks
															Practical							
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
311005	ENGINEERING WORKSHOP PRACTICES (Mechanical, Electrical and allied branches)	EWP	SEC	-	-	4	-	4	2		-	-	-	-	50	20	50@	20	-	-	100

IKS Content : 2 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Follow safety practices TLO 1.2 Explain the different types of fire extinguisher and their uses TLO 1.3 Use firefighting equipment TLO 1.4 Locate various machines and equipment in workshop TLO 1.5 Follow good housekeeping	**Unit - I General Workshop Practice** 1.1 Safety Practices, Causes of accidents, General safety rules, Safety signs and symbols 1.2 First Aid 1.3 Fire, Causes of Fire, Basic ways of extinguishing the fire,Classification of fire, Class A,B,C,D, Firefighting equipment, fire extinguishers, and their types . 1.4 Workshop Layout 1.5 Issue and return system of tools, equipment and consumables	Demonstration Collaborative learning Role Play
2	TLO 2.1 Identify fitting tools TLO 2.2 Explain operation of fitting shop machines TLO 2.3 Use fitting tools TLO 2.4 Operate machineries. TLO 2.5 Perform fitting operations TLO 2.6 Maintain tools, equipment and machineries.	**Unit - II Fitting** 2.1 Fitting hand tools bench vice, hammers, chisels, files, hacksaw, surface plate, punch, v block, angle plate, try square, marking block , steel rule, twist drills, reamers, tap set, die set and their Specifications 2.2 Operation of fitting shops machineries - Drilling machine, Power saw, grinder their specifications and maintenance. 2.3 Basic process chipping, filling, scraping, grinding, marking, sawing, drilling, tapping, dieing, reaming etc.	Model Demonstration
3	TLO 3.1 Identify plumbing tools. TLO 3.2 Explain operation of fitting shop machines. TLO 3.3 Use plumbing tools TLO 3.4 Operate machineries. TLO 3.5 Perform plumbing operations TLO 3.6 Maintain tools, equipment and machineries.	**Unit - III Plumbing** 3.1 Plumbing hand tools pipe vice, pipe bending equipment, pipe wrenches, dies and their Specifications 3.2 Pipe fittings- bends, elbows, tees, cross, coupler, socket, reducer, cap, plug, nipple and their Specifications 3.3 Operation of Machineries in plumbing shops- pipe bending machine their specifications and maintenance. Basic process cutting, threading.	Model Demonstration

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Identify metal joining tools. TLO 4.2 Explain gas and arc welding procedure TLO 4.3 Use metal joining tools. TLO 4.4 Perform welding, soldering, brazing operations TLO 4.5 Maintain tools, equipment and machineries.	**Unit - IV Metal Joining** 4.1 Gas welding hand tools- welding torch, welding tip, pressure regulator, oxygen and acetylene cylinders, spark lighter and their Specifications 4.2 Arc welding hand tools- electrode holder, cable connector, cable lugs, chipping hammer, earthing clamp, wire brush and their Specifications 4.3 Operation of machineries in welding shops- arc welding transformer their specifications and maintenance. 4.4 Welding Electrode, filler rod, fluxes, and solders. 4.5 Basic process welding, brazing and soldering.	Video Demonstrations Demonstration
5	TLO 5.1 Select wood working tools as per job/ requirement. TLO 5.2 Explain operation of wood working machines TLO 5.3 Use furniture making tools TLO 5.4 Operate machineries. TLO 5.5 Perform wood working operations TLO 5.6 Maintain tools, equipment and machineries.	**Unit - V Carpentry** 5.1 Types of artificial woods such as plywood, block board, hardboard, laminated boards, Veneer, fiber Boards and their applications. 5.2 Wood working hand tools carpentry vice, marking and measuring tools, saws, claw hammer, mallet, chisels, plans, squares, and their specifications 5.3 Operation of wood working machineries - Wood turning lathe, circular saw, their specifications and maintenance. 5.4 Basic process- marking, sawing, planning, chiseling, turning, grooving, boring.	Demonstration
6	TLO 6.1 Identify sheet metal tools. TLO 6.2 Explain operation of sheet metal machineries. TLO 6.3 Use sheet metal tools TLO 6.4 Operate sheet metal machineries. TLO 6.5 6.5 Perform bending operations Maintain tools, equipment and machineries.	**Unit - VI Sheet Metal** 6.1 Sheet metal hand tools snip, shears sheet gauge, straight edge, L square, scriber, divider, trammel, punches, pliers, stakes, groovers, limit set and their Specifications 6.2 Operation of machineries in sheet metal shops- sheet cutting and bending machine their specifications and maintenance. Basic process- marking, bending, folding, edging, seaming, staking, riveting.	Demonstration

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Use fire extinguisher	1	Identify fire extinguisher according to their specification.	2	CO1
LLO 2.1 Operate fire extinguisher	2	Perform mock drill session in group of minimum 10 students for extinguishing fire.	2	CO1
LLO 3.1 Identify different tools used in workshop.	3	Identify different tools used in workshop.	2	CO1 CO2 CO3 CO4 CO5

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 4.1 Select proper fitting tools LLO 4.2 Prepare fitting job using different tools.	4	Prepare job using following operations:part1 a. Marking operation as per drawing b. punching operation as per drawing c. Filing operation as per drawing d. sawing operation as per drawing e. drilling operation as per drawing f. tapping operation as per drawing	6	CO2
LLO 5.1 Select proper plumbing tools LLO 5.2 Use plumbing operations for preparing plumbing joints	5	Prepare T joint pipe fitting job as per given drawing (individually)	4	CO3
LLO 6.1 Select proper plumbing tools LLO 6.2 Use plumbing operations for preparing plumbing joints	6	Prepare elbow joint pipe fitting job as per given drawing(individually)	4	CO3
LLO 7.1 Develop list of different components as per the specification.	7	Prepare bill of material for given pipeline layout (individually)	2	CO3
LLO 8.1 Obey safety rules employed in welding shop.	8	Practice different safety rules in welding shop as per given instruction.	2	CO4
LLO 9.1 Prepare various welded joints using different welding processes.	9	Prepare lap joint using gas welding as per given drawing (individually)	4	CO4
LLO 10.1 Prepare various welded joints using different welding processes.	10	Prepare butt joint using gas welding as per given drawing (individually)	4	CO4
LLO 11.1 Assemble utility jobs using different manufacturing processes.	11	Prepare utility job (like stool, benches, tables or similar jobs) involving arc welding and artificial wood as per given drawing (in group of 4 to 5 students) Fabrication operation involve measuring, marking, cutting, edge preparation, welding	8	CO3 CO4
LLO 12.1 Select proper sheet metal tools LLO 12.2 Prepare sheet metal component using different operations.	12	Prepare sheet metal utility job using following operations a. Cutting And Bending b. Edging c. End curling d. Lancing e. Soldering f. Riveting	6	CO5
LLO 13.1 Collect information about ancient tools for understanding Indian Knowledge.	13	Draw sketches of various ancient tools	2	CO1 CO2 CO3 CO4 CO5

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING) : NOT APPLICABLE

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Fire buckets of standard size.	1,2
2	Fire extinguisher A,B and C types	1,2

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
3	Wood Turning Lathe Machine, Height of Centre: 200mm, Distance between Centers: 1200mm, Spindle Bore: 20mm with Taper, Range of Speeds: 425 to 2800 with suitable Motor Drive. with all accessories	11
4	Circular Saw Machine, Diameter of saw blade 200 mm, Maximum Depth of Cut 50 mm, Table Size -350 x 450 mm, Table Tilting - 450	11
5	Wood working tools- marking and measuring tools, saws, claw hammer, mallet, chisels, plans, squares	11
6	Carpentry Vice 200 mm	11
7	Work Benches- size:1800 x 900 x 750 mm	4
8	Bench Drilling machine (upto 13 mm drill cap.) with ½ H.P. Motor, 1000 mm height.	4
9	Power Saw machine 350 mm mechanical with 1 HP Motor & all Accessories.	4
10	Bench Grinder 200 mm Grinding Disc diameter 200 mm. with 25 mm. bore 32 mm. with ½ HP/1HP Motor.	4
11	Vernier height Gauge 450 mm	4,5,6,8
12	Surface Plate 600 x 900 mm Grade I	4,5
13	Angle Plate 450 x 450 mm	4,5
14	Welding machine 20 KVA 400A welding current 300A at 50, 100, 200, 250, 300 with std. Accessories and Welding Cable 400 amp. ISI with holder	8,9,10,11
15	Oxygen and acetylene gas welding and cutting kit with cylinders and regulators.	8,9,10,11
16	Pipe Bending Machine	5,6
17	Pipe Vice – 100 mm	5,6
18	Pipe Cutter- 50 mm	5,6
19	Bench Vice 100 mm	5,6
20	Portable Hammer Drill Machine 0-13 mm A.C. 230 V, 2.5Amp, Pistol type, having different types of bits	4
21	Sheet Bending Machine	12
22	Sheet Cutting Machine	12
23	Brazing Equipment	12
24	Fitting tools - hammers, chisels, files, hacksaw, surface plate, punch, v block, angle plate, try square, marking block, steel rule, twist drills, reamers, tap set, die set.	3,4
25	Plumbing tools- pipe vice, pipe bending equipment, pipe wrenches, dies.	3,5,6
26	Gas welding hand tools- welding torch, welding tip, pressure regulator, oxygen and acetylene cylinders, spark lighter	8,9,10,11
27	Arc welding hand tools- electrode holder, cable connector, cable lugs, chipping hammer, earthing clamp, wire brush.	8,9,10,11
28	Sheet metal hand tools- snip, shears sheet gauge, straight edge, L square, scriber, divider, trammel, punches, pliers, stakes, groovers, limit set	12

IX. SUGGESTED FOR WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table) : NOT APPLICABLE

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Assignment and Terms work

Summative Assessment (Assessment of Learning)

- Lab performance

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	-	-	2	3	3	1			
CO2	3	-	-	3	2	3	-			
CO3	3	-	-	3	2	3	1			
CO4	3	-	-	3	2	3	1			
CO5	3	-	-	3	2	3	1			
Legends :- High:03, Medium:02,Low:01, No Mapping: - *PSOs are to be formulated at institute level										

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher
1	Bawa, H.S.	Workshop Practice	McGraw Hill Education, Noida; ISBN-10: 0070671192 ISBN-13: 978-0070671195
2	Gupta, J.K.; Khurmi, R.S.	A Textbook of Manufacturing Process (Workshop Tech.)	S.Chand and Co. New Delhi ISBN:81-219-3092-8
3	Hegde, R.K.	Workshop Practice Manual For Engineering Diploma & ITI Students	Sapna Book House, 2012, ISBN:13: 9798128005830
4	Singh, Rajender	Introduction to Basic Manufacturing Process & Workshop Technology	New Age International, New Delhi; 2014, ISBN: 978-81-224-3070-7
5	Hajra; Choudhary	Elements of Workshop Technology	Media Promoters and Publishers Mumbai, 2009, ISBN: 10-8185099146
6	Sarathe, A.K	Engineering Workshop Practice	Khanna Book Publishing CO(P) LTD, New Delhi, ISBN No. 978-93-91505-51-6

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	http://www.asnu.com.au	Basic engineering tools.
2	http://www.abmtools.com/downloads/Woodworking%20Carpentry%20Tools.pdf	Wood working
3	http://www.weldingtechnology.org	Welding techniques
4	http://www.newagepublishers.com/samplechapter/001469.pdf	Basic engineering tools.
5	http://www.youtube.com/watch?v=TeBX6cKKHWY	Welding techniques
6	http://www.youtube.com/watch?v=QHF0sNHnttw&feature=related	Welding techniques
7	http://www.youtube.com/watch?v=Kv1zo9CAxt4&feature=relmfu	Wood working
8	http://www.piehtoolco.com	Basic engineering tools.
9	http://sourcing.indiamart.com/engineering/articles/materials-used-hand-tools/	Basic engineering tools.
10	https://www.youtube.com/watch?v=9_cnkaAbtCM	Basic engineering tools.

Programme Name/s : Architecture Assistantship/ Automobile Engineering./ Artificial Intelligence/ Agricultural Engineering/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Architecture/ Cloud Computing and Bi Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Fashion & Clothing Te Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Food Technology/ Computer Hardware & Maintenance/ Hotel Management & Catering Technology/ Instrumentation & Control/ I Information Technology/ Computer Science & Information Technology/ Instrumentation/ Interior Design & Dec Interior Design/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Medical Laboratory Technology/ Medical Electronics/ Production Engineering/ Printing Technology/ Polymer Technology/ Surface Coating Technology/ Textile Technology/ Electronics & Computer Engg./ Travel and Tourism/ Textile Manufactures

Programme: Code : AA/AE/AI/AL/AN/AO/AT/BD/CE/CH/CM/CO/CR/CS/CW/DC/DE/DS/EE/EJ/EP/ET/EX/FC/HA/HM/IC/IE/IF/

Semester : First

Course Title : FUNDAMENTALS OF ICT

Course Code : 311001

I. RATIONALE

In any typical business setup in order to carry out routine tasks related to create business documents, perform data analysis and its graphical representations and making electronic slide show presentations, the student need to learn various software as office automation tools like word processing applications, spreadsheets and presentation tools. They also need to use these tools for making their project reports and presentations. The objective of this course is to develop the basic competency in students for using these office automation tools to accomplish the job. This course also presents an overview of emerging technologies so that students of different discipline can appraise the applications of these technologies in their respective domain.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry identified outcome through various teaching learning experiences: 1) Use computers for Internet services, Electronics Documentation, Data Analysis and Slide Presentation. 2) Appraise Application of ICT based Emerging Technologies.in different domain.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Use computer system and its peripherals for given purpose
- CO2 - Prepare Business document using Word Processing Tool
- CO3 - Analyze Data and represent it graphically using Spreadsheet
- CO4 - Prepare professional Slide Show presentations
- CO5 - Use different types of Web Browsers and Apps
- CO6 - Explain concept and applications of Emerging Technologies

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TSL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
311001	FUNDAMENTALS OF ICT	ICT	SEC	1	-	2	1	4	2		-	-	-	-	25	10	25@	10	25	10	75

IKS Content : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Explain the functions of components in the block diagram of computer system. TLO 1.2 Classify the given type of software TLO 1.3 Explain characteristics of the given type of network TLO 1.4 Describe application of the given type of network connecting device TLO 1.5 Describe procedure to manage a file /folder in the given way.	**Unit - I Introduction to Computer System** 1.1 Basics of Computer System: Overview of Hardware and Software: block diagram of Computer System, Input/Output unit CPU, Control Unit, Arithmetic logic Unit (ALU), Memory Unit 1.2 Internal components: processor, motherboards, random access memory (RAM), read-only memory (ROM), video cards, sound cards and internal hard disk drives) 1.3 External Devices: Types of input/output devices, types of monitors, keyboards, mouse, printers: Dot matrix, Inkjet and LaserJet, plotter and scanner, external storage devices CD/DVD, Hard disk and pen drive 1.4 Application Software: word processing, spreadsheet, database management systems, control software, measuring software, photo-editing software, video-editing software, graphics manipulation software System Software compilers, linkers, device drivers, oper 1.5 Network environments: network interface cards, hubs, switches, routers and modems, concept of LAN, MAN, WAN, WLAN, Wi-Fi and Bluetooth 1.6 Working with Operating Systems: Create and manage file and folders, Copy a file, renaming and deleting of files and folders, Searching files and folders, application installation, creating shortcut of application on the desktop.	Hands-on Demonstration Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Write steps to create the given text document. TLO 2.2 Explain the given feature for document editing. TLO 2.3 Explain the given page setup features of a document. TLO 2.4 Write the given table formatting feature. TLO 2.5 Write the steps to set the given type of document layout	**Unit - II Word Processing** 2.1 Word Processing: Overview of Word processor Basics of Font type, size, colour, Effects like Bold, italic, underline, Subscript and superscript, Case changing options, Previewing a document, Saving a document, Closing a document and exiting application. 2.2 Editing a Document: Navigate through a document, Scroll through text, Insert and delete text, Select text, Undo and redo commands, Use drag and drop to move text, Copy, cut and paste, Use the clipboard, Clear formatting, Format and align text, Formatting 2.3 Changing the Layout of a Document: Adjust page margins, Change page orientation, Create headers and footers, Set and change indentations, Insert and clear tabs 2.4 Inserting Elements to Word Documents: Insert and delete a page break, Insert page numbers, Insert the date and time, Insert special characters (symbols), Insert a picture from a file, Resize and reposition a picture 2.5 Working with Tables: Insert a table, Convert a table to text, Navigate and select text in a table, Resize table cells, Align text in a table, Format a table, Insert and delete columns and rows, Borders and shading, Repeat table headings on subsequent page 2.6 Working with Columned Layouts and Section Breaks: a Columns, Section breaks, Creating columns, Newsletter style columns, Changing part of a document layout or formatting, Remove section break, Add columns to remainder of a document, Column widths, Adjust	Hands-on Demonstration Presentations
3	TLO 3.1 Write steps to create the given spreadsheet. TLO 3.2 Explain the given formatting feature of a worksheet. TLO 3.3 Write steps to insert formula and functions in the given worksheet. TLO 3.4 Write steps to create charts for the given data set. TLO 3.5 Explain steps to perform data filter, sort and validation operations on the given data set. TLO 3.6 Write steps to setup and print a spreadsheet.	**Unit - III Spreadsheets** 3.1 Working with Spreadsheets: Overview of workbook and worksheet, Create Worksheet Entering sample data, Save, Copy Worksheet, Delete Worksheet, Close and open Workbook. 3.2 Editing Worksheet: Insert and select data, adjust row height and column width, delete, move data, insert rows and columns, Copy and Paste, Find and Replace, Spell Check, Zoom In-Out, Special Symbols, Insert Comments, Add Text Box, Undo Changes, - Freeze 3.3 Formatting Cells and sheet: Setting Cell Type, Setting Fonts, Text options, Rotate Cells, Setting Colors, Text Alignments, Merge and Wrap, apply Borders and Shades, Sheet Options, Adjust Margins, Page Orientation, Header and Footer, Insert Page Breaks, S 3.4 Working with Formula: Creating Formulas, Copying Formulas, Common spreadsheet Functions such as sum, average, min, max, date, In, And, or, mathematical functions such as sqrt, power, applying conditions using IF. 3.5 Working with Charts: Introduction to charts, overview of different types of charts, Bar, Pie, Line charts, creating and editing charts. Using chart options: chart title, axis title, legend, data labels, Axes, grid lines, moving chart in a separate sheet. 3.6 Advanced Operations: Conditional Formatting, Data Filtering, Data Sorting, Using Ranges, Data Validation, Adding Graphics, Printing Worksheets, print area, margins, header, footer and other page setup options.	Hands-on Demonstration Presentations
4	TLO 4.1 Write the steps to create the given slide presentation. TLO 4.2 Write the steps to insert multiple media in the given presentation. TLO 4.3 Explain the method of including animation, transition effects in slide show. TLO 4.4 Write steps to apply table features in the given presentation TLO 4.5 Write steps to manage charts in the given presentation	**Unit - IV Presentation Tool** 4.1 Creating a Presentation: Outline of an effective presentation, Identify the elements of the User Interface, Starting a New Presentation Files, Creating a Basic Presentation, Working with textboxes, Apply Character Formats, Format Paragraphs, View a Prese 4.2 Inserting Media elements: Adding and Modifying Graphical Objects to a Presentation - Insert Images into a Presentation, insert audio clips, video/animation, Add Shapes, Add Visual Styles to Text in a Presentation, Edit Graphical Objects on a Slide, Format 4.3 Working with Tables: Insert a Table in a Slide, Format Tables, and Import Tables from Other Office Applications. 4.4 Working with Charts: Insert Charts in a Slide, Modify a Chart, Import Charts from Other Office Applications.	Hands-on Demonstration Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Explain use of the given setting option in browsers. TLO 5.2 Explain the given option used for effective searching in search engine TLO 5.3 Explain features of the given web service. TLO 5.4 Explain concepts and applications of emerging technologies TLO 5.5 Use various elementary cloud-based tools.	**Unit - V Basics of Internet and Emerging Technologies** 5.1 World Wide Web: Introduction, Internet, Intranet, Cloud, Web Sites, web pages, URL, web servers, basic settings of web browsers-history, extension, default page, default search engine, creating and retrieving bookmarks, use search engines effectively for 5.2 Web Services: e-Mail, Chat, Video Conferencing, e-learning, e-shopping, e-Reservation, e-Groups, Social Networking 5.3 Emerging Technologies: IOT, AI and ML, Drone Technologies,3D Printing. 5.4 Tools: Docs, Drive, forms, quiz, Translate and other Apps	Hands-on Demonstration Presentations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify various Input/output devices, connections and peripherals of computer system LLO 1.2 Work with Computer System, Input/output devices, and peripherals for manages files and folders for data storage.	1	a) Work with Computer System, Input/output devices, and peripherals. b) Work with files and folders	2	CO1
LLO 2.1 Create and manage word document. LLO 2.2 Apply formatting features on text at line, paragraph and page level.	2	Work with document files: a) Create, edit and save document in Word Processing. b) Text, lines and paragraph level formatting	2	CO2
LLO 3.1 Insert and edit images, shapes in a document file	3	Work with Images and Shapes in Word Processing.	2	CO2
LLO 4.1 Insert table and apply various table formatting features on it.	4	Work with tables in Word Processing.	2	CO2
LLO 5.1 Apply page layout features in word processing. LLO 5.2 Print a document by applying various print options LLO 5.3 Use mail merge in word processing	5	Working with layout and printing a) Document page layout, Themes, and printing. b) Use of mail merge with options.	2	CO2
LLO 6.1 Enter and format data in a worksheet. LLO 6.2 Insert and delete cells, rows and columns LLO 6.3 Apply alignment feature on cell	6	Create, open and edit Worksheet.	2	CO3
LLO 7.1 Create formula and “If” condition on cell data LLO 7.2 Apply various functions and named ranges in worksheet.	7	Formulas and functions in Worksheet.	2	CO3
LLO 8.1 Implement data Sorting, Filtering and Data validation features in a worksheet.	8	Sort, Filter and validate data in Spreadsheet.	2	CO3
LLO 9.1 Create charts using various chart options in spreadsheet.	9	Charts for Visual Presentation in Spreadsheet.	2	CO3
LLO 10.1 Print the worksheet by applying various print options for worksheet	10	Worksheet Printing.	2	CO3
LLO 11.1 Apply design themes to the given presentation LLO 11.2 Insert pictures text/images/shapes in slide LLO 11.3 Use pictures text/images/shapes editing options.	11	Make Slide Show Presentation.	2	CO4
LLO 12.1 Add tables and charts in the slides. LLO 12.2 Run slide presentation in different modes LLO 12.3 Print slide presentation as handouts/notes	12	Use Tables and Charts in Slide	2	CO4
LLO 13.1 Apply animation effects to the text and slides LLO 13.2 Add/set audio and video files in the presentation.	13	a) Insert Animation effects to Text and Slides. b) Insert Audio and Video files in presentation	2	CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 14.1 Configure internet connection on a computer system LLO 14.2 Use different web services on internet	14	a) Internet connection configuration b) Use Internet and Web Services.	1	CO5
LLO 15.1 Configure different browser settings LLO 15.2 Use browsers for the given purpose	15	Working with Browsers.	1	CO5
LLO 16.1 Create web forms for survey using different options.	16	Prepare Web Forms for Survey.	1	CO5
LLO 17.1 Create web forms for Quiz using different options	17	Prepare Web Forms for Quiz	1	CO5

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Self Learning

- Following are some suggestive self-learning topics: 1) Use ChatGPT/any other AI tool to explore information. 2) Use Calendar to Schedule and edit activities. 3) Use Translate app to translate the given content from one language to another. 4) Use cloud based storage drive to store and share your files.

Assignment

- Prepare journal of practical performed in the laboratory.

Micro project

- The microproject has to be industry application based, internet-based, workshop-based, laboratory-based or field-based as suggested by Teacher. 1) Perform a survey on various input and output devices available in market and make its report. 2) Prepare Time Table, Prepare Notes on Technical Topics, Reports, Biodata with covering letter (Subject teacher shall assign a document to be prepared by each students) 3) Prepare slides with all Presentation features such as: classroom presentation, presentation about department, presentation of Technical Topics. (Subject teacher shall assign a presentation to be prepared by each student). 4) Student Marksheet, Prepare Pay bills, tax statement, student's assessment record using spreadsheet. (Teacher shall assign a spreadsheet to be prepared by each student). 5) Carry-out Survey on different web browsers. 6) Generate resume for different job profile, survey report of any industry using ChatGPT/any other AI tool.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	a) Computer System with all necessary Peripherals and Internet connectivity. b) Any Office Software c) Any Browser (Any General Purpose Computer available in the Institute)	All

IX. SUGGESTED FOR WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Introduction to Computer System	CO1	2	0	0	0	0
2	II	Word Processing	CO2	3	0	0	0	0
3	III	Spreadsheets	CO3	3	0	0	0	0
4	IV	Presentation Tool	CO4	4	0	0	0	0
5	V	Basics of Internet and Emerging Technologies	CO5,CO6	3	0	0	0	0
Grand Total				**15**	**0**	**0**	**0**	**0**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Lab performance, Assignment, Self-learning and Seminar/Presentation

Summative Assessment (Assessment of Learning)

- Lab. Performance, viva voce

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	1	-	-	-	-	-	1			
CO2	-	-	-	3	-	-	1			
CO3	-	2	1	3	-	-	1			
CO4	-	-	-	3	-	-	1			
CO5	1	-	-	3	-	-	3			
CO6	1	-	-	3	-	-	3			
Legends :- High:03, Medium:02,Low:01, No Mapping: - *PSOs are to be formulated at institute level										

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher
1	Goel, Anita	Computer Fundamentals	Pearson Education, New Delhi, 2014, ISBN-13: 978-8131733097
2	Miller, Michael	Computer Basics Absolute Beginner's Guide, Windows 10	QUE Publishing; 8th edition August 2015, ISBN: 978-0789754516
3	Alvaro, Felix	Linux: Easy Linux for Beginners	CreatevSpace Independent Publishing Platform-2016, ISBN-13: 978-1533683731
4	Johnson, Steve	Microsoft Office 2010: On Demand	Pearson Education, New Delhi India, 2010. ISBN :9788131770641
5	Schwartz, Steve	Microsoft Office 2010 for Windows: Visual Quick Start	Pearson Education, New Delhi India, 2012, ISBN : 9788131766613
6	Leete, Gurdy, Finkelstein Ellen, Mary Leete	OpenOffice.org for Dummies	Wiley Publishing, New Delhi, 2003 ISBN : 978-0764542220

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.microsoft.com/en-in/learning/office-training.aspx	Office
2	http://www.tutorialsforopenoffice.org/	Open Office
3	https://s3-ap-southeast-1.amazonaws.com/r4ltue295xy0d/Special_Edition_Using_StarOffice_6_0.pdf	Open Office
4	https://ashishmodi.weebly.com/uploads/1/8/9/7/18970467/computer_fundamental.pdf	Computer Fundamental
5	http://www.tutorialsforopenoffice.org/	Open Office
6	https://www.tutorialspoint.com/computer_fundamentals/index.htm	Computer Fundamental
7	https://www.tutorialspoint.com/word/	Word Processing
8	https://www.javatpoint.com/ms-word-tutorial	Word Processing
9	https://support.microsoft.com/en-au/office/word-for-windows-training-7bcd85e6-2c3d-4c3c-a2a5-5ed8847	Word Processing
10	https://www.javatpoint.com/excel-tutorial	Spreadsheet
11	https://support.microsoft.com/en-au/office/excel-video-training-9bc05390-e94c-46af-a5b3-d7c22f6990bb	Spreadsheet
12	https://www.javatpoint.com/powerpoint-tutorial	Powerpoint Presentation
13	https://support.microsoft.com/en-au/office/powerpoint-for-windows-training-40e8c930-cb0b-40d8-82c4-b	Powerpoint Presentation

Sr.No	Link / Portal	Description
14	https://www.geeksforgeeks.org/ms-dos-operating-system/	Operating System
15	https://www.javatpoint.com/windows	Windows Operating System
16	https://www.javatpoint.com/what-is-linux	Linux Operating System
17	https://www.techtarget.com/iotagenda/definition/Internet-of-Things-IoT	IoT
18	https://www.geeksforgeeks.org/introduction-to-internet-of-things-iot-set-1/	IoT
19	https://www.javatpoint.com/machine-learning	AI & Machine Learning
20	https://www.skillrary.com/blogs/read/introduction-to-drone-technology	Drone Technology
21	https://www.cnet.com/tech/computing/what-is-3d-printing/	3D Printing
22	https://support.google.com/a/users/answer/9389764?hl=en	Apps

Programme Name/s : **Architecture Assistantship/ Automobile Engineering./ Artificial Intelligence/ Agricultural Engineering/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Architecture/ Cloud Computing and Bi Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Fashion & Clothing Te Dress Designing & Garment Manufacturing/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical Power System/ Electronics & Communication Engg./ Electr Food Technology/ Computer Hardware & Maintenance/ Hotel Management & Catering Technology/ Instrument Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Instrumentation/ Interior Design & Decoration/ Interior Design/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Medical Laboratory Technology/ Medical Electronics/ Production Engineering/ Printing Technology/ Polymer Technology/ Surface Coating Technology/ Textile Technology/ Electronics & Computer Engg./ Travel and Tourism/ Textile Manufactures**

Programme Code : **AA/AE/AI/AL/AN/AO/AT/BD/CE/CH/CM/CO/CR/CS/CW/DC/DD/DE/DS/EE/EJ/EP/ET/EX/FC/HA/HM/IC/IE**

Semester : **First**

Course Title : **YOGA AND MEDITATION**

Course Code : **311003**

I. RATIONALE

Diploma Graduate needs a sound body and mind to face the challenging situations in career as employee or as an entrepreneur. Yoga and Meditation brings about the holistic development of an individual and equips with necessary balance to handle the challenges. The age of polytechnic student is appropriate to get introduced to yoga practice as this will help them in studies as well as his professional life. Moreover, Yoga inculcates discipline in all walks of the life of student. Pranayama practice regulates breathing practices of the student to improve stamina, resilience. Meditation empowers a student to focus and keep calm to get peace of mind. World Health Organization (WHO) has also emphasized the role of yoga and meditation as stress prevention measure. National Education Policy -2020 highlights importance of yoga and meditation amongst students of all ages. Therefore, this course for Diploma students is designed for the overall wellbeing of the student and aims to empower students to adopt and practice "Yoga" in daily life .

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Practice basic Yoga and Pranayama in daily life

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Practice basic Yoga and Pranayama in daily life to maintain physical and mental fitness.
- CO2 - Practice meditation regularly for improving concentration and better handling of stress and anxiety.
- CO3 - Follow healthy diet and hygienic practices for maintaining good health.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TSL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
311003	YOGA AND MEDITATION	YAM	VEC	-	-	1	1	2	1		-	-	-	-	25	10	-	-	25	10	50

IKS Content : 1 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Practice warming up for Yoga.	1	Introduction :- Presentations on Introduction to Yoga and its History. Lab Exp: 1. Perform warming up exercises to prepare the body from head to toe for Yoga.	5	CO1
LLO 2.1 Practice Surya Namaskar	2	Lab Exp: 2. Perform all the postures of Surya Namaskar one by one in a very slow pace, after warm up. Lab Exp 3. Perform multiple Surya Namaskar (Starting with three and gradually increasing it to twelve) in one go. Experiment 2 to 4 must be followed by shavasana for self relaxation.	7	CO1 CO2
LLO 3.1 Practice basic Asanas	3	Lab Exp: 4 Perform Sarvangasna,Halasana,Kandharasana (setubandhasana) Lab Exp: 5 Perform Bhujangasana,Naukasana,Mandukasana Lab Exp: 6 Perform Paschimottasana,Baddhakonasana,Bharadwajasana. Lab Exp: 7 Perform Veera Bhadrasana,Vrukshasana,Trikonasana. Follow up experiment 5 to 7 with shavasana for self relaxation	8	CO2
LLO 4.1 Practice basic pranayama	4	Lab Exp: 8 Perform Bhastrika, Anulom Vilom Pranayam Kriya Lab Exp: 9 Practice Kapalbhati Pranayam Kriya Lab Exp:10 Practice Bhramary Pranayam.	5	CO3
LLO 5.1 Practice meditation	5	Lab Exp: 11 Perform sitting in Dhyan Mudra and meditating.Start with five minute and slowly increasing to higher durations. (Trainer will explain the benefits of Meditation before practice)	5	CO3

Note :
Note:
1. Start and end of each session can be with appropriate Yoga prayers and chanting of Omkar.
2. Trainers can add similar asanas in practical sessions.
3. Students are to be instructed to practice the experiment performed at least twice a week as part of self learning practices.
4. Live demonstration by the trainer needs to be carried out during practical hours. Yogic Videos can be used as well .

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Maintain a diary indicating date wise practice done by the student with a photograph of self in yogic posture.

Assignment

- Prepare Diet and nutrition chart for self

Self Learning

- • Practice at least thrice a week.

• Read books on different methods to maintain health, wellness and to enhance mood
• Watch videos on Yoga Practices.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Yoga and Meditation kits : Yoga Mats, Yoga Rollers, Yoga Blocks, Aero Yoga Clothing Blankets, Cloth Straps, Bolsters, Wheels	All

IX. SUGGESTED FOR WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table) : NOT APPLICABLE

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Lab performance, Self-learning and Terms work

Summative Assessment (Assessment of Learning)

- Actual Practical Performance

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	-	-	-	-	3	-	-			
CO2	-	-	-	-	3	-	-			
CO3	-	-	-	-	3	-	-			
Legends :- High:03, Medium:02,Low:01, No Mapping: - *PSOs are to be formulated at institute level										

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher
1	Swami Vivekananda	Patanjalis Yoga Sutras	Fingerprint Publishing (2023) Prakash Books India Pvt Ltd, New Delhi ISBN-13?: ? 978-9354407017
2	Luisa Ray, Angus Sutherland	Yoga for Every Body: A beginner’s guide to the practice of yoga postures, breathing exercises and me	Vital Life Books (2022) ISBN-13?: ? 978-1739737009
3	Swami Saradananda	Mudras for Modern Living: 49 inspiring cards to boost your health, enhance your yoga and deepen your	Watkins Publishing (2019) ISBN-13?: ? 978-1786782786

Sr.No	Author	Title	Publisher
4	Martha Davis, Elizabeth Robbins, Matthew McKay, Eshelman MSW	The Relaxation and Stress Reduction Workbook	A New Harbinger Self-Help Workbook (2019)
5	Ann Swanson	Science of Yoga: Understand the Anatomy and Physiology to Perfect Your Practice	ISBN-13?: ? 978-1465479358

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://onlinecourses.swayam2.ac.in/aic19_ed28/preview- introduction to Yoga and Applications of Yog	Yoga and Applications of Yoga
2	https://onlinecourses.swayam2.ac.in/aic23_ge09/preview	Yoga for Creativity
3	https://onlinecourses.swayam2.ac.in/aic23_ge05/preview	Yoga for concentration
4	https://onlinecourses.swayam2.ac.in/aic23_ge06/preview	yoga for memory development
5	https://onlinecourses.nptel.ac.in/noc21_hs29/preview	Psychology of Stress, Health and Well-being
6	https://onlinecourses.swayam2.ac.in/nce19_sc04/preview	Food Nutrition for Healthy Living - Course – Swayam
7	https://www.classcentral.com/course/swayam-fitness-management-	Fitness Management from Swayam

Maharashtra State Board Of Technical Education, Mumbai

Learning and Assessment Scheme for Post S.S.C Diploma Courses

Programme Name : Diploma In Electrical Engineering / Electrical Power System

Programme Code : EE / EP **With Effect From Academic Year** : 2023-24

Duration Of Programme : 6 Semester **Duration** : 16 WEEKS

Semester : Second **NCrF Entry Level : 3.0** **Scheme** : K

Sr No	Course Title	Abbrevation	Course Type	Course Code	Total IKS Hrs for Sem.	Learning Scheme					Credits	Assessment Scheme												
						Actual Contact Hrs./Week			Self Learning (Activity/ Assignment /Micro Project)	Notional Learning Hrs /Week		Paper Duration (hrs.)	Theory				Based on LL & TL				Based on Self Learning		Total Marks
																	Practical						
						CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
													Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
(All Compulsory)																								
1	APPLIED MATHEMATICS	AMS	AEC	312301	2	3	1	-	-	4	2	3	30	70	100	40	-	-	-	-	-	-	100
2	APPLIED SCIENCE APPLIED PHYSICS APPLIED CHEMISTY	ASC	DSC	312308	4	2 2	- -	2 2	0 0	8	4	1.5	30	70*#	100	40	25 25	10 10	25@ 25@	10 10	-	-	200
3	ELEMENTS OF ELECTRONICS	EOE	DSC	312309	-	4	-	4	2	10	5	3	30	70	100	40	25	10	25@	10	25	10	175
4	FUNDAMENTAL OF ELECTRICAL ENGINEERING	FEE	DSC	312310	-	4	-	4	2	10	5	3	30	70	100	40	25	10	25#	10	25	10	175
5	PROFESSIONAL COMMUNICATION	PCO	SEC	312002	-	-	-	2	-	2	1	-	-	-	-	-	25	10	25@	10	-	-	50
6	SOCIAL AND LIFE SKILLS	SFS	VEC	312003	-	-	-	-	2	2	1	-	-	-	-	-	-	-	-	-	50	20	50
7	BASIC MECHANICAL ENGINEERING	BME	SEC	312006	2	2	-	2	-	4	2	-	-	-	-	-	50	20	50@	20	-	-	100
Total					**8**	**17**	**1**	**16**	**6**		**20**		**120**	**280**	**400**		**175**		**175**		**100**		**850**

Sr No	Course Title	Abbrevation	Course Type	Course Code	Total IKS Hrs for Sem.	Learning Scheme					Credits	Assessment Scheme											
						Actual Contact Hrs./Week			Self Learning (Activity/ Assignment /Micro Project)	Notional Learning Hrs /Week		Paper Duration (hrs.)	Theory				Based on LL & TL				Based on Self Learning		Total Marks
																	Practical						
						CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
													Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	

Abbreviations : CL- Classroom Learning , TL- Tutorial Learning, LL-Laboratory Learning, FA - Formative Assessment,SA -Summative Assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends : @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

Course Category : Discipline Specific Course Core (DSC) , Discipline Specific Elective (DSE) , Value Education Course (VEC) , Intern./Apprenti./Project./Community (INP) , AbilityEnhancement Course (AEC) , Skill Enhancement Course (SEC) , GenericElective (GE)

♦ For the course Applied Science - candidate will have to appear for pre-examination of both physics & chemistry. If absent in any one section (physics / chemistry) student will be declared as absent & fail for the course and marks will not be processed or carried forward.

PROFESSIONAL COMMUNICATION **Course Code : 312002**

Programme Name/s	**: Architecture Assistantship/ Automobile Engineering./ Artificial Intelligence/ Agricultural Engineering/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Architecture/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Fashion & Clothing Technology/ Dress Designing & Garment Manufacturing/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Food Technology/ Computer Hardware & Maintenance/ Instrumentation & Control/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Instrumentation/ Interior Design & Decoration/ Interior Design/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Medical Laboratory Technology/ Medical Electronics/ Production Engineering/ Printing Technology/ Polymer Technology/ Surface Coating Technology/ Textile Technology/ Electronics & Computer Engg./ Travel and Tourism/ Textile Manufactures**
Programme Code	**: AA/ AE/ AI/ AL/ AN/ AO/ AT/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CW/ DC/ DD/ DE/ DS/ EE/ EJ/ EP/ ET/ EX/ FC/ HA/ IC/ IE/ IF/ IH/ IS/ IX/ IZ/ LE/ ME/ MK/ ML/ MU/ PG/ PN/ PO/ SC/ TC/ TE/ TR/ TX**
Semester	**: Second**
Course Title	**: PROFESSIONAL COMMUNICATION**
Course Code	**: 312002**

I. RATIONALE

Communication is key to smooth and efficient functioning of any industry or business . Professional communication is the need of every organization to maintain ethics, quality and standards. The efficacy of business communication skills are essential for engineering professionals to instruct, guide and motivate peers/ subordinates to achieve desired goals at work place. Strong Communication skills are highly valued in the professional world and contribute to career growth and opportunities. Thus, this course has been designed to enhance the professional communication skills for effective presentation both in written and oral forms at workplace.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

1. Communicate effectively at workplace. 2. Issues can be identified and resolved by brainstorming solutions 3. Effective communication ensures strong decision making

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Communicate effectively (oral / spoken and Written) in various formal and informal situations minimizing the barriers.
- CO2 - Develop listening skills through active listening and note taking.
- CO3 - Write circulars, notices and minutes of the meeting.
- CO4 - Draft inquiry letter, complaint letter , Job application with resume / CV, Compose effective E - mails .

PROFESSIONAL COMMUNICATION **Course Code : 312002**

- CO5 - Write Industrial reports.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
312002	PROFESSIONAL COMMUNICATION	PCO	SEC	-	-	2	-	2	1	-	-	-	-	-	25	10	25@	10	-	-	50

Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe the importance of professional communication in given situations TLO 1.2 Identify the types of communication barriers in given situations and suggestive remedies TLO 1.3 Use different types of verbal and non–verbal communication for the given situation	**Unit - I Professional Communication : An Overview** 1.1 Definition of professional communication- Importance, relevance, Elements and process of communication 1.2 7 C's of Professional Communication (Clarity, Conciseness, correctness, Coherent, concrete, courteous and Complete) 1.3 Types –Verbal (Oral-Written),Formal, Informal (Grapevine), Vertical 1.4 Barriers to communication,Types of barriers (Linguistic, Psychological, Technological)	Language lab Role plays Chalk board Reference books Case studies

PROFESSIONAL COMMUNICATION **Course Code : 312002**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Identify the difference between listening and hearing TLO 2.2 Differentiate the types of listening in various situations TLO 2.3 Take notes during lectures, seminars . Make use of types of note taking and note making for different subjects / topics	**Unit - II Listening & Note Taking** 2.1 Difference between listening & Hearing 2.2 Types of listening a)Active listening b)Passive listening c)Selective listening 2.3 Techniques of Note taking , Types of note taking (Outline notes, Mind Mapping, Flowcharts)	Language Lab Classroom learning NPTEL Role Play
3	TLO 3.1 Prepare notices / agenda for the given type of meeting / information TLO 3.2 Prepare minutes of meeting/s TLO 3.3 Draft a circular for a particular information/ event	**Unit - III Office Drafting** 3.1 Format of Notice and Circular 3.2 Drafting Agenda 3.3 Preparing Minutes of meeting	white board Language Lab Reference books Classroom learning
4	TLO 4.1 Compose cover letter and CV / Resume for jobs TLO 4.2 Apply E- mail Etiquette for professional purposes TLO 4.3 Compose E- mails for different official purposes	**Unit - IV Writing Skills for Professional Communication** 4.1 Job Application with Resume / CV 4.2 E-Mail Etiquettes 4.3 Writing official E- Mails to communicate intended purposes 4.4 Drafting Enquiry letter and Complaint letter	Language lab Classroom learning NPTEL Reference books
5	TLO 5.1 Compose technical reports TLO 5.2 Draft accident / Investigation/ Daily reports	**Unit - V Report Writing** 5.1 Introduction to report writing 5.2 Accident Report 5.3 Investigation Report 5.4 Daily Report	Chalk and talk Language Lab Collaborative learning Classroom learning

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Draw communication cycle using real life examples and explain process of communication.	1	*Communication Process and Cycle	2	CO1
LLO 2.1 Undertake the Role play / Group discussion to illustrate types / barriers to communication	2	Role plays and Group Discussion	2	CO1
LLO 3.1 Listen to audios in the language lab and make notes of it.	3	*Active Listening	2	CO2
LLO 4.1 Give a presentation / Seminar using 7 C's of Communication.	4	*Presentations / Seminars	2	CO1
LLO 5.1 Explain the types of note taking with examples and make notes on any one topic related to your curriculum.	5	*Note taking and Note Making	2	CO2
LLO 6.1 Prepare agenda for meeting and draft minutes of the meeting.	6	*Agenda and Minutes of the meeting	2	CO3
LLO 7.1 Draft circulars for the given situation .	7	*Office Drafting	2	CO3

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 8.1 Respond to job advertisements referring newspapers, LinkedIn. Write cover letter with resume /CV.	8	*Type Job Application with Resume / CV	2	CO4
LLO 9.1 Type Four (formal) E-mails using ethics and etiquette.	9	* E- Mail writing	2	CO4
LLO 10.1 Write a detailed report on Accident/ Investigation .	10	*Technical Report writing	2	CO5
LLO 11.1 Prepare a case study related to linguistic barriers : language ,pronunciation, punctuation, technical jargon and suggest remedies for the same.	11	*Barriers to Communication	2	CO1
LLO 12.1 Draft complaint / enquiry letter for various situations	12	Complaint and Enquiry letter	2	CO4
LLO 13.1 List psychological barriers to communication LLO 13.2 Prepare case studies on any two psychological barriers and suggest remedies to overcome the barriers	13	Psychological barriers to Communication	2	CO1
LLO 14.1 Draw flow chart and mind mapping for any topic related to the curriculum.	14	*Listening Skills	2	CO2
LLO 15.1 Face mock interview arranged by your teacher.	15	* Typed Job Application , Resume / CV/ formal dressing and Interview	2	CO4

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Conduct an interview of any person and follow the procedure (interview questions, photo with the interviewee etc.)
- Listening and Speaking are life long learnings . Explain with appropriate examples and real life case studies.
- Collect (four to five) emails with technical jargons, barriers, make required corrections and keep a record of both the mails (original and Corrected one)
- Complete any one certification course of (Two Weeks duration) from (MOOC/ NPTEL/ Coursera/ any other source)related to Communication Skills / Personality Development.
- Prepare a report on aspects of body language
- Prepare a case study on Technological /Psychological barriers to communication

Reading for vocabulary and sentence structure

- Read any motivational book and present a review of the book

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Note :

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. S/he ought to submit it by the end of the semester to develop the industry oriented COs. Each micro-project should encompass two or more COs. The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than 15 (fifteen) student engagement hours during the course. In the first four semesters, the micro-project could be group-based. However, in higher semesters, it should be individually undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. A suggestive list is given here. Similar micro-projects could be added by the concerned faculty.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Language Lab with software and internet facility	All
2	LCD Projector	All
3	Smart Board with networking	All
4	Printer	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table) : NOT APPLICABLE

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Term Work, Micro Project

Summative Assessment (Assessment of Learning)

- Practical Exam of 25 marks using language lab

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	1	1	1		1	3	1			
CO2	1	1				3	1			
CO3	1					3	1			
CO4		1				3	1			
CO5		1	1			3	1			

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Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	M Ashraf Rizvi	Effective Communication Skills	Tata McGraw-Hill Publication-ISBN 0070599521, 9780070599529
2	Sanjay Kumar and Pushp Lata	Communication Skills	Oxford University Press ISBN 9780199457069
3	MSBTE Textbook	Communication Skills	MSBTE
4	Robert King	Effective communication Skills	Audio Book -ISBN 978181667009742
5	N P Sudharshana , C Savitha	English for Technical Communication	Cambridge-ISBN 978-13-16640-08-1
6	C. Murlikrishna , Sunita Mishra	Communication Skills for Engineers	Pearson - ISBN 978-81-317-3384-4
7	Meenakshi Raman, Sangeeta Sharma	Technical Communication, Principles and Practice	Oxford University Press -ISBN 978-13-16640-08-1
8	K. K. Sinha	Business Communication	Galgotiya Publishing company, New Delhi - ISBN 9789356227064
9	Rajendra Pal, J.S. Korlahalli	Essentials of Business Communication	Sultan Chand & Sons, New Delhi ISBN 9788180547294

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.britishcouncil.in	conversations
2	https://www.coursera.org	certification courses
3	https://www.udemy.com	Communication skills training courses
4	http://www.makeuseof.com	Dale Carnegie's free resources

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Programme Name/s	**: Architecture Assistantship/ Automobile Engineering./ Artificial Intelligence/ Agricultural Engineering/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Architecture/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Fashion & Clothing Technology/ Dress Designing & Garment Manufacturing/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Food Technology/ Computer Hardware & Maintenance/ Hotel Management & Catering Technology/ Instrumentation & Control/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Instrumentation/ Interior Design & Decoration/ Interior Design/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Medical Laboratory Technology/ Medical Electronics/ Production Engineering/ Printing Technology/ Polymer Technology/ Surface Coating Technology/ Textile Technology/ Electronics & Computer Engg./ Travel and Tourism/ Textile Manufactures**
Programme Code	**: AA/ AE/ AI/ AL/ AN/ AO/ AT/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CW/ DC/ DD/ DE/ DS/ EE/ EJ/ EP/ ET/ EX/ FC/ HA/ HM/ IC/ IE/ IF/ IH/ IS/ IX/ IZ/ LE/ ME/ MK/ ML/ MU/ PG/ PN/ PO/ SC/ TC/ TE/ TR/ TX**
Semester	**: Second**
Course Title	**: SOCIAL AND LIFE SKILLS**
Course Code	**: 312003**

I. RATIONALE

Rationale : Life skills can be defined as abilities that enable humans to deal effectively with the demands and challenges of life. Social skills are a subset of life skills that are needed for successful, healthy relationships to easily adapt when moving from one social situation to the next. They help regulate our emotions effectively and develop enduring, supportive relationships, we’re happier and healthier. This is why developing life skills and eventually social skills is key not only to being successful in life, it’s key for our health and well-being. Thus, Teaching of Social and life skills provide students with essentials of knowing , understanding attitudes, values, morals ,social skills and better equip them to handle stress and build their self efficacy, self esteem and self confidence.

Note : The course offers four different alternatives(modules) for achieving above outcomes . Students must complete any one module from the following given options.

a. MODULE-I : Unnat Maharashtra Abhiyan (UMA)
b. MODULE-II : National Service Scheme (NSS)

c. MODULE-III : Unniversal Human Values
d. MODULE-IV: Value Education (Unnati Foundation)
e. MODULE-V : Financial Literacy (NABARD)

The institute can choose to offer any one MODULE to the groups of the students by taking into consideration the resources required and resources available in the institute . Different group of students maybe offered different MODULE based on their choices .

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Exhibit psychosocial competencies, workplace ethics, resilience, positive attitude , integrity and self-confidence

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Develop ability to adapt to new challenges.
- CO2 - Manage emotions effectively.
- CO3 - Follow workplace ethics and practices
- CO4 - Manage time Effectively.
- CO5 - Increased self confidence to handle stress.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
312003	SOCIAL AND LIFE SKILLS	SFS	VEC	-	-	-	2	2	1	-	-	-	-	-	-	-	-	-	50	20	50

SOCIAL AND LIFE SKILLS **Course Code : 312003**

Total IKS Hrs for Sem. : Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Explain developmental needs and connection of various stakeholders TLO 1.2 Enlist the local problems TLO 1.3 Design a methodology for fieldwork TLO 1.4 Select the attributes of engineering and social system for measurement, quantification, and documentation TLO 1.5 Measure & quantify the quantities / systems parameters TLO 1.6 Write a report using information collected tStudy the data collected from fieldwork and conclude the observations	**Unit - I MODULE I : Activities Under Unnat Maharashtra Abhiyan (UMA)** 1.1 Introduction to Societal Needs and respective stakeholders : Regional societal issues that need engineering intervention 1.2 Multidisciplinary approach-linkages of academia, society and technology 1.3 Stakeholders' involvement 1.4 Introduction to Important secondary data sets available such as census, district economic surveys, cropping pattern, rainfall data, road network data etc 1.5 Problem Outline and stakeholders : Importance of activity and connection with Mapping of system components and stakeholders (engineering / societal) 1.6 Key attributes of measurement 1.7 Various instruments used for data collection - survey templates, simple measuring equipments 1.8 Format for measurement of identified attributes/ survey form and piloting of the same 1.9 Fieldwork : Measurement and quantifications of local systems such as agriculture produce, rainfall, Road network, production in local industries, Produce /service which moves from A to B 1.10 Analysis and Report writing Report writing containing- 1. Introduction of the topic 2. Data collected in various formats such as table, pie chart, bar graph etc 3. Observations of field visits and data collected.	Implementation Methodology: Considering the nature of the course designed, following points shall be considered while implementing the course. i) Regroup in the batches of 5-6 students for conducting the fieldwork from the bigger group. ii) Assign a few batches of the students for this course to all the faculty members. iii) A group of course teachers will visit local governance bodies such as Municipal Corporations, Village Panchayats, Zilla Parishads, Panchayat Samitis to assess the small technological / engineering needs in their area of work. iv) The group of course teachers will carry out initial field visits to evaluate the various possibilities of field visits / various scenarios wherein students can conduct field work to measure / quantify the parameters / attributes. v) The course will be implemented in eight sessions and fieldwork. a) Session I - Introduction to development paradigm, fieldwork and case study as pedagogy b) Session II - VII - Society,

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
			stakeholders and value creation, measurements, rudimentary analysis and reporting c) Session VIII - Final closure session feedback and assessment d) Field work - 1. Pilot Visit - Pilot of survey instrument 2. Survey Visit 1 - Data gathering / Information Collection 3. Survey Visit 2 - Data gathering 4. Summary Visit - Closure after analysis
2	TLO 2.1 Adoption of Village or Slum TLO 2.2 Survey and Problem Identification TLO 2.3 Conduct Project / Programs in the selected village / slum TLO 2.4 Undertake Special Camping Programme	**Unit - II MODULE II : National Service Scheme (NSS)** 2.1 Contacting Village/Area Leaders 2.2 Primary socio economic survey of few villages in the vicinity of the institute. 2.3 Selection of the village for adoption - conduct of activities 2.4 Comprehensive Socio Economic Survey of the Village/Area 2.5 Identification of Problem(s) 2.6 Dissemination of information about the latest developments in agriculture, watershed management, wastelands development, non-conventional energy, low cost housing, sanitation, nutrition and personal hygiene, schemes for skill development, income generation, government schemes, legal aid, consumer protection and allied fields. 2.7 A liaison between government and other development agencies for the implementation of various development schemes in the selected village / slum.	(i) The teachers should visit the village / slum before adopting it for NSS activities. (ii) The selected area should be compact. (iii) The community people should be receptive to the ideas of improving their living standard. They should also be ready to coordinate and involve in the projects undertaken by the NSS for their upliftment; (iv) The areas where political conflicts are likely to arise should be avoided by the NSS units. (v) The area should be easily accessible to the NSS volunteers to undertake frequent visits to slums;

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Love and Compassion (Prem and Karuna) TLO 3.2 Truth (Satya) TLO 3.3 Non-Violence (Ahimsa) TLO 3.4 Righteousness (Dharma) TLO 3.5 Peace (Shanti) TLO 3.6 Service (Seva) TLO 3.7 Renunciation (Sacrifice) Tyaga TLO 3.8 Gender Equality and Sensitivity	**Unit - III MODULE-III : Universal Human Values** 3.1 Love and Compassion (Prem and Karuna): Introduction, Practicing Love and Compassion (Prem and Karuna) 3.2 Truth (Satya) : Introduction, Practicing Truth (Satya) 3.3 Non-Violence (Ahimsa) : Introduction, Practicing Non-Violence (Ahimsa) 3.4 Righteousness (Dharma) : Introduction, Practicing Righteousness (Dharma) 3.5 Peace (Shanti) : Introduction, Practicing Peace (Shanti) 3.6 Service (Seva) : Introduction, Practicing Service (Seva) 3.7 Renunciation (Sacrifice) Tyaga : Introduction, Practicing Renunciation (Sacrifice) Tyaga 3.8 Gender Equality and Sensitivity: Introduction, Practicing Gender Equality and Sensitivity	i) Lectures ii) Demonstration iii) Case Study iv) Role Play v) Observations vi) Portfolio Writing vii) Simulation viii) Motivational talks by Practitioners ix) Site/Industry Visit

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Puntuality TLO 4.2 Cleanliness, Hygiene and Orderliness TLO 4.3 Responsibility TLO 4.4 Gratitude and Appreciations TLO 4.5 Determination & Persistence TLO 4.6 Respect TLO 4.7 Team Spirit TLO 4.8 Caring & Sharing TLO 4.9 Honesty TLO 4.10 Forgive and Forget	**Unit - IV MODULE-IV: Value Education (Unnati Foundation)** 4.1 Punctuality, Icebreaker and Simple Greeting, Understanding & Managing Emotions, Introducing Self, The power of a Positive Attitude, Talking about one's Family, Talking about one's Family, Making a Positive Impression, Give word list for a Word based 4.2 Cleanliness , Hygiene and Orderliness , Likes and Dislikes, Developing Confidence in Self and Others, Strengths and Weaknesses, Listening Skills , Greeting gestures, Gender Equality and Sensitivity 4.3 Responsibility, OCSEM- Visual Comprehension and Word Based Learning, Goal Setting – Make it happen, Follow, Like & Share Unnati Social Media - Facebook / Instagram/ Twitter Introducing Others, Time Management, Talking about the daily routine, Money Management 4.4 Gratitude and Appreciation , Asking Simple Questions & Asking for the price , Stress Management, Student Referral process ,Comprehending & Paraphrasing Information, A Plate of Rice and Dignity of Labour, Topics for Public Speaking, Placement Process , OCSEM-E-Newspaper, Critical Thinking to overcome challenges 4.5 Determination and Persistence, Guiding and Giving Directions, Language Etiquette & Mannerism, . Unnati Philosophy , b. Unnati Branding - Follow, Like & Share Unnati Social Media - Facebook / Instagram/ Twitter, Simple instructions to follow procedures, Assertiveness, Give topics for Debate, Describing a person/Objects, Refusal Skills, Word List for Word based Learning 4.6 Respect, Comparing , OCSEM - Public Speaking, Student referral process,	i) Video Demonstrations ii) Flipped Classroom iii) Case Study iv) Role Play v) Collaborative learning vi) Cooperative Learning vii) Chalk-Board

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
		Attending a phone call, Being a Good Team Player , Placement Process, At a Restaurant, Workplace ethics 4.7 Team Spirit, Inviting someone, OCSEM - Picture Reading & Word, a. Unnati Philosophy & b. Unnati Branding - Follow, Like & Share Unnati Social Media - Facebook / Instagram/ Twitter, Apologizing, Apologizing, Dealing effectively with Criticism, Introduce Importance of Self Learning and upskilling 4.8 Caring and Sharing , Handling Customer queries, Flexibility & Adaptibility, Student referral process, Writing a Resume, OCSEM-Public Speaking, Placement Process, Meditation/ Affirmation & OCSEM-Debate, Introduce Certif-ID, how to create Certif-ID Project , 4.9 Honesty, Email etiquette & Official Email communication, Alcohol & Substance use & abuse, Describing a known place , Leadership Skills, Describing an event, OSCEM-Picture Reading & Visual Comprehension 4.10 Forgive and Forget, Facing and Interview, OSCEM-Public Speaking , Attending a telephonic/Video interview & Mock Interview , Affirmation , Pat-a-Back & Closure (Valediction , Unnati Branding, Student Testimonials), Meditation/ Affirmation & Sponsor connect (Speak to UNXT HO)	

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Literacy About Savings and Investments TLO 5.2 Literacy About Financial Planning TLO 5.3 Literacy About Transactions TLO 5.4 Literacy About Income, expenditure and budgeting TLO 5.5 Literacy About Inflation TLO 5.6 Literacy About Loans TLO 5.7 Literacy About the Importance of Insurance TLO 5.8 Literacy About the Dos and Donts in finances	**Unit - V MODULE-V : Financial Literacy** 5.1 Introduction - Life Goals and financial goals 5.2 Savings and Investments - Three pillars of investments, Popular asset classes, Government schemes, Mutual Funds, Securities markets (Shares and bonds), Gold, Real Estate, Do's and Don'ts of investments 5.3 Retirement planning 5.4 Cashless transactions 5.5 Income, expenditure and budgeting – Concepts and Importance 5.6 Inflation- Concept, effect on financial planning of an individual 5.7 Loans – Types, Management of loans, Tax benefits 5.8 Insurance – Types, Advantages, selection 5.9 Dos and Donts in Financial planning and Transactions	i) Online/Offline Mode of Instructions ii) Video Demonstrations iii) Presentations iv) Case Study v) Chalk-Board vi) Collaborative learning

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES : NOT APPLICABLE.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Suggestive list of activities during Regular as well as Special Camping (NSS Activities)

- Following list is only an illustrative list of the type of activities that can be undertaken. Under the programme it would be open to each NSS Unit to undertake one of these programmes or any other activity which may seem desirable to them according to local needs. The NSS Unit should aim at the integrated development of the area selected for its operation which could be a village or a slum. It has also to be ensured that at least a part of the programme does involve manual work.

(a) Environment Enrichment and Conservation:
The activities under this sub-theme would inter-alia, include:
(i) plantation of trees, their preservation and upkeep
(ii) Construction & maintenance of village streets, drains
(iii) Cleaning of village ponds and wells;
(iv) Popularization and construction of Gobar Gas Plants, use of non-conventional energy;
(v) Disposal of garbage & composting;

(vi) Prevention of soil erosion and work for soil conservation,
(vii) Watershed management and wasteland development
(viii) Preservation and upkeep of monuments, and creation of consciousness about the preservation of cultural heritage among the community.

(b) Health, Family Welfare and Nutrition Programme:

(i) Programme of mass immunization;
(ii) Working with people in nutrition programmes with the help of Home Science and medical college students;
(iii) Provision of safe and clean drinking water;
(iv) Integrated child development programmes;
(v) Health education, AIDS Awareness and preliminary health care.
(vi) Population education and family welfare programme;
(vii) Lifestyle education centres and counselling centres.
© Programmes aimed at creating an awareness for improvement of the status of women: (i) programmes of educating people and making them aware of women's rights both constitutional and legal;
(ii) creating consciousness among women that they too contributed to economic and social well-being of the community;
(iii) creating awareness among women that there is no occupation or vocation which is not open to them provided they acquire the requisite skills; and
(iv) imparting training to women in sewing, embroidery, knitting and other skills wherever possible.

(d) Social Service Programmes:

(i) work in hospitals, for example, serving as ward visitors to cheer the patients, help the patients, arranging occupational or hobby activities for long term patients; guidance service for out-door-patients including guiding visitors about hospital's procedures, letter writing and reading for the patients admitted in the hospital; follow up of patients discharged from the hospital by making home visits and places of work, assistance in running dispensaries etc.
(ii) work with the organisations of child welfare;
(iii) work in institutions meant for physically and mentally handicapped;
(iv) organising blood donation, eye pledge programmes;
(v) work in Cheshire homes, orphanages, homes for the aged etc.;
(vi) work in welfare organisations of women;
(vii) prevention of slums through social education and community action;

(e) Production Oriented Programmes:

(i) working with people and explaining and teaching improved agricultural practices;
(ii) rodent control land pest control practices;
(iii) weed control;
(iv) soil-testing, soil health care and soil conservation;
(v) assistance in repair of agriculture machinery;
(vi) work for the promotion and strengthening of cooperative societies in villages;
(vii) assistance and guidance in poultry farming, animal husbandry, care of animal health etc.;
(viii) popularisation of small savings and assistance in procuring bank loans

(f) Relief & Rehabilitation work during Natural Calamities:

(i) assisting the authorities in distribution of rations, medicine, clothes etc.;
(ii) assisting the health authorities in inoculation and immunisation, supply of medicine etc.;
(iii) working with the local people in reconstruction of their huts, cleaning of wells, building roads etc.;
(iv) assisting and working with local authorities in relief and rescue operation;
(v) collection of clothes and other materials, and sending the same to the affected areas;

(g) Education and Recreations: Activities in this field could include:

(i) adult education (short-duration programmes);
(ii) pre-school education programmes;
(iii) programmes of continuing education of school drop outs, remedial coaching of students from weaker sections;
(iv) work in crèches;
(v) participatory cultural and recreation programmes for the community including the use of mass media for instruction and recreation, programmes of community singing, dancing etc.;
(vi) organisation of youth clubs, rural land indigenous sports in collaboration with Nehru Yuva Kendras;
(vii) programmes including discussions on eradications of social evils like communalism, castism, regionalism, untouchability, drug abuse etc.;
(viii) non- formal education for rural youth and
(ix) legal literacy, consumer awareness.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Simple engineering measurement devices GPS data collection tools GIS open source softwares- Google Earth and QGIS MS office suite	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table) : NOT APPLICABLE

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Formative assessment (Assessment for Learning) Report and presentation of fieldwork activities, Self-Learning (Assignment)

Summative Assessment (Assessment of Learning)

XI. SUGGESTED COS - POS MATRIX FORM : NOT APPLICABLE

XII. SUGGESTED LEARNING MATERIALS / BOOKS

SOCIAL AND LIFE SKILLS **Course Code : 312003**

Sr.No	Author	Title	Publisher with ISBN Number
1	IRAP, Hyderabad, CTARA, IIT Bombay and UNICEF, Mumbai	Compendium of Training Materials for the Capacity Building of the Faculty and Students of Engineering Colleges on 'IMPROVING THE PERFORMANCE OF RURAL WATER SUPPLY AND SANITATION SECTOR IN MAHARASHTRA' Districts Economic survey reports	UNICEF
2	Central Public Health and Environmental Engineering Organisation	Manual on Water Supply and Treatment	Ministry of Urban Development, New Delhi
3	Specifications And Standards Committee	Indian Standards (IS) Codes and Indian Roads Congress (IRC) Codes	Bureau of Indian Standards and The Indian Road Congress
4	Prepared by each district administration	Districts Economic survey reports	Govt. of Maharashtra
5	Local college students, UMA staffs	Sample Case Studies on UMA website	IITB-UMA team

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://gr.maharashtra.gov.in/Site/Upload/Government%20Resolutions/English/201601131501523808.pdf	Government Resolution of Government of Maharashtra regarding Unnat Maharashtra Abhiyan
2	https://gr.maharashtra.gov.in/Site/Upload/Government%20Resolutions/English/201606151454073708.pdf	Government Resolution of Government of Maharashtra regarding Unnat Maharashtra Abhiyan Guidelines
3	https://censusindia.gov.in/census.website/	A Website of Census of India
4	https://gsda.maharashtra.gov.in/english/	A Website of Groundwater Survey and Development Agency, GoM
5	https://mrsac.gov.in/MRSAC/map/map	A Website where district-wise maps showcasing different attributes developed by Maharashtra Remote Sensing Applications Centre.
6	https://ejalshakti.gov.in/jjmreport/JJMIndia.aspx	A Website of Jal Jivan Mission, Government of India
7	https://cpcb.nic.in/	A Website of Central Pollution Control Board, Government of India

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Sr.No	Link / Portal	Description
8	http://www.mahapwd.com/#	A Website of Public Works Department, GoM
9	http://tutorial.communitygis.net/	A Website for GIS data sets developed by Unnat Maharashtra Abhiyan
10	https://youtu.be/G71maumVZ1A?si=TzDTxKUpLYaRos7U	A video record of lecture by Prof. Milind Sohoni, IIT Bombay, on Engineering, Development and Society
11	https://youtu.be/TUcPNwtdKyE?si=wnSWrhGc9dJTC-ac	A keynote talk by Prof. Milind Sohoni, IIT Bombay, on Interdisciplinary Engineering: The Road Ahead
12	https://youtu.be/mKJj6j_1gWg?si=ajE8s4lfB2OM63Ng	A TED talk by Prof. Milind Sohoni, IIT Bombay, on Vernacular Science: The Science of Delivery
13	https://www.ugc.gov.in/pdfnews/4371304_LifeSKill_JeevanKaushal_2023.pdf	UHV: UGC Course on life skils. Unit 4 i.e. Course 4 is to be referred
14	https://nss.gov.in/	NSS : Know about the NSS Scheme and details

MSBTE Approval Dt. 29/11/2023 **Semester - 2, K Scheme**

BASIC MECHANICAL ENGINEERING **Course Code : 312006**

Programme Name/s : **Electrical Engineering/ Electrical Power System**
Programme Code : **EE/ EP**
Semester : **Second**
Course Title : **BASIC MECHANICAL ENGINEERING**
Course Code : **312006**

I. RATIONALE

Electrical power supply system is needed for operating various mechanical equipment. Electrical engineer has to take care of installation and maintenance of mechanical systems like refrigeration and air conditioning, portable generators, industrial material handling system and power generation plants. This course will help to understand various mechanical systems for identifying different mechanical faults.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Interpret various mechanical faults in industrial mechanical systems.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Find faults in Thermal Power Plant using acquired knowledge and skills in a given situation.
- CO2 - Diagnose faults of Material handling system using acquired knowledge and skills.
- CO3 - Identify faults of Hydraulic turbines and Hydraulic pumps in a given situation.
- CO4 - Diagnose faults of given Air compressor and Refrigeration system using acquired knowledge and skills.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical							
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
312006	BASIC MECHANICAL ENGINEERING	BME	SEC	2	-	2	-	4	2	-	-	-	-	-	50	20	50@	20	-	-	100

Total IKS Hrs for Sem. : 2 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 List components of steam boilers and turbines TLO 1.2 Explain working of portable generator TLO 1.3 Identify different faults in different power plant equipment	**Unit - I Power plants equipment** 1.1 Layout of Thermal Power Plant, Major thermal power plants in India 1.2 Introduction to steam boilers- Babcock-Wilcox boilers, Lamont and Loeffler boilers 1.3 Introduction to steam Turbines- Impulse and reaction turbine 1.4 Layout of Portable Generator, Manufacturers and specifications of portable generator 1.5 Introduction to portable generators: I.C engine 1.6 Mechanical parameters measurement- Introduction to •Pressure measurement: Bourdon tube pressure gauge •Temperature measurement: Optical pyrometer, Thermocouple •Heat measurement: Calorimeter •Speed measurement of rotating elements: Tachometer, Stroboscope 1.7 Preliminary mechanical faults occurred in steam boilers and turbines	Demonstrate various models/Charts of boilers and turbines .

BASIC MECHANICAL ENGINEERING **Course Code : 312006**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Use of mechanical components in simple Machines/ equipment TLO 2.2 Select appropriate material handling system. TLO 2.3 Identify faults in Industrial Material handling systems	**Unit - II Industrial Material handling systems and components** 2.1 Mechanical components for motion and power transmission: Types and uses of • Gears • Belt drives • Chain drives • Bearings • Couplings 2.2 Introduction to material handling systems: Manufacturers, specifications, construction and working of • Material transfer lifts, • Conveyors, • Overhead cranes 2.3 Preliminary mechanical faults occurred in Industrial Material handling systems	Demonstration of various mechanical components using charts and models
3	TLO 3.1 List different components of hydraulic turbines and Pumps. TLO 3.2 Explain working of hydraulic pumps. TLO 3.3 Identify faults in hydraulic equipment	**Unit - III Hydraulic pumps, turbines, and equipment** 3.1 Layout of Hydraulic Power Plant, Major hydraulic power plants in India 3.2 Introduction to hydraulic turbines: construction and working of Pelton wheel, Francis turbine, Kaplan turbine 3.3 Introduction to hydraulic pumps: construction and working centrifugal pump, reciprocation pump and submersible pump 3.4 Preliminary mechanical faults occurred in Centrifugal, reciprocating, and submersible pumps	Demonstrate working of Hydraulic power plant /Pumps using Chart/models
4	TLO 4.1 Explain working of air compressor. TLO 4.2 List different components of refrigerator and air conditioner. TLO 4.3 Explain working of refrigerator and air conditioner. TLO 4.4 Identify faults in Refrigeration and air conditioning equipment system	**Unit - IV Compressor, Refrigeration and Air conditioning equipment** 4.1 Introduction to Compressor- Manufacturers, Specifications, construction and working of reciprocating compressor, screw compressor 4.2 Introduction to Refrigeration and Air conditioning : Vapour compression cycle, Construction and working of simple domestic refrigerator and window air conditioner, Manufacturers and specification 4.3 Preliminary mechanical faults occurred in reciprocating compressor and Refrigeration and air conditioning equipment	Demonstrate air compressor, Refrigeration system and air conditioning system using charts.

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs

BASIC MECHANICAL ENGINEERING **Course Code : 312006**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify different components of Thermal Power Plants	1	*Identify steam boilers using models and charts	2	CO1
LLO 2.1 Observe working of Steam turbine	2	*Demonstrate working of steam turbine	2	CO1
LLO 3.1 Use temperature measuring devices	3	*Measure temperature of different equipment using temperature measuring devices.	2	CO1
LLO 4.1 Use pressure measuring devices	4	*Measure pressure of different equipment using pressure measuring devices	2	CO1
LLO 5.1 Use speed measuring devices	5	Measure speed of different rotating elements using sped measuring devices.	2	CO1
LLO 6.1 Use heat measuring devices	6	Measure heat of given fluid using calorimeter	2	CO1
LLO 7.1 Observe working of portable generator	7	Demonstrate working of portable generator	2	CO1
LLO 8.1 Select different drive system for given application with justification	8	*Identify drive system using models/ actual set up.	2	CO2
LLO 9.1 Calculate velocity ratio of given mechanical system	9	*Calculate Velocity Ratio of given gear/belt drive of suitable mechanical system.	2	CO2
LLO 10.1 Identify different components of material handling system used in Industry	10	Demonstrate working of lift / conveyor used in Industry.	2	CO2
LLO 11.1 Observe working of material handling system used in Industry	11	Demonstrate working of Overhead Crane used in Industry	2	CO2
LLO 12.1 Observe working of Hydraulic power plant.	12	*Demonstrate Working of Hydraulic Power plant using pelton wheel turbine set up or suitable turbine models /set up	2	CO3
LLO 13.1 Use of centrifugal pump for given application	13	*Identify different components of Centrifugal Pump.	2	CO3
LLO 14.1 Use of reciprocating pump for given application	14	Identify different components of Reciprocating Pump	2	CO3
LLO 15.1 Use pressure and temperature measuring devices	15	*Measure pressure, Temperature at different points of Air Compressor.	2	CO4
LLO 16.1 Calculate velocity ratio of given air compressor	16	*Calculate Speed ratio of Belt Drive used in air compressor and Driven Motor.	2	CO2 CO4
LLO 17.1 Identify different components of household refrigerator	17	*Demonstrate working of household refrigerator for identifying different components and type.	2	CO4
LLO 18.1 Identify different components of window air conditioner	18	Demonstrate working of window air conditioner for identifying different components	2	CO4
LLO 19.1 Collect information related to water lifting systems in ancient India.(IKS)	19	*Collect information of water lifting systems in ancient India relation with Hydraulic pumps (IKS)	2	CO1 CO2 CO3 CO4

BASIC MECHANICAL ENGINEERING **Course Code : 312006**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

NA

- NA

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Model of Babcock Wilcox Boiler	1
2	Model of Lamont Boiler	1
3	Model of Loeffler Boiler	1
4	Charts of Thermal power Plant, Steam Boilers, Steam turbines	2
5	Mercury/Alcohol Thermometers (Range 0 to 150 °C)	3,15
6	Optical Thermometer/Pyrometer (Range 30 to 400 °C)	3,15
7	Bourdon Tube Pressure Gauge (Range 0 to 15 bar)	4,15
8	Portable generator with load bank minimum capacity 2.2 kVA	7
9	Tube in Tube type water calorimeter with temperature measuring devices	6
10	Digital Tachometer (Max. speed 10000 rpm)	5,16
11	Stroboscope (Max. speed 10000 rpm)	5,16
12	Models of Different gears- Spur, Helical, Bevel, Worm and worm, Rack and Pinion	8,9
13	Models of Belt drive- Open and Cross Flat Belt, V belt	8,9
14	Models of Chain Drive- Sprockets and chain	8,9
15	Deep groove Ball bearings – Single row, self-aligned, Roller	8,9
16	Working model of Belt and Pulley for determining speed ratio	8,9
17	Working model of Gear train for determining speed ratio	8,9
18	Pelton wheel turbine set up or working models of turbines	13
19	Centrifugal pump -minimum up to single phase 0.5 HP/Reciprocating pump-minimum up to 1 HP	14
20	Household refrigerator- minimum up to 165 liter	17
21	Air Compressor- Multistage reciprocating, pressure up to 12 bar, Motor- 1 HP	15,16
22	Window air conditioner capacity minimum1.5 TR	18

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Power plants equipment	CO1	8	0	0	0	0

BASIC MECHANICAL ENGINEERING **Course Code : 312006**

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
2	II	Industrial Material handling systems and components	CO2	8	0	0	0	0
3	III	Hydraulic pumps, turbines, and equipment	CO3	7	0	0	0	0
4	IV	Compressor, Refrigeration and Air conditioning equipment	CO4	7	0	0	0	0
Grand Total				**30**	**0**	**0**	**0**	**0**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Term work
- "Each practical will be assessed considering 60% weightage to process 40% weightage to product" & other instructions of Assessment.

Summative Assessment (Assessment of Learning)

- Practical
- "Each practical will be assessed considering 60% weightage to process 40% weightage to product" & other instructions of Assessment.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	-	-	2	-	-	2			
CO2	2	-	-	2	-	-	2			
CO3	2	-	-	2	-	-	2			
CO4	2	-	-	-	-	-	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	P.K.Nag	Power Plant Engineering	McGraw Hill Education ,ISBN: 978-9339204044
2	R.K. Rajput	Power Plant Engineering	Tata-McGraw Hill Education. ISBN : 9788131802557

Sr.No	Author	Title	Publisher with ISBN Number
3	K. Subramanya	Hydraulic Machines	McGraw Hill Education (India) Private, ISBN, 1259006840, 9781259006845
4	S.S.Rattan	Theory of Machines	Tata-McGraw Hill Education. ISBN, 1283187124, 9781283187121
5	C. P. Arora	Refrigeration and Air conditioning	Tata-McGraw Hill Education ISBN-13: 978-0-07-008390-5
6	Mahadevan B., Bhat Vinayak Rajat, Nagendra Pavana R.N.	Introduction to Indian Knowledge System(IKS) : concepts and Applications	PHI Learning Pvt. Ltd., ISBN -2022,9391818218, 9789391818210
7	Siddhartha Ray	Introduction to Materials Handling	New Age International Private Limited; ISBN-9788122440072

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=IdPTuwKEfmA	Steam Power Plant working animation
2	https://www.youtube.com/watch?v=fk3DjD9gSsk	Principle and working of Steam boiler animation
3	https://www.youtube.com/watch?v=dVBoZ4PfZmE	Working of Steam boiler animation
4	https://www.youtube.com/watch?v=SPg7hOxFItI	Working of Steam turbine animation
5	https://www.youtube.com/watch?v=N70vbRbF36A	Mechanical Drive System
6	https://www.youtube.com/watch?v=hhE_2oVIZiI	Manual Material Handling system
7	https://www.youtube.com/watch?v=o_C2XISZ3Uc	Belt conveyor animation
8	https://www.youtube.com/watch?v=-hooifWJ1jY	Hydraulic Power Plant animation
9	https://www.youtube.com/watch?v=BaEHVpKc-1Q	Principle of Centrifugal Pump
10	https://www.youtube.com/watch?v=XpcCUtYzwy0	Centrifugal Pump working animation
11	https://www.youtube.com/watch?v=41vb6T42_Tk	Reciprocating Pump - Construction and working
12	https://www.youtube.com/watch?v=3BCiFeykRzo&t=155s	Water turbine (Francis)
13	https://www.youtube.com/watch?v=7NwxMyqUyJw	Refrigerator system working animation
14	https://www.youtube.com/watch?v=FzydmAmZM54	Window Air Conditioner working animation
15	https://www.youtube.com/watch?v=PjcdqAkP0UA	Vapour compression system construction and working
16	https://www.youtube.com/watch?v=_qyF1yolDgY	Problems & Remedies of Centrifugal Pump
17	https://www.youtube.com/watch?v=k0NOLbZXSNc	Refrigeration - System Troubleshooting
18	https://www.indiawaterportal.org/articles/persian-wheel-water-lifting-device-kolar-karnataka	Information on Persian wheel : The water lifting device in Kolar, Karnataka (IKS)
19	https://www.youtube.com/watch?v=eCNpJ-_iksQ&t=5s	Persian wheel : The water lifting device in Kolar, Karnataka (IKS)
20	https://rezavisblastfromthepast.co.in/2018/04/30/the-early-waterlifting-devices-dhenkli-or-shaduf-and-the-araghatta-noria/	The early waterlifting devices: Dhenkli or shaduf and the araghatta (Noria) (IKS)

APPLIED MATHEMATICS **Course Code : 312301**

Programme Name/s	**: Architecture Assistantship/ Automobile Engineering./ Artificial Intelligence/ Agricultural Engineering/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Architecture/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Computer Hardware & Maintenance/ Instrumentation & Control/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Instrumentation/ Interior Design & Decoration/ Interior Design/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Medical Electronics/ Production Engineering/ Electronics & Computer Engg./**
Programme Code	**: AA/ AE/ AI/ AL/ AN/ AO/ AT/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CW/ DE/ DS/ EE/ EJ/ EP/ ET/ EX/ HA/ IC/ IE/ IF/ IH/ IS/ IX/ IZ/ LE/ ME/ MK/ MU/ PG/ TE/**
Semester	**: Second**
Course Title	**: APPLIED MATHEMATICS**
Course Code	**: 312301**

I. RATIONALE

An Applied Mathematics course, covering integration, definite integration, differential equations, numerical methods, and probability distribution, equips engineering students with essential problem-solving tools. It enables them to model and analyze complex systems, make informed decisions and address real-world engineering challenges effectively.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Engineers applying Mathematics should proficiently solve complex real-world problems, enhancing decision-making, design and innovation with precision and efficiency.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Solve the broad-based engineering problems of integration using suitable methods.
- CO2 - Use definite integration to solve given engineering related problems.
- CO3 - Apply the concept of differential equation to find the solutions of given engineering problems.
- CO4 - Employ numerical methods to solve programme specific problems.
- CO5 - Use probability distributions to solve elementary engineering problems.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

APPLIED MATHEMATICS **Course Code : 312301**

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											Total Marks
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
312301	APPLIED MATHEMATICS	AMS	AEC	3	1	-	-	4	2	3	30	70	100	40	-	-	-	-	-	-	100

Total IKS Hrs for Sem. : 2 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Solve the given simple problem(s) based on rules of integration. TLO 1.2 Evaluate the given simple integral(s) using substitution method. TLO 1.3 Integrate given simple functions using the integration by parts. TLO 1.4 Solve the given simple integral by partial fractions.	**Unit - I Indefinite Integration** 1.1 Simple Integration: Rules of integration and integration of standard functions 1.2 Integration by substitution. 1.3 Integration by parts. 1.4 Integration by partial fractions (only linear non repeated factors at denominator of proper fraction).	Improved Lecture Demonstration Chalk-Board Presentations Video Demonstrations
2	TLO 2.1 Solve given examples based on Definite Integration. TLO 2.2 Use properties of definite integration to solve given problems.	**Unit - II Definite Integration** 2.1 Definite Integration: Definition, rules of definite integration with simple examples. 2.2 Properties of definite integral (without proof) and simple examples.	Video Simulation Chalk-Board Improved Lecture Presentations

APPLIED MATHEMATICS **Course Code : 312301**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Find the order and degree of given differential equations. TLO 3.2 Form simple differential equation for given elementary engineering problems. TLO 3.3 Solve given differential equations using the methods of Variable separable and Exact Differential Equation(Introduce the concept of partial differential equation). TLO 3.4 Solve given Linear Differential Equation.	**Unit - III Differential Equation** 3.1 Concept of Differential Equation. 3.2 Order, degree and formation of Differential equations 3.3 Methods of solving differential equations: Variable separable form, Exact Differential Equation, Linear Differential Equation.	Video Demonstrations Presentations Chalk-Board Improved Lecture Flipped Classroom
4	TLO 4.1 Find roots of algebraic equations by using appropriate methods. TLO 4.2 Solve the system of equations in three unknowns by iterative methods. TLO 4.3 Solve problems using Bakhshali iterative method for finding approximate square root. (IKS)	**Unit - IV Numerical Methods** 4.1 Solution of algebraic equations: Bisection method, Regula falsi method and Newton –Raphson method. 4.2 Solution of simultaneous equations containing three Unknowns by iterative methods: Gauss Seidal and Jacobi's method. 4.3 Bakhshali iterative method for finding approximate square root. (IKS)	Video SCILAB Spreadsheet Chalk-Board Flipped Classroom Presentations
5	TLO 5.1 Solve given problems based on repeated trials using Binomial distribution. TLO 5.2 Solve given problems when number of trials are large and probability is very small. TLO 5.3 Utilize the concept of normal distribution to solve related engineering problems.	**Unit - V Probability Distribution** 5.1 Binomial distribution. 5.2 Poisson's distribution. 5.3 Normal distribution.	Video ORANGE Chalk-Board Improved Lecture Presentations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Solve simple problems of Integration by substitution	1	*Integration by substitution	1	CO1
LLO 2.1 Solve integration using by parts	2	*Integration by parts	1	CO1
LLO 3.1 Solve integration by partial fractions(only linear non repeated factors at denominator of proper fraction).	3	Integration by partial fractions.	1	CO1
LLO 4.1 Solve examples on Definite Integral based on given methods.	4	Definite Integral based on given methods.	1	CO2
LLO 5.1 Solve problems on properties of definite integral.	5	*Properties of definite integral	1	CO2

APPLIED MATHEMATICS **Course Code : 312301**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 6.1 Solve given problems for finding the area under the curve and volume of revolution.	6	* #Area under the curve and volume of revolution.(Only for Civil and Mechanical Engineering Group)	1	CO2
LLO 7.1 Solve examples on mean value and root mean square value.	7	* #Mean value and root mean square value. (Only for Computer, Electrical and Electronics Engineering Group)	1	CO2
LLO 8.1 Solve examples on order, degree and formation of differential equation.	8	Order, degree and formation of differential equation.	1	CO3
LLO 9.1 Solve first order first degree differential equation using variable separable method.	9	Variable separable method.	1	CO3
LLO 10.1 Solve first order first degree differential equation using exact differential equation and linear differential equation.	10	*Exact differential equation and linear differential equation.	1	CO3
LLO 11.1 Solve engineering application problems using differential equation.	11	*Applications of differential equations.(Take programme specific problems)	1	CO3
LLO 12.1 Solve problems on Bisection method and Regula falsi method.	12	*Bisection method and Regula falsi method.	1	CO4
LLO 13.1 Solve problems on Newton-Raphson method.	13	Newton- Raphson method.	1	CO4
LLO 14.1 Solve problems on Jacobi's method and Gauss Seidal Method.	14	Jacobi's method and Gauss Seidal Method.	1	CO4
LLO 15.1 Use Bakhshali iterative methods for finding approximate value of square root. (IKS)	15	*Bakhshali iterative methods for finding approximate value of square root. (IKS)	1	CO4
LLO 16.1 Solve engineering problems using Binomial distribution.	16	*Binomial Distribution	1	CO5
LLO 17.1 Solve engineering problems using Poisson distribution.	17	*Poisson Distribution	1	CO5
LLO 18.1 Solve engineering problems using Normal distribution.	18	Normal Distribution	1	CO5
LLO 19.1 Solve problems on Laplace transform and properties of Laplace transform.	19	* # Laplace transform and properties of Laplace transform.(Only for Electrical and Electronics Engineering Group)	1	CO2
LLO 20.1 Solve problems on Inverse Laplace transform and properties of Inverse Laplace transform.	20	* # Inverse Laplace transform and properties of Inverse Laplace transform.(Only for Electrical and Electronics Engineering Group)	1	CO2

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING /

APPLIED MATHEMATICS **Course Code : 312301**

SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- NA

Assignment

- NA

Note :
NA

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Open-source software like wolfram alpha, SageMaths, MATHS3D, GeoGebra, Graph, DPLOT, and Graphing Calculator (Graph Eq2.13), ORANGE can be used for Algebra, Calculus, Trigonometry and Statistics respectively.	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Indefinite Integration	CO1	15	2	6	12	20
2	II	Definite Integration	CO2	8	2	4	6	12
3	III	Differential Equation	CO3	8	2	4	6	12
4	IV	Numerical Methods	CO4	6	2	4	8	14
5	V	Probability Distribution	CO5	8	2	4	6	12
Grand Total				**45**	**10**	**22**	**38**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Tests

Summative Assessment (Assessment of Learning)

- End Term Exam

XI. SUGGESTED COS - POS MATRIX FORM

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APPLIED MATHEMATICS **Course Code : 312301**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	-	-	1	-	1			
CO2	3	1	-	-	1	-	1			
CO3	3	2	1	1	1	1	1			
CO4	2	3	2	2	1	1	1			
CO5	2	2	1	1	2	1	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Grewal B. S.	Higher Engineering Mathematics	Khanna publication New Delhi, 2013 ISBN: 8174091955
2	Dutta. D	A text book of Engineering Mathematics	New age publication New Delhi, 2006 ISBN: 978- 81-224-1689-3
3	Kreysizg, Ervin	Advance Engineering Mathematics	Wiley publication New Delhi 2016 ISBN: 978-81- 265-5423-2
4	Das H.K.	Advance Engineering Mathematics	S Chand publication New Delhi 2008 ISBN: 9788121903455
5	S. S. Sastry	Introductory Methods of Numerical Analysis	PHI Learning Private Limited, New Delhi. ISBN-978-81-203-4592-8
6	C. S. Seshadri	Studies in the History of Indian Mathematics	Hindustan Book Agency (lndia) P 19 Green Park Extension New Delhi. ISBN 978-93-80250-06-9
7	Marvin L. Bittinger David J.Ellenbogen Scott A. Surgent	Calculus and Its Applications	Addison-Wesley 10th Edition ISBN-13: 978-0-321-69433-1
8	Gareth James, Daniela Witten,Trevor Hastie Robert andTibshirani	An Introduction to StatisticalLearning with Applications in R	Springer New York Heidelberg Dordrecht LondonISBN 978-1-4614-7137-0 ISBN 978-1-4614-7138-7 (eBook)

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	http://nptel.ac.in/courses/106102064/1	Online Learning Initiatives by IITs and IISc
2	https://www.khanacademy.org/math?gclid=CNqHuabCys4CFdOJaddHoPig	Concept of Mathematics through video lectures and notes
3	https://www.wolframalpha.com/	Solving mathematical problems, performing calculations, and visualizing mathematical concepts.

APPLIED MATHEMATICS **Course Code : 312301**

Sr.No	Link / Portal	Description
4	http://www.sosmath.com/	Free resources and tutorials
5	http://mathworld.wolfram.com/	Extensive math encyclopedia with detailed explanations of mathematical concepts
6	https://www.mathsisfun.com/	Explanations and interactive lessons covering various math topics, from basic arithmetic to advanced
7	http://tutorial.math.lamar.edu/	Comprehensive set of notes and tutorials covering a wide range of mathematics topics.
8	https://www.purplemath.com/	Purplemath is a great resource for students seeking help with algebra and other foundational mathematics to improve learning.
9	https://www.brilliant.org/	Interactive learning in Mathematics
10	https://www.edx.org/	Offers a variety of courses
11	https://www.coursera.org/	Coursera offers online courses in applied mathematics from universities and institutions around the globe.
12	https://ocw.mit.edu/index.htm	The Massachusetts Institute of Technology (MIT) offers free access to course materials for a wide range of mathematical courses.

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MSBTE Approval Dt. 29/11/2023 **Semester - 2, K Scheme**

APPLIED SCIENCE **Course Code : 312308**

Programme Name/s	**: Automobile Engineering./ Agricultural Engineering/ Automation and Robotics/ Civil Engineering/ Civil & Rural Engineering/ Construction Technology/ Electrical Engineering/ Electrical Power System/ Instrumentation & Control/ Instrumentation/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Production Engineering**
Programme Code	**: AE/ AL/ AO/ CE/ CR/ CS/ EE/ EP/ IC/ IS/ LE/ ME/ MK/ PG**
Semester	**: Second**
Course Title	**: APPLIED SCIENCE**
Course Code	**: 312308**

I. RATIONALE

Diploma engineers have to deal with various processes, materials and machines. The comprehension of concepts and principles of Science like Elasticity, motion, Oscillation, Photoelectricity, X rays ,LASER, Nanomaterials, metals, alloys, water treatment ,fuel and combustion, cells and batteries will help the students to use relevant materials ,processes and methods for various engineering applications .

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to attain following industry/ employer expected outcome through various teaching learning experiences. Apply the principles of physics and chemistry to solve broad-based engineering problems.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Select relevant material in industries by analyzing its physical properties .
- CO2 - Apply the concept of simple harmonic motion , resonance and ultrasonic sound for various engineering applications.
- CO3 - Apply the concept of modern Physics (X-rays, LASER, Photosensors and Nanotechnology) for various engineering applications.
- CO4 - Use the relevant metallurgical processes in different engineering applications.
- CO5 - Use relevant water treatment processes to solve industrial problems.
- CO6 - Use appropriate fuel and electrolyte for engineering applications.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical							
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA			
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min		
312308	APPLIED SCIENCE	ASC	DSC	4	-	4	-	8	4	1.5	30	70*#	100	40	50	20	50@	20	-	-	200	

APPLIED SCIENCE **Course Code : 312308**

Total IKS Hrs for Sem. : 4 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Apply the concept of elasticity and plasticity to select the material for engineering applications. TLO 1.2 Establish relation between given types of moduli of elasticity. TLO 1.3 Predict the behavior of the given metallic wire. TLO 1.4 Explain the relevant Newton's laws of motion for the given moving object. TLO 1.5 Calculate the work, power, energy for the given situation.	**Unit - I Properties of matter and kinematics** 1.1 Deforming Force and Restoring Force, Elasticity, Plasticity, Rigidity. 1.2 Stress and Strain and their types, elastic limit and Hooke's law, types of moduli of elasticity. 1.3 Stress -Strain diagram, Poisson's ratio, factors affecting elasticity 1.4 Newton's laws of motion, and their applications. 1.5 Angular displacement, angular velocity, angular acceleration, three equations of angular motion,projectile motion, trajectory, range of projectile angle of projection ,time of flight 1.6 Work, power and energy: potential energy, kinetic energy, work –energy principle.	Improved lecture Video Demonstrations Model Demonstration

APPLIED SCIENCE **Course Code : 312308**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Find the parameters required to analyze the given wave motion and simple harmonic motion. TLO 2.2 Explain the concept of resonance and its applications. TLO 2.3 Describe the properties of given ultrasonic waves. TLO 2.4 Explain the given method of production of ultrasonic waves .	**Unit - II Waves and Oscillations** 2.1 Sound waves, amplitude, frequency, time - period, wave-length and velocity of wave, relation between velocity, frequency and time - period of wave. 2.2 Simple Harmonic Motion , Uniform Circular Motion as Simple Harmonic Motion, Equation of simple harmonic motion , Phase of Simple Harmonic Motion. 2.3 Resonance , Application of resonance. 2.4 Resonance concept in prehistoric times, concept of different frequencies (Mantras) used to ignite different chakras in body (IKS). 2.5 Ultrasonic waves, properties of ultrasonic waves. 2.6 Piezoelectric and Magnetostriction method to produce ultrasonic waves . 2.7 Applications of ultrasonic waves.	Improved lecture Demonstration Video Demonstrations
3	TLO 3.1 Explain properties of photon on basis Planck's hypothesis. TLO 3.2 Explain the construction and working of given photoelectric device. TLO 3.3 Explain the method to produce X-Rays with its properties and engineering applications. TLO 3.4 Differentiate between LASER and ordinary light. TLO 3.5 Explain the given terms related to LASER. TLO 3.6 Describe the properties of nanomaterials and its various applications.	**Unit - III Modern Physics (Photoelectricity , X rays, LASER and nanotechnology)** 3.1 Planck's hypothesis, properties of photons. 3.2 Photo electric effect: threshold frequency, threshold wavelength, stopping potential, Work function, characteristics of photoelectric effect, Einstein's photoelectric equation 3.3 Photoelectric cell and LDR : principle ,Working and applications 3.4 Production of X-rays by modern Coolidge tube, properties and engineering applications. 3.5 Laser: properties, absorption, spontaneous and stimulated emission, 3.6 Population inversion, active medium, optical pumping, three energy level system, He-Ne Laser. 3.7 Engineering applications of Laser. 3.8 Nanotechnology : Properties of nanomaterials (optical, magnetic and dielectric properties) , applications of nanomaterials, Metallic Bhasma (Ancient Ayurveda, IKS).	Improved lecture Presentations Demonstration Video Demonstrations

APPLIED SCIENCE **Course Code : 312308**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Describe the extraction process of the ore. TLO 4.2 Explain Mechanical properties of metals. TLO 4.3 State purposes of making alloys. TLO 4.4 Describe methods of preparation of alloys. TLO 4.5 State Composition ,properties and applications of ferrous and nonferrous alloys.	**Unit - IV Metals and Alloys** 4.1 Ancient Indian Metallurgy (IKS) 4.2 Metals: Occurrence of metals in free and combined state. Basic concepts : Mineral, ore, gangue, flux and slag, metallurgy. 4.3 Metallurgy:Extraction processes of metal from ore Concentration : Gravity separation, electromagnetic separation, froth floatation, calcination and roasting, Reduction : Smelting, aluminothermic process, Refining,poling , electrorefining. 4.4 Mechanical properties of metals :Hardness, ductility, malleability, tensile strength, toughness, machinability, weldability, forging, soldering, brazing, castability. 4.5 Alloys: Purposes of making alloys with examples. 4.6 Preparation methods of alloys : Fusion, compression. 4.7 Classification of alloys :Ferrous and non-ferrous alloys Ferrous alloys: Composition ,properties and applications of low carbon, medium carbon, high carbon steels. Non-ferrous alloy:Composition ,properties and applications of Brass, Bronze, Duralumin, Tinman Solder, Woods metal.	Chalk-Board Demonstration Case Study Video Demonstrations
5	TLO 5.1 Explain types of hardness of water. TLO 5.2 List salts causing temporary and permanent hardness to water. TLO 5.3 Describe boiler corrosion and caustic embrittlement. TLO 5.4 Explain the given type of water softening process. TLO 5.5 Describe the Wastewater treatment and potable water treatment. TLO 5.6 Solve numerical based on pH and pOH.	**Unit - V Water Treatment** 5.1 Hard and soft water, causes of hardness, types of hardness 5.2 Hard water in boilers and prevention: Boiler corrosion, caustic embrittlement, priming and foaming, scales and sludges,and methods of prevention of boiler corrosion. 5.3 Methods of water softening: lime soda process (hot lime soda and cold lime soda process), zeolite process, ion exchange process. 5.4 Potable water treatment: Sedimentation, coagulation, filtration and sterilization . 5.5 Wastewater treatment: Sewage treatment, BOD and COD of sewage water. 5.6 pH and pOH: Concept of pH, pOH, pH Scale, Numerical.	Chalk-Board Demonstration Case Study Video Demonstrations

APPLIED SCIENCE **Course Code : 312308**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
6	TLO 6.1 Describe the properties of the given type of fuel. TLO 6.2 Describe Proximate analysis and Ultimate analysis of coal samples. TLO 6.3 Calculate the calorific value of the given solid fuel using Bomb calorimeter. TLO 6.4 Describe fractional distillation of crude petroleum. TLO 6.5 Explain properties of liquid fuels. TLO 6.6 Describe composition, properties of given gaseous fuel with their applications. TLO 6.7 Describe production of green hydrogen by electrolysis. TLO 6.8 Describe construction and working of given cells and batteries.	**Unit - VI Fuels and Combustion** 6.1 Fuel: Calorific value and ignition temperature, classification. 6.2 Solid fuels: Coal, Classification and composition , Proximate analysis, Ultimate analysis, Calorific value of coal by Bomb calorimeter. 6.3 Liquid fuels: Fractional distillation of crude petroleum, boiling range, composition, propertie Knocking, cracking, octane number and cetane number. 6.4 Gaseous fuels: Biogas, LPG, and CNG. Combustion equation of gaseous fuels, mass and volume of air required for complete combustion. 6.5 Green hydrogen: Producing green hydrogen by electrolysis from renewable sources , Advantages and disadvantages of green hydrogen. 6.6 Electrical conductance in metals and electrolytes, specific conductance, equivalent conductance, cell constant 6.7 Cells and batteries :Construction ,working and applications of dry cell, lead acid storage cell H2 - O2 fuel cell, Ni-Cd battery and Lithium ion battery	Chalk-Board Demonstration Case Study Video Demonstrations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Use Searle's method to determine the Young's modulus of given wire	1	* Determination of Young's modulus of given wire.	2	CO1
LLO 2.1 Compare young's modulii of different materials of wires .	2	Comparison of Young's modulii of given materials of wires.	2	CO1
LLO 3.1 Use of inclined plane to find the downward force.	3	* Determination of relationship between angle of inclination and downward force using inclined plane.	2	CO1
LLO 4.1 Use projectile motion to find the range from initial launch speed and angle	4	*Determination of range of projectile	2	CO1
LLO 5.1 Use helical spring to find force constant .	5	* Determination of force constant using helical spring .	2	CO2
LLO 6.1 Use resonance tube method to determine velocity of sound	6	* Determination of velocity of sound using resonance tube method.	2	CO2
LLO 7.1 Use Simple pendulum to find acceleration due to gravity .	7	* Determination of acceleration due to gravity by using simple pendulum .	2	CO2
LLO 8.1 Use ultrasonic distance – meter to measure distance of object .	8	Determination of distance of object using ultrasonometer.	2	CO2

APPLIED SCIENCE **Course Code : 312308**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 9.1 Use ultrasonic interferometer to determine velocity of sound	9	Determination of velocity of ultrasonic sound waves in different liquids using ultrasonic interferometer .	2	CO2
LLO 10.1 Use photo electric cell to find dependence of the stopping potential on the frequency of given light source.	10	Determination of the dependence of the stopping potential on the frequency of given light source .(Virtual Lab)	2	CO3
LLO 11.1 Determine I-V characteristics of the given photo electric cell.	11	* Determination of I-V characteristics of photoelectric cell.	2	CO3
LLO 12.1 Determine I-V characteristics of given light dependent resistor.	12	* Determination of I-V characteristics of LDR.	2	CO3
LLO 13.1 Find divergence of given laser .	13	Determination of the divergence of laser beam.	2	CO3
LLO 14.1 Use LASER beam to find the refractive index of glass plate	14	Determination of refractive index of glass plate using laser beam. (Virtual Lab)	2	CO3
LLO 15.1 Find the wavelength of given laser.	15	Determination of wavelength of helium neon laser (Virtual Lab)	2	CO3
LLO 16.1 Prepare KMnO4 solution. LLO 16.2 Prepare standard oxalic acid. LLO 16.3 Standardize KMnO4 solution.	16	Standardization of KMnO4 solution using standard oxalic acid and preparation of Fe alloy sample.	2	CO4
LLO 17.1 Set up titration Assembly. LLO 17.2 Record the observations. LLO 17.3 Calculate percentage of iron in haematite ore by titration method .	17	* Determination of the percentage of iron present in given Haematite ore by KMnO4 solution.	2	CO4
LLO 18.1 Prepare Cu ore sample. LLO 18.2 Calculate percentage of Cu .	18	* Determination of percentage of copper in given copper ore .	2	CO4
LLO 19.1 Prepare EDTA solution of known concentration. LLO 19.2 Determine total hardness of water by titration.	19	*Calculation of total hardness, temporary hardness and permanent hardness of water sample by EDTA method.	2	CO5
LLO 20.1 Prepare acid solution of known concentration. LLO 20.2 Determine alkalinity of water sample.	20	* Determination of the alkalinity of a given water sample.	2	CO5
LLO 21.1 Determine turbidity by using a Nephelometer or simulation.	21	Determination of turbidity of a given water sample by Nephelometric method by using Nephelometer or simulation.	2	CO5
LLO 22.1 Set up titration Apparatus LLO 22.2 Record the observations. LLO 22.3 Calculate dissolved oxygen.	22	Determination of dissolved oxygen in the given water sample.	2	CO5

APPLIED SCIENCE **Course Code : 312308**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 23.1 Prepare AgNO3 Solution of known concentration. LLO 23.2 Calculate chloride content in water sample.	23	Determination of chloride content in the given water sample by Mohr's method.	2	CO5
LLO 24.1 Use universal indicator for PH values. LLO 24.2 Calculate PH value by using PH meter.	24	* Determination of pH value of given solution using pH meter and universal indicator.	2	CO5
LLO 25.1 Use of oven for appropriate temperature settings. LLO 25.2 Calculate moisture and ash content in coal samples.	25	* Determination of the moisture and ash content in a given coal sample using proximate analysis.	2	CO6
LLO 26.1 Set up a Bomb Calorimeter. LLO 26.2 Calculate calorific value.	26	* Determination of calorific value of given solid fuel using Bomb calorimeter.	2	CO6
LLO 27.1 Use gravimetric analysis method LLO 27.2 calculate the percentage of Sulphur.	27	Calculate the percentage of Sulphur in a given coal sample by ultimate analysis. (Gravimetric analysis)	2	CO6
LLO 28.1 Standardize conductivity meter. LLO 28.2 Measure the conductance of given solutions.	28	Determination of conductance of given electrolyte by using a conductivity meter.	2	CO6
LLO 29.1 Set up conductometric titration assembly. LLO 29.2 Record conductance. LLO 29.3 Determine specific conductance and equivalence conductance.	29	* Determination of specific conductance and equivalence conductance of given salt sample solution.	2	CO6
LLO 30.1 Set up conductometric titration assembly. LLO 30.2 Record conductance. LLO 30.3 Determine equivalence point.	30	Determination of equivalence point of acetic acid and ammonium hydroxide using conductivity meter.	2	CO6

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING) : NOT APPLICABLE

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Searle's apparatus(with slotted mass of 0.5 kg each)	1,2
2	An inclined plane , a trolly or a roller , pan , weight box , spring balance spirit level, strong thread , meter scale .	3
3	Retort stand, helical spring , 6 slotted weight of 50 grams ., scale , stop watch.	4
4	Resonance tube , Tuning forks of different frequencies	5

APPLIED SCIENCE **Course Code : 312308**

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
5	Metallic bob , strong thread , stopwatch .	6
6	Ultrasonometer	7
7	ultrasonic interferometer	8
8	Experimental setup for characteristics of photoelectric cell	9,10
9	Experimental setup for characteristics of LDR, optical bench .Source of light ,LDR .	11
10	Laser Source (He Ne, diode laser), optical bench , graph paper, glass plate	12,13,14
11	Electronic balance, with the scale range of 0.001g to 500g. pan size 100 mm; response time 3-5 sec.; power requirement 90-250 V, 10 watt.	All
12	Nephelometer ; Auto-ranging from 20-200 NTU,+/- 2% of reading plus 0.1 NTU, power 220 Volts +/- 10% AC 50 Hz	21
13	pH meter reading up to pH14; ambient temp. -40 to 700 C.; pH/mV resolution:13 bit	24
14	Electric oven inner size 18''x18''x18''; temperature range 100 to 2500 C with the capacity of 40 lt.	25
15	Bomb calorimeter Temperature Resolution:0.001°C Oxygen Filling Automatic /Manual	26
16	Conductivity meter; conductivity range – 0.01 uS /cm to 200 mS/cm, Cell constant – digital 0.1 to 2.00; Temp. range – 0 to 100°C	28,29,30

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Properties of matter and kinematics	CO1	9	3	4	4	11
2	II	Waves and Oscillations	CO2	10	3	5	4	12
3	III	Modern Physics (Photoelectricity , X rays, LASER and nanotechnology)	CO3	11	3	5	4	12
4	IV	Metals and Alloys	CO4	10	2	3	5	10
5	V	Water Treatment	CO5	8	3	4	4	11
6	VI	Fuels and Combustion	CO6	12	3	5	6	14
Grand Total				**60**	**17**	**26**	**27**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two unit tests of 30 marks (Physics 15 marks,Chemistry-15 marks) and average of two unit tests.
- For laboratory learning 50 marks (Physics 25 marks,Chemistry-25 marks).

Summative Assessment (Assessment of Learning)

- End semester assessment of 50 marks for laboratory learning (Physics 25 marks,Chemistry-25 marks).
- End semester assessment of 70 marks through online MCQ examination.

XI. SUGGESTED COS - POS MATRIX FORM

APPLIED SCIENCE **Course Code : 312308**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	1	1	1	1	2			
CO2	3	1	1	1	1	1	2			
CO3	3	2	1	1	1	1	2			
CO4	3	1	-	1	2	2	1			
CO5	3	2	1	2	2	2	1			
CO6	3	1	-	1	2	2	1			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Aryabhatta	The Surya Siddhanta	Baptist mission press, Calcutta
2	Haliday, David; Resnik, Robert and Walker, Jearl	Fundamentals of Physics	John Wiley & sons, Hoboken, USA, 2014 ISBN : 812650823X.
3	Hussain Jeevakhan	Applied Physics II	Publisher: Khanna Book Publishing ISBN: 9789391505578.
4	Narlikar, J.V.;Joshi , A. W.; Ghatak A.K. et al	Physics Textbook Part I - Class XII	National Council of Education Research and Training, New Delhi, 2013, ISBN : 8174506314
5	Narlikar, J.V.;Joshi , A. W.; Ghatak A.K. et al	Physics Textbook Part II - Class XII	National Council of Education Research and Training, New Delhi, 2013, ISBN : 8174506713
6	Jain and Jain	Engineering Chemistry	National Council of Education Research and Training, New Delhi, 2010, ISBN : 8174505083
7	Dara, S. S.	Engineering Chemistry	National Council of Education Research and Training, New Delhi, 2015, ISBN : 8174505660
8	Bagotsky V.S.	Fundamental of electrochemistry	National Council of Education Research and Training, New Delhi, 2013, ISBN : 8174506314.
9	Agnihotri Rajesh	Chemistry for Engineers	Wiley India Pvt. Ltd. New Delhi, 2014, ISBN: 9788126550784.
10	Anju Rawlley, Devdatta V. Saraf	Applied Chemistry with Lab Manual	Khanna Book Publishing Co. (P) Ltd. New Delhi, 2021, ISBN- 978-93-91505-44-8
11	Vairam S.	Engineering Chemistry	Wiley India Pvt. Ltd. New Delhi, 2013, ISBN: 9788126543342

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.iberdrola.com/sustainability/green-hydrogen	Green hydrogen

APPLIED SCIENCE **Course Code : 312308**

Sr.No	Link / Portal	Description
2	https://vedicheritage.gov.in/vedic-heritage-in-present-context/metallurgy	Ancient indian metallurgy (IKS)
3	https://vlab.amrita.edu/?sub=2&brch=193&sim=575&cnt=4	Determine turbidity by using a simulation
4	https://www.britannica.com/science/metallurgy	Metals and alloy
5	https://phet.colorado.edu/en/simulations/ph-scale	PH and POH
6	https://archive.nptel.ac.in/courses/103/105/103105110/	Solid fuel
7	www.physicsclassroom.com	Concepts of Physics
8	www.fearofphysics.com	Fundamental terms in Physics
9	https://iksindia.org	IKS

MSBTE Approval Dt. 29/11/2023 **Semester - 2, K Scheme**

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ELEMENTS OF ELECTRONICS **Course Code : 312309**

Programme Name/s : **Electrical Engineering/ Electrical Power System**
Programme Code : **EE/ EP**
Semester : **Second**
Course Title : **ELEMENTS OF ELECTRONICS**
Course Code : **312309**

I. RATIONALE

Diploma in Electrical Engineering students need to maintain and operate electronics systems. This course deals with basic operating principles and handling of electronics devices to troubleshoot electronics circuits used in Electrical system.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Use electronic components and circuits in electrical equipment and systems

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Identify various electronic components
- CO2 - Use semiconductor diodes in different applications.
- CO3 - Use semiconductor transistors in different applications.
- CO4 - Use different types of Oscillators as per requirement
- CO5 - Test operation of regulated power supply.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical							
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
312309	ELEMENTS OF ELECTRONICS	EOE	DSC	4	-	4	2	10	5	3	30	70	100	40	25	10	25@	10	25	10	175

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ELEMENTS OF ELECTRONICS **Course Code : 312309**

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Differentiate between given active and passive electronic components. TLO 1.2 Calculate value of given resistor and capacitor using colour code and printed information. TLO 1.3 Interpret with sketches given signal. TLO 1.4 Compare characteristics of given voltage and current source	**Unit - I Electronic components and Signals** 1.1 Active and passive components 1.2 Resistor,Capacitor,inductor,symbols,applications,colour codes, specifications 1.3 Concept of Unipolar and Bipolar Devices. 1.4 Classification of signals-sinusoidal, triangular and square 1.5 Signal waveform ,Time and Frequency domain, Representation, Amplitude,Frequency,phase,wavelength 1.6 Voltage and current source Ideal and non ideal Sources Dependent voltage and current sources .	Chalk-Board Assignment Demonstrations Hands-on

ELEMENTS OF ELECTRONICS **Course Code : 312309**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 TLO 2.1 Check the operation of the given diode TLO 2.2 TLO 2.2 Plot V-I characteristic of the given diode TLO 2.3 TLO 2.3 Describe working Principle of given type of Rectifier without and with Filter. TLO 2.4 TLO 2.4 Explain given type of wave shaping circuits	**Unit - II Semiconductor Diodes** 2.1 Construction, symbol, working principle, specification, applications ,types of biasing and V-I characteristic of Zener diode ,LED , Photo diode. Working principle and applications of OLED 2.2 Rectifiers- Full wave center tapped and Bridge Rectifier, circuit diagram, wave forms ,working principle . Rectifier IC KBU 808 Pin diagram and applications 2.3 Parameters of rectifier: Average DC value of current and voltage, ripple factor, PIV of diode, TUF and efficiency of rectifier. 2.4 Need of filters ,Types- C,LC,CLC,L ,circuit diagram wave forms and working principle. 2.5 Wave shaping circuits Linear and non linear wave shaping - RC integrator, RC Differentiator, Diode based Clipper circuits , Diode based Clamper. Circuits	Chalk-Board Assignment Presentations Hands-on
3	TLO 3.1 Describe the working of the given type of transistors TLO 3.2 Compare the performance of three type of transistor configurations. TLO 3.3 Solve simple numerical on Current gains. TLO 3.4 Use transistor for various applications (Amplifier and Switch) . TLO 3.5 Explain working of given type of JFET and MOSFET.	**Unit - III Semiconductor Transistors** 3.1 Current operating Devices, Bipolar Junction Transistor- Types NPN , PNP, symbol, construction and working principle . 3.2 Need of biasing ,Types- Fixed bias and Voltage divider bias 3.3 Regions of operation and their significance - Cut off region , Active region and Saturation region 3.4 Transistor configurations: CB, CE, CC, working , comparison and applications 3.5 Transistor parameters- Alpha, Beta, Gama, Input, and output resistance, Relationship between alpha and beta, numerical on same. 3.6 Applications- Transistor as an amplifier- Small signal and power amplifier , Class A, Class B, Class C, Class AB Amplifier , Transistor as a switch , 3.7 Voltage operating devices, Construction Of JFET(N-Channel and P channel),symbol ,working principle, different parameters of JFET and applications. 3.8 MOSFET: Construction ,symbol ,working principle of Enhancement and Depletion MOSFET, and their applications.	Chalk-Board Assignment Demonstration Hands-on

ELEMENTS OF ELECTRONICS **Course Code : 312309**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Explain working principle of Oscillator with its need. TLO 4.2 Compare the performance of the given feedback. TLO 4.3 Explain Barkhausen's criterion. TLO 4.4 Describe working of the given type of oscillator with circuit diagram.	**Unit - IV Oscillators** 4.1 Oscillator: Need, Definition 4.2 Types of feedback: Positive feedback, Negative feedback. Barkhausen's criterion 4.3 Oscillator: Circuit Diagram , working and comparison of RC ,LC, and Crystal oscillator. 4.4 Types of RC oscillator- Wien bridge and RC Phase shift Oscillator Frequency calculation 4.5 Types of LC oscillator-Colpitts oscillators ,Hartley oscillators.Frequency calculation	Chalk-Board Assignment Demonstration Hands-on
5	TLO 5.1 Explain parameters of voltage regulators. TLO 5.2 Calculate output voltage of the given regulator. TLO 5.3 Check the working of the given type of regulator ICs. TLO 5.4 Explain working of SMPS.	**Unit - V Regulators and power supply.** 5.1 Voltage regulation Load and line regulation :Definition, formulae 5.2 Block diagram, Construction, and operation of DC Regulated power supply 5.3 Basic Zener diode as a voltage regulator. 5.4 Regulator IC's: IC's 78XX,79XX ,IC 723 as fixed, variable and Dual Regulated DC power supply 5.5 Switch mode power supply: Need, block diagram and working.	Chalk-Board Assignment Demonstration Hands-on

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify active and passive components in given circuit LLO 1.2 Measure the value of given resistors on Digital Multimeter(DMM) LLO 1.3 Test Diode and LED on Digital Multimeter.	1	Identification of Active and Passive components and DMM handeling.	4	CO1
LLO 2.1 Measure amplitude, time period and frequency of given signal on CRO	2	Measurement of amplitude, time period and frequency of given signal on CRO	2	CO1
LLO 3.1 Check PN junction Diode in forward bias. and Plot the V-I characteristics of PN junction diode and determine cut in voltage.	3	Check the performance of PN Junction diode.	2	CO2
LLO 4.1 Check the performance of Zener diode in forward and reverse biasing	4	* Check performance of Zener diode.	2	CO2
LLO 5.1 Build the circuit for Photo Diode and Observe the change in current with change in light intensity of the source	5	Test the performance of photo diode by varying the light intensity as well as the distance of the light source.	2	CO2

ELEMENTS OF ELECTRONICS **Course Code : 312309**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 6.1 Construct and test half wave rectifier on breadboard .	6	* Construct and Test the half wave rectifier.	2	CO2
LLO 7.1 Prepare the circuit for Half Wave Rectifier with LC filter/ pi filter using PN junction Diode . LLO 7.2 Observe and draw input & output waveforms for sinusoidal wave .	7	*Prepare and Test the half wave rectifier with LC filter/ π filter	2	CO2
LLO 8.1 Build the circuit for Full Wave Centre Tapped Rectifier using PN junction Diode. LLO 8.2 Observe and draw input & output waveform for sinusoidal wave	8	*Build and Test the full wave rectifier using two diodes	2	CO2
LLO 9.1 Construct the circuit for Full Wave Bridge Rectifier using PN junction Diodes LLO 9.2 Observe and draw input and output waveform for sinusoidal wave	9	* Construct and Test the full wave Bridge rectifier on bread board using four diodes	2	CO2
LLO 10.1 Build the circuit for Full Wave Rectifier using PN junction Diode with LC/Pi filter LLO 10.2 Calculate ripple factor for given setup.	10	*Use LC/ π filter with full wave rectifier to measure ripple factor.	2	CO2
LLO 11.1 Prepare the circuit for full wave rectifier using IC KBU 808 with filter LLO 11.2 Observe and draw input & output waveform for sinusoidal wave.	11	* Prepare and Test the full wave rectifier on bread board using IC KBU 808 with filter.	2	CO2
LLO 12.1 Build/Test positive Clipper circuit. LLO 12.2 Build/Test negative Clipper circuit.	12	*Build clipper circuit and observe the waveforms.	2	CO2
LLO 13.1 Construct and Test Positive Clamper Circuit LLO 13.2 Construct and Test negative Clamper Circuit	13	* Construct clamper circuit and observe waveforms.	2	CO2
LLO 14.1 Identify the terminals of the PNP and NPN transistor for TO-5, TO-220, TO-66 LLO 14.2 Selection of transistor for different parameters as max. voltage, current and switching speed	14	Identify and select transistors for given application using datasheets	2	CO3
LLO 15.1 Build the circuit for BJT in common base configuration LLO 15.2 Plot input and output characteristics of common base configuration	15	Build and Test the performance of BJT in CB mode	2	CO3
LLO 16.1 Construct the circuit for BJT in common emitter configuration. LLO 16.2 Plot input and output characteristics of common emitter configuration.	16	* Construct and test the circuit for BJT in common emitter configuration.	2	CO3

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 17.1 Test the performance parameters of BJT as Switch LLO 17.2 Identify Cutoff and saturation regions.	17	*Test the performance parameters of BJT as Switch	2	CO3
LLO 18.1 Build the circuit for FET in common source configuration. LLO 18.2 Plot characteristics for drain to source voltage VDS verses drain current ID for different Values of VGS	18	* Check the performance of FET drain Characterstics.	2	CO3
LLO 19.1 Build the circuit for FET in common source configuration LLO 19.2 Plot characteristics for Gate to source voltage VGS verses drain current ID and calculate transconductance.	19	Test the performance of FET transfer characteristics and calculate transconductance.	2	CO3
LLO 20.1 Build the circuit and measure the frequency of given LC Oscillator circuit LLO 20.2 Build the circuit and measure the frequency of given RC Oscillator circuit	20	Measure the frequency of given Oscillator circuit	2	CO4
LLO 21.1 Test the voltages &waveforms at various Test points of regulated dc power supply. LLO 21.2 Identify the various faults in the Regulated DC power supply	21	*Find out faults at different stages of regulated DC power supply	2	CO5
LLO 22.1 Rectify the various faults in the Regulated DC power supply.	22	*Trouble shoot given DC regulated power supply	2	CO5
LLO 23.1 Build Zener voltage regulator for given voltage. LLO 23.2 Calculate load and line regulation.	23	*Build and Test the performance of Zener voltage regulator for given voltage.	2	CO5
LLO 24.1 Construct the circuit for Positive voltage regulator using 78XX IC. LLO 24.2 Calculate load and line regulation.	24	* Construct and Test the performance of Positive voltage regulator using 78XX , three terminal IC for given voltage.	2	CO5
LLO 25.1 Prepare the circuit for Dual voltage regulator using 78XX and 79XX IC LLO 25.2 Calculate load and Line regulation.	25	* Prepare and Test the performance of Dual voltage regulator using 78XX and 79XX ,three terminal IC for given voltage	2	CO5
LLO 26.1 Build LOW/High voltage regulator circuit using IC LM723. Calculate load and line regulation	26	*Test the performance of IC 723 as Regulator.	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

ELEMENTS OF ELECTRONICS **Course Code : 312309**

Micro project

- Transistor as switch- Build /Test transistor switch circuit on General purpose PCB for various input signals
- Diode: Build a circuit on general purpose PCB to clip a positive half cycle at 1.5 v of a waveform with input signal 5Vpp, and prepare the report
- Diode: Build a circuit on general purpose PCB to clamp a waveform at 3.0 V using diode and passive components.
- Photodiode: Build a circuit on breadboard to turn the relay on and off by using photo diode and prepare a report.
- Rectifier: Build a half wave rectifier for 6V, 500mA output current on general purpose PCB.
- Rectifier: Build a full wave bridge rectifier with capacitor filter for 6V, 500mA output current on general purpose PCB
- Using Data sheets compare various electronic parameters of different types of JFET and MOSFET.
- Transistor as switch- Build /Test transistor switch circuit on General purpose PCB for various input signals
- Transistor- Build a circuit to switch on and off the LED using BJT as a switching component
- Voltage Regulator: Build a circuit of DC regulated power supply on general purpose PCB for 9V and 500mA output
- Oscillator: Build circuit to generate audio frequency.
- Prepare display boards/models/charts to visualize the appearance of electronic active and passive components.

Assignment

- Study Different types of Rectifier ICs available.
- Study working of OLED Display.

Note :

This is a suggestive list of micro project and assignments , Similar activities can be set for relevant skill development For this course in L A scheme 2 hrs per week are allocated for self learning,Course teacher shall allocate micro project or / and assignments by considering 30 hrs SL work . Micro project may be assign for a team of 4 to 5 students .SL work shall be assessment is a formative (continuous)assessment . Depending on allocated task Course teacher shall set rubrics , This continuous assessment record will be helpful for SLA

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Variable DC power supply 0-30V, 2A, SC protection, display for voltage and current.	3,4,11,12,16,17,18,19
2	Cathode Ray Oscilloscope Dual Trace 20Mhz. 1 5Mega ohm Input impedance	5,6,7,8,9,10
3	Function Generator 0-2 MHz with Sine, square and triangular output with variable frequency and amplitude.	2,5,6,7,8,9,10
4	Digital Multimeter: 3 1/2 digit display, 9999 counts digital multimeter measures: Vae Vee (1000V max), Ade- Aae (10 amp max), Resistance (0-100 MS2). Capacitance and Temperature measurement	All
5	Lux meter 3000 Lumen. Battery operated hand held type	4
6	Trainer Kits/Breadboard for Rectifiers, Regulators, Transistors, JFET	5,6,7,8,9,10,11,13,14,16,17,18,19

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Electronic components and Signals	CO1	10	4	4	4	12

ELEMENTS OF ELECTRONICS **Course Code : 312309**

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
2	II	Semiconductor Diodes	CO2	14	4	6	6	16
3	III	Semiconductor Transistors	CO3	14	4	6	6	16
4	IV	Oscillators	CO4	12	4	4	6	14
5	V	Regulators and power supply.	CO5	10	4	4	4	12
Grand Total				**60**	**20**	**24**	**26**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Each practical will be assessed considering 60% weightage to process and 40% product based on the nature of practicals.
- Two formative assessment tests for 30 marks and average of two unit tests.

Summative Assessment (Assessment of Learning)

- End semester assessment of 25 marks for laboratory learning
- End semester assessment of 70 marks

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	-	1	1	1	-	2			
CO2	2	-	1	1	2	-	2			
CO3	2	1	1	1	2	1	2			
CO4	2	1	1	1	2	1	2			
CO5	2	1	1	1	2	1	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	V .K. Mehta ,Rohit Mehta	Principles of Electronics	S.Chand and Company Ram Nagar, New Delhi-110 055,11th edition 2014, ISBN 9788121924504
2	B.L.Theraja	Basic Electronics	S. Chand Publishing, 2007,ISBN:9788121925556
3	R.S.Sedha	A textbook of Applied Electronics	S Chand, New Delhi 2008, ISBN:978-8121927833

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Sr.No	Author	Title	Publisher with ISBN Number
4	Mottershead,Allen	Electronic Devices and Circuit: An introduction	Goodyear Publishing Co. New Delhi ISBN: 9780876202654
5	Horowitz, Paul Hill, Winfield	The Art of Electronics	Cambridge University Press, New Delhi 2015 ISBN: 9780521689175
6	Bell, David	Fundamentals of Electronic Devices and Circuits	Oxford University Press, International edition, USA,2015,ISBN:9780195425239
7	Vijay Baru, Rajendra Kaduskar, Sunil T. Gaikwad	Basic Electronic Engineering	Dreamtech press,New Delhi,2015,ISBN:9789350040126

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=Fwj_d3uO5g8	Diodes
2	http://www.eleccircuit.com	Electronic circuit
3	https://www.electroschematics.com/tools/	Electronic tools
4	www.futurlec.com	Electronic tools/components
5	www.alldatasheet.com	Datasheets
6	www.nptel.iitm.ac.in	Electronic circuits
7	www.electronics-tutorials	Electronic circuits
8	https://www.learningaboutelectronics.com/	Voltage Regulator
9	https://www.animations.physics.unsw.edu.au/	Electronic tools/components/Circuit

FUNDAMENTAL OF ELECTRICAL ENGINEERING **Course Code : 312310**

Programme Name/s : **Electrical Engineering/ Electrical Power System**
Programme Code : **EE/ EP**
Semester : **Second**
Course Title : **FUNDAMENTAL OF ELECTRICAL ENGINEERING**
Course Code : **312310**

I. RATIONALE

Technologists in electrical engineering are expected to handle electrical machines, instruments, devices and equipment. The basic aim of this course is that, the student must understand the basic concepts, principles and laws of electric and magnetic circuits and practical thereof. The basic aim of this course is that the student must develop the basic concepts, fundamental laws of electric circuits, magnetic circuits,electromagnetic induction,Capacitors,Batteries and practical thereof. This course will enable the students to apply the fundamental concepts of electrical engineering to understanding of other higher level subjects in further study.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Apply basic principles of electrical engineering to solve the simple electrical engineering problems.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Determine various parameters used in electric circuit.
- CO2 - Use basic laws of electrical engineering in D.C. Circuits.
- CO3 - Use capacitor and battery in electrical circuits.
- CO4 - Use principles of magnetism in Magnetic Circuits.
- CO5 - Apply Laws of electromagnetism in electrical circuit and systems.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
312310	FUNDAMENTAL OF ELECTRICAL ENGINEERING	FEE	DSC	4	-	4	2	10	5	3	30	70	100	40	25	10	25#	10	25	10	175

FUNDAMENTAL OF ELECTRICAL ENGINEERING **Course Code : 312310**

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Interpret the given electric parameters. TLO 1.2 Explain the given terms of electric circuit. TLO 1.3 Explain the given effect of the electric current TLO 1.4 Calculate work, power and energy for the given circuit.	**Unit - I Basic Electrical Parameters** 1.1 Direct Current (DC),Alternating Current (AC), Voltage Source and Current Source: Ideal and Practical. 1.2 Electric Current, Electric Potential, Potential Difference(PD), Electro-Motive Force(EMF) 1.3 Electrical Work, Power and Energy. 1.4 Resistance, Resistivity, Conductivity, Effect of Temperature on Resistance 1.5 Types of Resistor and their application 1.6 Heating Effect, Magnetic Effect, Chemical Effect of Electric current	Chalk-Board Presentations Demonstration Model Demonstration Video Demonstrations
2	TLO 2.1 Apply Ohm's law to calculate internal resistance of the given circuit. TLO 2.2 Calculate equivalent resistance for the given circuit. TLO 2.3 Categorize the given type of network TLO 2.4 Apply the Kirchhoff's current law and Kirchhoff's voltage law to calculate the electrical quantities in the given circuit.	**Unit - II D.C. Circuits** 2.1 Ohm's Law, Internal resistance of source, internal voltage drop, Terminal Voltage. 2.2 Resistance in Series, Resistance in Parallel. (theory and numerical) 2.3 Active, Passive, Linear, Non-linear Circuit, Unilateral Circuit and Bi-lateral Circuit, Passive and Active Network, Node, Branch, Loop, Mesh. 2.4 Comparison of Kirchhoff's Current Law, Kirchhoff's Voltage Law (Simple numericals).	Chalk-Board Demonstration Video Demonstrations Presentations

FUNDAMENTAL OF ELECTRICAL ENGINEERING **Course Code : 312310**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Describe the construction of the given type of capacitor. TLO 3.2 Explain the working of the capacitor in the given circuit. TLO 3.3 Calculate equivalent capacitance in the given D.C. circuit. TLO 3.4 Define Battery and state its types and connections TLO 3.5 Plot charging and discharging curves for the given capacitor and battery.	**Unit - III Capacitors and Battery** 3.1 Capacitor, it's construction, Parallel Plate Capacitor 3.2 Various connections of capacitor. 3.3 Energy Stored in Capacitor. 3.4 Charging and Discharging of Capacitor. 3.5 Breakdown voltage and Di-electric strength. 3.6 Applications of Capacitor 3.7 Types of battery, Construction, series and parallel connection of Battery 3.8 Charging and Discharging of Capacitor and battery	Chalk-Board Video Demonstrations Presentations Model Demonstration Hands-on
4	TLO 4.1 Interpret the terms related to a magnetic circuit. TLO 4.2 Calculate various parameters of the given magnetic circuit. TLO 4.3 Compare the series and parallel magnetic circuit based on the given criteria. TLO 4.4 Plot B-H curve and hysteresis loop of the given magnetic materials.	**Unit - IV Magnetic Circuits** 4.1 Magnetic lines of force, Flux, Flux density, Magnetic flux intensity. 4.2 Magneto-Motive-Forces (MMF), Ampere Turns (AT), Reluctance, Permeance, Reluctivity. 4.3 Electric and Magnetic circuit: Series Magnetic and Parallel Magnetic Circuit. 4.4 Magnetization Curve (B-H Curve) 4.5 Magnetic Hysteresis, Hysteresis Loop, Applications.	Chalk-Board Video Demonstrations Demonstration Model Demonstration Presentations
5	TLO 5.1 Describe the use of Faraday's laws of electromagnetic induction in the given application. TLO 5.2 Distinguish between the given type of e.m.fs. TLO 5.3 Apply Faraday's laws to calculate induced e.m.f. in the given circuit. TLO 5.4 Calculate self-inductance and energy stored in the magnetic field of the given circuit.	**Unit - V Electromagnetic Induction** 5.1 Development of Induced e.m.f. and Current, Faraday's Laws of Electromagnetic Induction. 5.2 Static and dynamic emf, Lenz's Law, Fleming's Right hand rule 5.3 Self Inductance, Coefficient of Self-inductance (L), Mutual inductance, Coefficient of Mutual inductance (M), self induced e.m.f. and mutually induced e.m.f, Coefficient of Coupling. 5.4 Inductance in series 5.5 Types of inductor, their application and Energy Stored in Magnetic Field	Chalk-Board Model Demonstration Video Demonstrations Presentations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 *Draw layout of Electrical Engineering laboratory.	1	Preparation of Layout of Electrical Engineering Laboratory.	2	CO1
LLO 2.1 *Operate the fire extinguishers and prepare charts of the safety rules to be followed in the electrical lab	2	Operation of fire extinguisher and preparation of safety rules charts	2	CO1
LLO 3.1 *Use relevant electric tools for various applications	3	Check lab supply system and make use of relevant electric tools for various applications.	2	CO1

FUNDAMENTAL OF ELECTRICAL ENGINEERING **Course Code : 312310**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 4.1 *Verify Ohm's Law	4	Verification of Ohm's Law	2	CO1 CO2
LLO 5.1 *Able to connect and read multi range analog meters (Ammeter, Voltmeter)	5	Read analog meters for measurement of various electrical quantities in AC/DC circuits.	2	CO1
LLO 6.1 *Operate Multimeter and Clip-On meter for the measurement of AC/DC Current, Voltage and Resistance in the given circuit.	6	Use of Multimeter and Clip-On meter for the measurement of AC/DC Current, Voltage and Resistance in the given circuit	2	CO1 CO2
LLO 7.1 *Check frequency, Time period, Peak Value and Average Value of the given A.C. wave on CRO	7	Measurement of frequency, Time period, Peak Value and Average Value of the given A.C. wave on CRO.	2	CO1 CO2
LLO 8.1 *Verify Kirchoff's Voltage Law	8	Verification of Kirchoff's Voltage Law	2	CO1
LLO 9.1 *Verification of Kirchoff's Current Law.	9	Verification of Kirchoff's Current Voltage Law	2	CO1 CO2
LLO 10.1 **Use rheostat as current regulator and potential divider.	10	Use of rheostat as current regulator and potential divider	2	CO1 CO2
LLO 11.1 *Determine PD,EMF and internal resistance of DC source .	11	Determination of PD,EMF and internal resistance of DC source .	2	CO1 CO2
LLO 12.1 *Verify the properties of circuit of series connected resistance.	12	Verification of parameters of two/three resistances connected in series connection.	2	CO1 CO2
LLO 13.1 *Verify the properties of circuit of parallel connected resistance.	13	Verification of parameters of two/three resistances connected in parallel connection.	2	CO1 CO2
LLO 14.1 Determine the time constant (RC) by plotting the charging curves of a capacitor(C) through resistor (R)	14	Plot the charging characteristics of capacitor and find the time constant (RC).	2	CO1 CO3
LLO 15.1 Determine the time constant (RC) by plotting the discharging curves of a capacitor(C) through resistor (R)	15	Plot the discharging characteristics of capacitor and find the time constant (RC).	2	CO1 CO3
LLO 16.1 * Find the equivalent capacitance in the series connected circuits	16	Verification of the equivalent capacitance in series connected circuits	2	CO1 CO3
LLO 17.1 *Find equivalent capacitance of the parallel connected circuits	17	Verification of equivalent capacitance of the parallel connected circuits	2	CO1 CO3
LLO 18.1 Determine the Rise characteristics of Electric current in a circuit consisting of resistance and inductance in the circuit.	18	Plot the Rise characteristics of Electric current in a circuit consisting of resistance and inductance in the circuit.	2	CO1 CO4
LLO 19.1 Determine the Decay characteristics of Electric current in a circuit consisting of resistance and inductance in the circuit.	19	Plot the decay characteristics of Electric current in a circuit consisting of resistance and inductance in the circuit.	2	CO1 CO4
LLO 20.1 *Find B-H curve for the given magnetic material	20	Plot B-H curve for the given magnetic material.	2	CO4
LLO 21.1 *Obtain magnetization curve for magnetic material	21	Plot magnetization curve for magnetic core	2	CO4
LLO 22.1 *Plot Hysteresis Loop for the given transformer coil	22	Study of Hysterisis loop for the given transformer coil	2	CO4

FUNDAMENTAL OF ELECTRICAL ENGINEERING **Course Code : 312310**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 23.1 *Verify Faraday's Law of Electromagnetic Induction (Statically Induced EMF)	23	Verification of Faraday's Law of Electromagnetic Induction (Statically Induced EMF)	2	CO4 CO5
LLO 24.1 *Verify Faraday's Law of Electromagnetic Induction (Dynamically Induced EMF)	24	Verification of Faraday's Law of Electromagnetic Induction (Dynamically Induced EMF)	2	CO4 CO5
LLO 25.1 Verify Fleming's Right Hand Rule	25	Verification of Fleming's Right Hand Rule	2	CO4 CO5
LLO 26.1 Verify Fleming's Left Hand Rule	26	Verification of Fleming's Left Hand Rule	2	CO4 CO5
LLO 27.1 *Determine Charging and discharging Curves of Battery.	27	Plot the Charging and discharging Curves of Battery	2	CO1 CO3

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- a.Types of Electrical equipment: Prepare chart showing real-life examples indicating various types of electrical equipment.
- b. Resistance: Collect samples of resistors and prepare models of simple series circuit and parallel circuit.
- c. Capacitance: Collect samples of capacitors and prepare models of simple series circuit and parallel circuit.
- d. Inductance: Collect samples of inductors and prepare models of simple series circuit and parallel circuit.
- e. Batteries : Collect samples and specifications of various batteries of different make and prepare chart of the same.
- f. EV-Batteries : Collect samples and specifications of various EV-batteries of different make and prepare chart of the same.
- g. Connect battery in series connection and measure voltage across each battery and total voltage .
- h. Connect battery in parallel connection and measure voltage across each battery and total voltage

Assignment

- a. Numerical based on Voltage and Current Source.

b. Numerical based on Resistance, Resistivity, Effect of temperature on Resistance.
c. Numerical based on Equivalent Resistance of Series and Parallel connection of Resistances in given D.C. Circuits.
d. Numerical based on Equivalent Capacitance in given D.C. Circuits.
e. Numerical based on calculation of various parameters of given magnetic circuit.
f. Numerical based on calculation of self Inductance.
g. Numerical based on Energy Stored in Magnetic Field.

Suggested Student Activity

- a. Illustrate situations wherein electrical energy is required.

b. Prepare models in the form of mini-projects.
c. Prepare power point presentation related to basics of electrical engineering.

d. Prepare a chart of electric circuit elements and relevant industrial application.
e. Prepare question bank referring old MSBTE question papers.

Note :
"These are the just suggestive topics. Faculty must design Microproject/Activities/ Assignments based on Course Outcome requirements".

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Rheostat (0-90 Ohm,5A), Nichrome wire wound rheostat on epoxy resin or class F insulating tube with two fixed and one sliding contact, DC Source, Milliameter	4
2	Lugs, Wire crimping tool, Soldering Gun, Banana clips	5
3	1.CRO with probe,10Hz-30MHz,01No 2.Rheostat of suitable rating 3. Autotransformer of suitable rating	7
4	1.EMF source: Ampere=0-1A ,Voltage=0-20V ,1 No. 2 Voltmeter: Suitable Voltage range,2 No. 3 Ammeter: Suitable current range,1 No 4 Series resistance: Suitable resistance in ohm,2 No.	12
5	1.EMF source: Ampere:0-1A ,Voltage:0-20V ,1 No. 2 Voltmeter: Suitable Voltage range,2 No. 3 Ammeter: Suitable current range,1 No. 4 Parallel resistance: Suitable resistance in ohm,2 No.	13
6	1.EMF source: Ampere=0-1uA,Voltage=0-20V,1 No. 2.Voltmeter: Suitable voltage,1 No. 3. Ammeter: Suitable current,1 No. 4.Capacitors: Suitable capacitor,1 No. 5.Resistance: Suitable resistance ,1 No. 6.Stop watch: Suitable stop watch 1 No.	14
7	1.EMF source: Ampere=0-1uA,Voltage=0-20V,1 No. 2.Voltmeter: Suitable voltage,1 No. 3. Ammeter: Suitable current,1 No. 4.Capacitors: Suitable capacitor,1 No. 5.Resistance: Suitable resistance ,1 No. 6.Stop watch: Suitable stop watch 1 No.	15
8	1.EMF source: Ampere=0-1A, Voltage=0-20V :1 No. 2.Voltmeter : Suitable Voltage,1 No. 3.Ammeter :Suitable Current,1 No. 4.Capacitor:Suitable Capacitor in Farad ,3 No.	16
9	1.EMF source: Ampere=0-1A, Voltage=0-20V :1 No. 2.Voltmeter : Suitable Voltage,1 No. 3.Ammeter :Suitable Current,1 No. 4.Capacitor:Suitable Capacitor in Farad ,3 No.	17
10	1.EMF source : Ampere:0-1A,Voltage:0-300V ,1 No. 2.Voltmeter : Suitable voltage,1 No. 3.Ammeter: Suitable current,1 No. 4.Inductive coil :Suitable Inductor 1 No.	23

FUNDAMENTAL OF ELECTRICAL ENGINEERING **Course Code : 312310**

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
11	1.EMF source: Ampere=0-1A,Voltage:0-300V ,1 No. 2.Voltmeter:Suitable Voltage,1 No. 3.Ammeter :Suitable current,1 No. 4.Inductive coil: Suitable inductor,1 No.	24
12	1.DC motor: Suitable motor:1No	26
13	1.EMF source: Ampere: 0-1A,Voltage:0-300V ,1 No. 2. Voltmeter: Suitable voltage:1 No. 3.Ammeter: Suitable current: 1 No. 4.Inductive coil: Suitable inductor,1 No.	21
14	1.EMF source: Ampere: 0-1A,Voltage:0-300V ,1 No. 2. Voltmeter: Suitable voltage:1 No. 3.Ammeter: Suitable current: 1 No. 4.Inductive coil: Suitable inductor,1 No.	20
15	1:EMF source: Ampere: 0-1A,Voltage:0-300V ,1 No. 2:Voltmeter:Suitable Voltage,1 No. 3:Ammeter: Suitable current,1 No. 4.Transformer :(0.5/1kVA)Suitable transformer,1 No.	22
16	Fire Extinguisher Kit	2
17	Electrical Drawing of the Laboratory	1
18	1.EMF source: Ampere:0-1A,Voltage:0-20V ,1 No. 2.Voltmeter Suitable voltage1 No. 3.Ammeter: Suitable current1 No. 4.Rheostat : Suitable load in ohm,1 No. 5. Resistive Load,1No	10
19	1.DC Generator: Suitable rating,1No	25
20	Stripper, Hammer, Plier, Nose Plier, Multi-meter, tester ,Tachometer, Megger,Standard Wire Gauge crimping tool, wire gauge etc	3
21	Multi-meter, Clip -On Meter, Ammeter ,Voltmeter, Rheostat,etc	6
22	1.Battery or D.C. Supply: Suitable Range 2. Single Pole Two Way Switch 3. Multi-meter 4. Stopwatch 5.A Choke Coil or a resistor in series with inductor	18
23	1.Battery or D.C. Supply: Suitable Range 2. Single Pole Two Way Switch 3. Multi-meter 4. Stopwatch 5.A Choke Coil or a resistor in series with inductor	19
24	1. D.C. Dual Power Supply, 1No 2.D.C. Voltmeter of Suitable Range,3No 3. Rheostat of Suitable Range,3No	8
25	1.Rheostat of suitable range, 3 No 2.D.C. Dual Power Supply ,suitable range,1 No 3.D.C. milli-Ammeter, suitable range,3 No	9

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FUNDAMENTAL OF ELECTRICAL ENGINEERING **Course Code : 312310**

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
26	1.EMF source: Ampere=0-1uA,Voltage=0-20V,1 No. 2.Voltmeter: Suitable voltage,1 No. 3. Ammeter: Suitable current,1 No. 4.Capacitors: Suitable capacitor,1 No. 5.Resistance: Suitable resistance ,1 No. 6.Stop watch: Suitable stop watch 1 No. 7. Suitable EV-Battery Data	27

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Basic Electrical Parameters	CO1	10	2	6	4	12
2	II	D.C. Circuits	CO2	12	4	6	4	14
3	III	Capacitors and Battery	CO3	12	4	6	4	14
4	IV	Magnetic Circuits	CO4	12	4	4	6	14
5	V	Electromagnetic Induction	CO5	14	4	4	8	16
Grand Total				**60**	**18**	**26**	**26**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two unit tests of 30 marks will be conducted and average of two unit tests considered.
- For formative assessment of laboratory learning 25 marks.
- Each practical will be assessed considering appropriate % weightage to process and product and other instructions of assessment.

Summative Assessment (Assessment of Learning)

- End semester summative assessment of 25 marks for laboratory learning.
- End semester assessment of 70 marks through offline mode of examination.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	-	1	-	-	2			
CO2	3	1	1	1	1	-	2			
CO3	3	1	1	2	2	-	2			

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CO4	3	1	1	2	2	-	2			
CO5	3	1	1	2	2	-	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Theraja, B. L. Theraja, A. K.	A Text Book of Electrical Technology Vol-I	S.Chand and Co. New Delhi 2014 ISBN: 9788121924405
2	Mittle, V. N.	Basic Electrical Engg.	Tata McGraw-Hill, New Delhi ISBN : 978-0-07-0088572-5
3	Hughes, Edward	Electrical Technology	Pearson Education, New Delhi ISBN-13: 978-0582405196
4	S. B. Lal Seksena and Kaustuv Dasgupta	Fundamentals of Electrical Engineering Part-1	Cambridge University Press, New Delhi ISBN : 9781107464353
5	Jegathesan V., Vinoth Kumar K., Saravanakumar R.	Basic Electrical and Electronics Engineering	Wiley India, New Delhi 2014 ISBN : 97881236529513
6	Husain Ashfaq	Fundamentals of Electrical Engineering	Dhanpat Rai & Co. (p) Ltd-delhi, ISBN: 978-8177000436

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.electrical4u.com/electrical-engineering-articles/basic-electrical/	Basic Electrical Parameters
2	https://en.wikipedia.org/wiki/Capacitor	Capacitor
3	https://www.corsi.univr.it/documenti/OccorrenzaIns/matdid/matdid441904.pdf	D.C. Circuits
4	https://www.slideshare.net/ChetanPatil396/basic-electrical-parameters-basic-electrical-engineering	Basic Electrical Parameters
5	https://www.britannica.com/science	Magnetic Circuits
6	https://en.wikipedia.org/wiki/Magnetic_circuit	Magnetic Circuits
7	https://en.wikipedia.org/wiki/Electromagnetic_induction	Electromagnetic Induction
8	https://youtu.be/XT-UmPviH64?si=MLIZBB5BgOA2SWBk	Electromagnetic Induction
9	https://youtu.be/M-QfX2fvpp4?si=xpZDAiX3-_7xrnnr	Basics Magnetic Circuits
10	https://archive.nptel.ac.in/courses/117/106/117106108/	Basic Electrical Circuits
11	https://en.wikipedia.org/wiki/Electric_battery	Battery

Maharashtra State Board Of Technical Education, Mumbai

Learning and Assessment Scheme for Post S.S.C Diploma Courses

Programme Name : Diploma In Electrical Engineering / Electrical Power System

Programme Code : EE / EP | **With Effect From Academic Year** : 2023-24

Duration Of Programme : 6 Semester | **Duration** : 16 WEEKS

Semester : Third | **NCrF Entry Level : 3.5** | **Scheme** : K

Sr No	Course Title	Abbrevation	Course Type	Course Code	Total IKS Hrs for Sem.	Learning Scheme					Credits	Assessment Scheme												
						Actual Contact Hrs./Week			Self Learning (Activity/ Assignment /Micro Project)	Notional Learning Hrs /Week		Paper Duration (hrs.)	Theory				Based on LL & TL				Based on Self Learning		Total Marks
																	Practical						
						CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
													Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
(All Compulsory)																								
1	ELECTRICAL CIRCUITS AND NETWORK	ECN	DSC	313332	-	4	-	4	-	8	4	3	30	70	100	40	25	10	50#	20	-	-	175
2	ELECTRICAL POWER GENERATION,TRANSMISSION AND DISTRIBUTION	GTD	DSC	313333	-	4	-	2	2	8	4	3	30	70	100	40	25	10	25@	10	25	10	175
3	ELECTRICAL AND ELECTRONIC MEASUREMENT	EEM	DSC	313334	-	3	-	4	1	8	4	3	30	70	100	40	25	10	25#	10	25	10	175
4	FUNDAMENTALS OF POWER ELECTRONICS	FPE	SEC	313335	-	3	-	4	1	8	4	3	30	70	100	40	25	10	25@	10	25	10	175
5	ESSENCE OF INDIAN CONSTITUTION	EIC	VEC	313002	-	1	-	-	1	2	1	-	-	-	-	-	-	-	-	-	50	20	50
6	ELECTRICAL MATERIAL AND WIRING PRACTICE	EMW	SEC	313015	-	1	-	4	1	6	3	-	-	-	-	-	50	20	25@	10	25	10	100
Total						**16**		**18**	**6**		**20**		**120**	**280**	**400**		**150**		**150**		**150**		**850**

Abbreviations : CL- Classroom Learning , TL- Tutorial Learning, LL-Laboratory Learning, FA - Formative Assessment,SA -Summative Assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends : @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

Course Category : Discipline Specific Course Core (DSC) , Discipline Specific Elective (DSE) , Value Education Course (VEC) , Intern./Apprenti./Project./Community (INP) , AbilityEnhancement Course (AEC) , Skill Enhancement Course (SEC) , GenericElective (GE)

Programme Name/s	**: Architecture Assistantship/ Automobile Engineering./ Artificial Intelligence/ Agricultural Engineering/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Architecture/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Fashion & Clothing Technology/ Dress Designing & Garment Manufacturing/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Food Technology/ Computer Hardware & Maintenance/ Hotel Management & Catering Technology/ Instrumentation & Control/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Instrumentation/ Interior Design & Decoration/ Interior Design/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Medical Laboratory Technology/ Medical Electronics/ Production Engineering/ Printing Technology/ Polymer Technology/ Surface Coating Technology/ Textile Technology/ Electronics & Computer Engg./ Travel and Tourism/ Textile Manufactures**
Programme Code	**: AA/ AE/ AI/ AL/ AN/ AO/ AT/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CW/ DC/ DD/ DE/ DS/ EE/ EJ/ EP/ ET/ EX/ FC/ HA/ HM/ IC/ IE/ IF/ IH/ IS/ IX/ IZ/ LE/ ME/ MK/ ML/ MU/ PG/ PN/ PO/ SC/ TC/ TE/ TR/ TX**
Semester	**: Third**
Course Title	**: ESSENCE OF INDIAN CONSTITUTION**
Course Code	**: 313002**

I. RATIONALE

This course will focus on the basic structure and operative dimensions of Indian Constitution. It will explore various aspects of the Indian political and legal system from a historical perspective highlighting the various events that led to the making of the Indian Constitution. The Constitution of India is the supreme law of India. The document lays down the framework demarcating the fundamental political code, structure, procedures, powers, and sets out fundamental rights, directive principles, and the duties of citizens. The course on constitution of India highlights key features of Indian Constitution that makes the students a responsible citizen. In this online course, we shall make an effort to understand the history of our constitution, the Constituent Assembly, the drafting of the constitution, the preamble of the constitution that defines the destination that we want to reach through our constitution, the fundamental right constitution guarantees through the great rights revolution, the relationship between fundamental rights and fundamental duties, the futurist goals of the constitution as incorporated in directive principles and the relationship between fundamental rights and directive principles.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry /employer expected outcome – Abide by the Constitution in their personal and professional life.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - List salient features and characteristics of the constitution of India.
- CO2 - Follow fundamental rights and duties as responsible citizen of the country.
- CO3 - Analyze major constitutional amendments in the constitution.
- CO4 - Follow procedure to cast vote using voter-id.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
313002	ESSENCE OF INDIAN CONSTITUTION	EIC	VEC	1	-	-	1	2	1	-	-	-	-	-	-	-	-	-	50	20	50

Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Explain the meaning of preamble of the constitution. TLO 1.2 Explain the doctrine of basic structure of the constitution. TLO 1.3 List the salient features of constitution. TLO 1.4 List the characteristics of constitution.	**Unit - I Constitution and Preamble** 1.1 Meaning of the constitution of India. 1.2 Historical perspectives of the Constitution of India. 1.3 Salient features and characteristics of the Constitution of India. 1.4 Preamble of the Constitution of India.	Presentations Blogs Hand-outs Modules Flipped classrooms Case studies
2	TLO 2.1 Enlist the fundamental rights. TLO 2.2 . Identify fundamental duties in general and in particular with engineering field. TLO 2.3 Identify situations where directive principles prevail over fundamental rights.	**Unit - II Fundamental Rights and Directive Principles** 2.1 Fundamental Rights under Part-III. 2.2 Fundamental duties and their significance under part-IV-A. 2.3 Relevance of Directive Principles of State Policy under part-IV A.	Presentations Blogs Hand-outs Modules Case Study Flipped Classroom

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Enlist the constitutional amendments. TLO 3.2 Elaborate the elements of Centre-State Relationship TLO 3.3 Analyze the purposes of various amendments.	**Unit - III Governance and Amendments** 3.1 3.1 Amendment procedure of the Constitution and their types - simple and special procedures. 3.2 The Principle of Federalism and its contemporary significance along with special committees that were setup. 3.3 Major Constitutional Amendment procedure - 1st, 7th, 42nd, 44th, 73rd & 74th, 76th, 86th, 52nd & 91st, 102nd	Cases of Federal disputes with relevant Supreme court powers and Judgements Presentations Blogs Hand-outs Problem based learning
4	TLO 4.1 Explain the importance of electoral rights. TLO 4.2 Write the step by step procedure for process of registration TLO 4.3 Explain the significance of Ethical electoral participation TLO 4.4 Explain the steps to motivation and facilitation for electoral participation TLO 4.5 Enlist the features of the voter's guide TLO 4.6 Explain the role of empowered voter TLO 4.7 Write the steps of voting procedure TLO 4.8 Write steps to create voter awareness TLO 4.9 Fill the online voter registration form TLO TLO 4.10 Follow procedure to cast vote using voter-id.	**Unit - IV Electoral Literacy and Voter's Education** 4.1 Electoral rights , Electoral process of registration 4.2 Ethical electoral participation 4.3 Motivation and facilitation for electoral participation 4.4 Voter's guide 4.5 Prospective empowered voter 4.6 Voting procedure 4.7 Voter awareness 4.8 Voter online registration https:/ /www.ceodelhi.gov.in/ELCdetails.aspx	Presentations Hand-outs Modules Blogs Problem based Learning

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES : NOT APPLICABLE.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- Outline the procedure to submit application for Voter-id
- Assignments are to be provided by the course teacher in line with the targeted COs.

A1. Prepare an essay on Constitution of India .
A2 Prepare a comparative chart of Unique features of Indian Constitution of India and Constitution of USA

- Assignments are to be provided by the course teacher in line with the targeted COs. A1. Prepare an essay on Constitution of India . A2 Prepare a comparative chart of Unique features of Indian Constitution of India and Constitution of USA A3. Self-learning topics: Parts of the constitution and a brief discussion of each part Right to education and girl enrollment in schools. GER of Girls and Boys. Right to equality. Social Democracy. Women Representation in Parliament and State Assemblies. LGBTQIA+

Micro project

- 1. Organize a workshop-cum discussions for spreading awareness regarding Fundamental Rights of the citizen of the country

2. Prepare elaborations where directive principle of State policy has prevailed over Fundamental rights with relevant Supreme Court Judgements.
3. Organize a debate on 42nd, 97th and 103rd Constitutional Amendment Acts of Constitution of India.

Seminar

- 1 Differences in the ideals of Social democracy and Political democracy.

2 Democracy and Women's Political Participation in India.
3 Khap Panchayat - an unconstitutional institution infringing upon Constitutional ethos.
4 Situations where directive principles prevail over fundamental rights.

Group discussions on current print articles.

-

- Art 356 and its working in Post-Independent India.
- Women's Resrvation in Panchayat leading to Pati Panchayats - Problems and Solutions.
- Adoption of Article 365 in India.
- Need of Amendments in the constitution.
- Is India moving towards a Unitary State Model ?

Activity

- Arrange Mock Parliament debates.

Prepare collage/posters on current constitutional issues.
i. National (Art 352) & State Emergencies (Art 356) declared in India.
ii. Seven fundamental rights.
iii. Land Reforms and its effectiveness - Case study of West-Bengal and Kerala.

Cases: Suggestive cases for usage in teaching:

- A.K. Gopalan Case (1950) :SC contented that there was no violation of Fundamental Rights enshrined in Articles 13, 19, 21 and 22 under the provisions of the Preventive Detention Act, if the detention was as per the procedure established by law. Here, the SC took a narrow view of Article 21.

Shankari Prasad Case (1951) : This case dealt with the amendability of Fundamental Rights (the First Amendment's validity was challenged). The SC contended that the Parliament's power to amend under Article 368 also includes the power to amend the Fundamental Rights guaranteed in Part III of the Constitution.
Minerva Mills case (1980) :This case again strengthens the Basic Structure doctrine. The judgement struck down 2 changes made to the Constitution by the 42nd Amendment Act 1976, declaring them to violate the basic structure. The judgement makes it clear that the Constitution, and not the Parliament is supreme.
Maneka Gandhi case (1978) :A main issue in this case was whether the right to go abroad is a part of the Right to Personal Liberty under Article 21. The SC held that it is included in the Right to Personal Liberty. The SC also ruled that the mere existence of an enabling law was not enough to restrain personal liberty. Such a law must also be "just, fair and reasonable."
Other cases:
1. Kesavananda Bharati Case (1973) : In this case the Hon. SC laid down a new doctrine of the 'basic structure' (or 'basic features') of the Constitution. It ruled that the constituent power of Parliament under Article 368 does not enable it to alter the 'basic structure' of the Constitution. This means that the Parliament cannot abridge or take away a Fundamental Right that forms a part of the 'basic structure' of the Constitution.
2. Mathura Rape Case(1979) : A tribal woman Mathura (aged 14 to 16 years) was raped in Police Custody. The case raised the questions on the idea of 'Modesty of Woman' and here it was was a tribal woman who succumbs to multiple pattiarchies. Custodial rape was made an offence and was culpable with the detainment of 7 years or more under Section 376 of Indian Penal Code. The weight of proofing the allegations moved from the victim to the offender, once sexual intercourse is established. The publication of the victim's identity was banned and it was also held that rape trials should be conducted under the cameras.
3. Puttswamy vs Union of India (2017) : In this landmark case which was finally pronounced by a 9-judge bench of the Supreme Court on 24th August 2017, upholding the fundamental right to privacy emanating from Article 21. The court stated that Right to Privacy is an inherent and integral part of Part III of the Constitution that guarantees

fundamental rights. The conflict in this area mainly arises between an individual's right to privacy and the legitimate aim of the government to implement its policies and a balance needs to be maintained while doing the same.
4. Navtej Singh Johar & Ors. v. Union of India (2018) : Hon. SC Decriminalised all consensual sex among adults, including homosexual sex by scrapping down section 377 of the Indian penal code (IPC). The court ruled that LGBTQ community are equal citizens and underlined that there cannot be discrimination in law based on sexual orientation and gender.
5. Anuradha Bhasin Judgement (2020) : The Supreme Court of India ruled that an indefinite suspension of internet services would be illegal under Indian law and that orders for internet shutdown must satisfy the tests of necessity and proportionality. The Court reiterated that freedom of expression online enjoyed Constitutional protection, but could be restricted in the name of national security. The Court held that though the Government was empowered to impose a complete internet shutdown, any order(s) imposing such restrictions had to be made public and was subject to judicial review.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED : NOT APPLICABLE

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Constitution and Preamble	CO1	4	0	0	0	0
2	II	Fundamental Rights and Directive Principles	CO2	4	0	0	0	0
3	III	Governance and Amendments	CO3	4	0	0	0	0
4	IV	Electoral Literacy and Voter's Education	CO4	3	0	0	0	0
Grand Total				**15**	**0**	**0**	**0**	**0**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Assignment, Self-learning and Terms work Seminar/Presentation

Summative Assessment (Assessment of Learning)

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	1	-	-	-	2	-	-			
CO2	1	-	-	-	2	-	-			
CO3	1	2	-	-	2	-	1			
CO4	-	-	-	1	-	-	-			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	P.M.Bakshi	The Constitution of India	Universal Law Publishing, New Delhi 15th edition, 2018, ISBN: 9386515105 (Check the new edition)
2	D.D.Basu	Introduction to Indian Constitution	Lexis Nexis Publisher, New Delhi, 2015, ISBN:935143446X
3	B. K. Sharma	Introduction to Constitution of India	PHI, New Delhi, 6thedition, 2011, ISBN:8120344197
4	MORE READS :	Oxford Short Introductions - The Indian Constitution by Madhav Khosla. The Indian Constitution: Cornerstone of a Nation by Granville Austin. Working a Democratic Constitution: A History by Garnville Austin Founding Mothers of the Indian Republic: Gender Politics of the Framing of the Constitution by Achyut Chetan. Our Parliament by Subhash C. Kashyap. Our Political System by Subhash C. Kashyap. Our Constitution by Subhash C. Kashyap. Indian Constitutional Law by Rumi Pal.	Extra Read
5	B.L. Fadia	The Constitution of India	Sahitya Bhawan,Agra, 2017, ISBN:8193413768

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	http://www.legislative.gov.in/constitution-of-india	Constitution overview
2	https://en.wikipedia.org/wiki/Constitution_of_India	Parts of constitution
3	https://www.india.gov.in/my-government/constitution-india	Constitution overview
4	https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of-india/	Fundamental rights and duties
5	https://main.sci.gov.in/constitution	Directive principles
6	https://legalaffairs.gov.in/sites/default/files/chapter%203.pdf	Parts of constitution

Sr.No	Link / Portal	Description
7	https://www.concourt.am/armenian/legal_resources/world_constitutions/constit/india/india-e.htm	Parts of constitution
8	https://constitutionnet.org/vl/item/basic-structure-indian-constitution	Parts of constitution

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

Programme Name/s : **Electrical Engineering/ Electrical Power System**
Programme Code : **EE/ EP**
Semester : **Third**
Course Title : **ELECTRICAL MATERIAL AND WIRING PRACTICE**
Course Code : **313015**

I. RATIONALE

Electrical diploma engineers should be able to select relevant electrical materials and accessories for different applications while carrying out new work or maintenance work. They should be well conversant with the specifications of material as per the applications and wiring practices. This course will enable the students to identify and select the material for a particular application and also take up the wiring related work like, selection of material for wiring, carry out the wiring and testing etc.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Carry out wiring and maintenance activities using relevant materials, tools and safety practices.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Follow safe working practices when undertaking electrical work.
- CO2 - Select relevant conducting, electromagnetic and magnetic materials.
- CO3 - Select relevant insulating materials.
- CO4 - Perform different types of electrical wiring and cabling activities.
- CO5 - Implement relevant earthing systems.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
313015	ELECTRICAL MATERIAL AND WIRING PRACTICE	EMW	SEC	1	-	4	1	6	3	-	-	-	-	-	50	20	25@	10	25	10	100

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 State safety rules/ standards applicable for the given electrical systems. TLO 1.2 Describe the use of the given tools in the given electrical engineering situation. TLO 1.3 Describe the use of the given safety accessories in the given electrical engineering situation. TLO 1.4 Describe the functions/applications of the given components of wiring.	**Unit - I Wiring Components, Tools and Safety Devices** 1.1 IE rules 1956 (Chapter IV-General safety requirements- No. 29 to 46) 1.2 Applications of Tools used in wiring: Pliers, nose pliers, cutter, screw driver, tester, test lamp, crimping tool, continuity tester, outside micrometer, knife. 1.3 Applications of safety Accessories: hand gloves, helmet, boots, goggles, rubber mats, types of fire extinguishers. 1.4 Components with specifications used in wiring systems: different types of switches (single and double pole), plugs, sockets, DBs, MCBs, MCCBs, RCCBs, holders, wires, cables. (No working only ratings needs to be explained for all these components)	Chalk-Board Presentations Videos Demonstrations, Role play
2	TLO 2.1 Explain the salient features of the given type of conductor with respect to the needed functional properties. TLO 2.2 Explain with justification the applications for the given electrical conductors in specified situations. TLO 2.3 Describe with justification the use of various magnetic materials in the given electrical engineering situation.	**Unit - II Conducting and Electromagnetic Materials** 2.1 Conducting materials: Electrical, Mechanical and Thermal Properties. 2.2 Applications of Conducting materials: copper, aluminium, tungsten, brass, bronze, mercury, silver, lead, nickel and tin. 2.3 Magnetic materials- silicon Steel (CRGO, HRGO) and Amorphous material: properties and their applications	Chalk-Board, Presentations, Demonstration
3	TLO 3.1 Explain the properties of the given electrical insulating materials. TLO 3.2 Classify insulating materials based on working temperature TLO 3.3 Describe the failure phenomena in the given type of insulating material(s). TLO 3.4 Suggest relevant insulating material(s) for the given application(s) with justification.	**Unit - III Electrical Insulating Materials** 3.1 Significance and properties of electrical insulating materials: electrical, mechanical and thermal properties. 3.2 Classification of insulating materials based on working temperature. 3.3 Causes of failure of insulating materials 3.4 Applications of insulating materials in electrical machines and devices.	Chalk-Board, Presentations, Video Demonstration, Model Demonstration

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Explain with justification the criteria for selecting wire/cable and other electrical components for the given type of installation. TLO 4.2 Describe with sketches the installation of wiring systems for the given type of occupancy. TLO 4.3 Describe with sketches the wiring type as per the functional requirements of the given type of occupancy. TLO 4.4 Explain the process of installing the given type of cable(s).	**Unit - IV Electrical Wiring** 4.1 Types of wires and cables, components and accessories of electrical wiring systems. 4.2 Electrical Wiring systems (PVC casing-capping, conduit and concealed), panel wiring 4.3 Electrical Wiring types (one lamp control, staircase and godown) 4.4 Cable laying, Cable joints (terminations), proper size lugs, crimping of joints.	Chalk-Board, Presentations, Demonstration, Videos
5	TLO 5.1 Recommend with justification the necessity of the type of earthing in the given electrical installation system(s). TLO 5.2 Explain the criteria for recommending the earthing system for the given electrical installation. TLO 5.3 Describe with sketches the installation of the given earthing system. TLO 5.4 Describe the testing procedure for the given earthing systems.	**Unit - V Earthing Systems** 5.1 Types of earthing systems (Rod, pipe, plate, chemical earthing). 5.2 Installation of earthing systems. 5.3 Measurement of earthing resistance by Earth tester, Earth resistance values for various installations as per IEEE standards 5.4 Adverse effects of improper earthing system, methods to reduce the earth resistance	Chalk-Board, Presentations, Videos, Model demonstration

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Use different electrical safety accessories and follow safe practices.	1	*Use of different electrical safety accessories and follow safe practices.	2	CO1
LLO 2.1 Douse the class ‘A’ type fire with suitable medium.	2	*Dousing of class ‘A’ type fire with suitable medium.	2	CO1
LLO 3.1 Rescue a person and apply respiratory methods.	3	*Rescue a person and practice artificial respiration.	2	CO1
LLO 4.1 Use different types of electrical/electronic tools.	4	*Use of different types of electrical/electronic tools.	2	CO1
LLO 5.1 Test the working of single pole one way and two way switches and MCB.	5	Testing of single pole one way, two way switches and MCB using relevant tools and instruments.	2	CO1
LLO 6.1 Operate the MCCB	6	Demonstration of MCCB	2	CO1
LLO 7.1 Test the working of fuse.	7	Testing of rewirable fuse.	2	CO1
LLO 8.1 Prepare series lamp test board with 2 m wire extention.	8	*Preparation of series lamp test board with 2m wire extention.	2	CO1
LLO 9.1 Test the performance of the RCCB.	9	Testing of the RCCB.	2	CO1
LLO 10.1 Choose the appropriate fuse rating and its location for the given circuit.	10	*Selection of fuses in different lighting circuits.	2	CO2
LLO 11.1 Measure insulation resistance of cables using insulation tester	11	*Measurement of insulation resistance of cables using insulation tester	2	CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 12.1 Select insulating materials for specific applications.	12	Selection of insulating materials for specific applications from given samples (at least five).	2	CO3
LLO 13.1 Measure insulation resistance of electrical installation using insulation tester	13	*Insulation resistance test on electrical installation.	2	CO3
LLO 14.1 Test insulating oil for its dielectric strength.	14	*Dielectric strength test of given insulating oil sample.	2	CO4
LLO 15.1 Carry out staircase wiring LLO 15.2 Test the working of staircase wiring.	15	Preparation of staircase wiring and its testing.	2	CO4
LLO 16.1 Carry out godown wiring. LLO 16.2 Test the working of godown wiring.	16	Preparation of godown wiring and its testing.	2	CO4
LLO 17.1 Carry out switch board wiring LLO 17.2 Test the working of switch board.	17	*Preparation of switch board containing four switch, four socket arrangements (with MCB, indicator etc.).	4	CO4
LLO 18.1 Fix and test LED tube.	18	LED tube light mounting, testing and fault finding.	2	CO4
LLO 19.1 Trace cable laying.	19	Power cable tracing. (For machine installation in laboratory)	2	CO4
LLO 20.1 Carry out the polarity test of the electrical installation of machine laboratory.	20	*Electrical installation testing.	2	CO4
LLO 21.1 Draw and trace LT cable.	21	LT cable tracing. (from LT substation-transformer of your college to your laboratory.)	2	CO4
LLO 22.1 Carry out electrical wire joints.	22	*Preparation of electrical wire joints (simple twist, married, Tee and western union joints).	2	CO4
LLO 23.1 Carry out electrical wire joints.	23	*Preparation of electrical wire joints (britannia straight, Britannia tee and rat tail joints).	2	CO4
LLO 24.1 Carry out lug crimping for cable.	24	Lug crimping for cable leads.	2	CO4
LLO 25.1 Carry out PVC casing-capping and conduit wiring.	25	*Preparation of PVC casing-capping, conduit wiring for minimum four points of 3m length.	4	CO4
LLO 26.1 Carry out wiring to control lamp from different places.	26	One lamp control from three and/or four different places.	2	CO4
LLO 27.1 Trace and draw electrical schematic drawings of a panel.	27	*Tracing of electrical schematic drawings of a panel of any electrical machine in your laboratory.	2	CO4
LLO 28.1 Carry out plate earthing.	28	*Plate earthing.	2	CO5
LLO 29.1 Carry out chemical earthing.	29	Chemical earthing.	2	CO5
LLO 30.1 Test / measure earthing resistance of electrical installation.	30	Testing and measurement of earthing resistance.	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- Prepare chart about the information of different types of magnetic materials (ferromagnetic, paramagnetic, diamagnetic).
- Draw the sketches of plate/pipe/rod/chemical earthing.
- Draw the wiring diagram of Flat/Bunglow 1BHK/2BHK.
- Prepare chart about the information of different types of magnetic materials (ferromagnetic, paramagnetic, diamagnetic).
- Draw the wiring diagram of electrical panel.
- Draw symbols related to electrical accessories and wiring.
- Draw the hysteresis loops for hard steel, wrought iron and alloyed steel.
- Identify various parts of electrical panel.

Visit

- Visit to a nearby construction site and observe the electrification work being carried out and note details of wires, switchgears, earthing practices, safety aspects being followed etc.

Micro project

- Collect the information about distribution substation earthing and submit report on it.
- Collect the sample/information about different types and sizes of wires, cables, and switches available in the market and submit report on it.
- Collect information from internet or otherwise on the different electromagnetic materials along with the forms in which they are available and submit report on it.
- Carry out profile lighting upto 5m length with suitable driver (choke).
- Collect the information about methods of wiring and submit report on it.
- Collect the information about MCBs and MCCBs of different specifications and submit report on it.
- Collect the information about RCCBs of different specifications and submit report on it.

Self learning topics

- Latest tools and techniques in the field of electrical wiring, earthing, materials.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Various fuse mounting units, fuse wire of different rating, ammeter, lamp bank.	10
2	Insulation tester 500V or 1000V	11,13
3	Insulating materials of different classes, electric iron	12
4	Dielectric oil test kit, dielectric oil samples	14
5	Wooden/PVC board, two way switches (6A)- 2 Nos, lamp holder- 1 No., lamp- 1 No.	15

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
6	Wooden/PVC board, one way switch- 1 No., two way switches (6A)- 2 Nos, lamp holder- 3 No., lamp- 3 No.	16
7	Wooden/PVC board, single pole switches (6A)- 4 Nos., sockets (5 pin-6A), MCB- 2A, red color indicator- 1No.	17
8	18/20 Watt LED tube with mounting brackets and screws	18
9	Bucket filled with water, sand, Class 'A' type fire extinguisher.	2
10	Electric tester, test lamp, multimeter.	20
11	Electrician's knife, stainless steel rule, diagonal cutting plier, combination plier, wooden mallet, bastard flat file, hard vice, wires of various sizes, bare copper wire, GI wire, sand paper, cotton cloth.	22,23
12	Crimping lugs, crimping tool, combination plier, knife.	24
13	PVC casing capping-3 meter, PVC conduit -3 meter, wires, wooden/PVC board, switches and sockets	25
14	Wooden/PVC board, lamp holder, lamp, 2 way switches(6A)- 2 Nos.	26
15	Copper plate, salt, wood coal, copper or GI wire etc.	28
16	Chemical mixture containing Bentonite, salt, charcoal, chemical electrode, Copper or GI strip/conductor	29
17	Wooden stick, rubber mat, chart or videos of rescue procedure and respiratory methods.	3
18	Earth tester (Anolog/Digital)	30
19	Pliers, screw driver set, nose pliers, measuring tape, cutter cum insulation remover, screw driver, tester, test lamp, crimping tool, lugs, continuity tester, outer micrometer, knife, soldering gun	4
20	Single pole one way and two switches (6A) – 1 No. each, MCB 1/2A- 1No. each, MI/Digital type AC Ammeter 0-10 A, Lamp bank- 10A.	5,7
21	MCCB TP- 100A- 1 No. MCCB TPN- 100A- 1No.	6
22	Rewirable Kitkat fuse, fuse wire.	7
23	Wooden/PVC board, lamp holder, lamp, extention wire 2m	8
24	RCCB- 16 A double pole, sensitivity 30mA, lamp bank, switch.	9
25	Safety hand gloves, safety boots, safety goggles, safety rubber mats, safety helmet (All ISI Mark).	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Wiring Components, Tools and Safety Devices	CO1	3	0	0	0	0
2	II	Conducting and Electromagnetic Materials	CO2	3	0	0	0	0
3	III	Electrical Insulating Materials	CO3	3	0	0	0	0
4	IV	Electrical Wiring	CO4	3	0	0	0	0
5	V	Earthing Systems	CO5	3	0	0	0	0
Grand Total				**15**	**0**	**0**	**0**	**0**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- For formative assessment of laboratory learning 50 marks. Each practical will be assessed considering appropriate % weightage to process and product and other instructions of assessment.

Summative Assessment (Assessment of Learning)

- End semester summative assessment of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	2	2	3	3	1	3			
CO2	3	2	3	1	1	1	2			
CO3	3	2	3	1	1	1	2			
CO4	3	3	2	3	1	2	2			
CO5	3	1	1	2	2	2	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Bhattacharya S. K.	Electrical Engineering Drawing	New Age International, New Delhi, ISBN: 978-81-224-0855-3.
2	Uppal S.L; Garg G.C.	Electrical Wiring, Estimating and Costing	Khanna Publishers, New Delhi, ISBN-13: 978-81-7409-240-3.
3	Singh R.P.	Electrical Workshop: Safety, commissioning, maintenance and testing of electrical equipment	I.K. International Publishing House , Pvt. Ltd. New Delhi, ISBN:978-9389447057
4	Gupta J. B.	Electrical Estimating and Costing	S. K. Kataria & Sons, New Delhi, ISBN:978-93-5014-279-0
5	Indulkar C.S. & Thiruvengadam S.	An introduction to electrical engineering materials	S Chand & Co., ISBN :978-8121906661

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	www.bharatskills.gov.in	Directorate general of training - central repository for skills in NSQF curriculum
2	https://www.osha.gov/sites/default/files/publications/osha3075.pdf	Controlling Electrical Hazards
3	https://nsc.org.in/	National safety council of India
4	https://www.esfi.org/	Electrical safety foundation

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

Programme Name/s : **Electrical Engineering/ Electrical Power System**
Programme Code : **EE/ EP**
Semester : **Third**
Course Title : **ELECTRICAL CIRCUITS AND NETWORK**
Course Code : **313332**

I. RATIONALE

Electrical Circuits and Network are integral part of power system. This is one of the most important core electrical engineering course and a pre-requisite to learn advanced electrical courses. This course develops skills to apply principle of single and three phase AC circuits and network theorems to analyze and solve simple electric circuits related problems.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Diagnose and Rectify simple electric circuit and network related problems in industry.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Analyze the parameters of single-phase AC series circuits.
- CO2 - Analyze the parameters of single-phase AC parallel circuits.
- CO3 - Analyze the parameters of polyphase AC circuits.
- CO4 - Apply network reduction methods to solve DC circuits.
- CO5 - Apply network theorems to solve basic electrical circuits.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											Total Marks
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
313332	ELECTRICAL CIRCUITS AND NETWORK	ECN	DSC	4	-	4	-	8	4	3	30	70	100	40	25	10	50#	20	-	-	175

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Determine the current, voltage and draw vector diagram for the given AC series circuit. TLO 1.2 Calculate inductive, capacitive reactance and impedance for the given AC series circuit. TLO 1.3 Determine active, reactive, apparent power and power factor for the given AC series circuit. TLO 1.4 Determine resonant frequency, voltage magnification and Q-factor for the given R-L-C series circuit.	**Unit - I Single Phase A.C Series Circuits** 1.1 Generation of alternating voltage, Phasor representation of sinusoidal quantities. 1.2 R, L, C circuit elements it's voltage and current response. 1.3 R-L, R-C, R-L-C series A.C. circuits- vector diagram, active, reactive, apparent power, power triangle and power factor. (Simple Numerical). 1.4 Resonance in R-L-C series circuit- Graphical Representation, Resonance curve, Quality (Q) Factor. (Simple Numerical)	Lecture Using Chalk-Board Video Demonstrations Flipped Classroom Case Study Collaborative learning Presentations
2	TLO 2.1 Determine the current, voltage and draw vector diagram for the given AC parallel circuit. TLO 2.2 Calculate inductive, capacitive reactance and impedance for the given AC parallel circuit. TLO 2.3 Determine active, reactive, apparent power and power factor for the given AC parallel circuit. TLO 2.4 Determine resonant frequency, current magnification and Q-factor for the given R-L-C parallel circuit.	**Unit - II Single Phase A.C Parallel Circuits** 2.1 R-L, R-C and R-L-C parallel combination of A.C. circuits. Impedance, reactance, phasor diagram, impedance triangle. 2.2 R-L, R-C, R-L-C parallel A.C. circuits- vector diagram, active, reactive, apparent power, power triangle and power factor (Simple Numerical). 2.3 Resonance in parallel circuit- Graphical Representation, Resonance curve, Quality (Q) Factor. (Simple Numerical)	Lecture Using Chalk-Board Case Study Video Demonstrations Flipped Classroom Collaborative learning Presentations
3	TLO 3.1 Explain the principle of generation of 3-phase waveform. TLO 3.2 Compare of 3-phase circuit with 1-phase circuit. TLO 3.3 Calculate line, phase values and 3-phase power for star and delta connection. TLO 3.4 Explain the concept of balanced and unbalanced load condition.	**Unit - III Three Phase Circuits** 3.1 Generation of 3-phase alternating emf, Phase Sequence. 3.2 Comparison of 3-phase circuit with single phase circuit. 3.3 Types of three phase connections-star and delta, Relation between phase and line values. 3.4 3-Phase power- active, reactive and apparent power in star and delta connected system. 3.5 Concept of balanced and unbalanced load (Numerical on balanced load only)	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom Collaborative learning Case Study
4	TLO 4.1 Apply source transformation techniques for the given network. TLO 4.2 Reduce the given network by applying Star/delta and delta/star transformation. TLO 4.3 Apply Mesh analysis to solve the given network. TLO 4.4 Apply Node analysis to solve the given network.	**Unit - IV Network Reduction Methods for DC Circuits.** 4.1 Source transformation Techniques. 4.2 Star to delta and delta to star transformation. 4.3 Mesh Analysis. 4.4 Node Analysis.	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom Collaborative learning Case Study

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Apply superposition theorem to determine the current in the given branch of a circuit. TLO 5.2 Draw Thevenin's equivalent circuit and determine load current in the given branch of a circuit. TLO 5.3 Draw Norton's equivalent circuit and determine load current in the given branch of a circuit. TLO 5.4 Apply maximum power transfer theorem to determine the maximum power in the given network. TLO 5.5 Apply Reciprocity theorem for the given network. TLO 5.6 Describe the procedure to solve the AC network theorem.	**Unit - V Network Theorems** 5.1 Superposition theorem. 5.2 Thevenin's theorem. 5.3 Norton's theorem 5.4 Maximum power transfer theorem 5.5 Reciprocity Theorem 5.6 Introduction to AC Network Theorem (No numerical for 5.6)	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom Collaborative learning Case Study

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Trace the output waveforms across R L circuit to identify the phase difference and measure the amplitude. LLO 1.2 Observe the nature of current with respect to voltage in R-L series circuit. LLO 1.3 Operate various controls of CRO	1	*Determination of the phase difference between A.C voltage and current in a given R-L series circuit by using dual trace oscilloscope.	2	CO1
LLO 2.1 Trace the output waveforms across R C circuit to identify the phase difference and measure the amplitude. LLO 2.2 Observe the nature of current with respect to voltage in R-C series circuit. LLO 2.3 Operate various controls of CRO	2	Determination of the phase difference between A.C voltage and current in a given R-C series circuit by using dual trace oscilloscope.	2	CO1
LLO 3.1 Trace the output waveforms across R L C circuit to identify the phase difference and measure the amplitude. LLO 3.2 Observe the nature of current with respect to voltage for $X_L > X_C$ or $X_L < X_C$. LLO 3.3 Operate various controls of CRO	3	*Determination of the phase difference between A.C voltage and current in a given R-L-C series circuit by using dual trace oscilloscope.	2	CO1
LLO 4.1 Measure voltage, current and draw phasor diagram to find pf and verify the same.	4	*Determination of voltage, current and pf in a given R-L series circuit. Draw phasor diagram.	2	CO1
LLO 5.1 Measure active power and calculate reactive and apparent power for R-L series circuit and verify the same.	5	Determination of active, reactive and apparent power consumed in given R-L series circuit.	2	CO1

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 6.1 Measure active power and calculate reactive and apparent power for R-C series circuit and verify the same.	6	*Determination of voltage, current and pf in a given R-C series circuit. Draw phasor diagram.	2	CO1
LLO 7.1 Measure active power and calculate reactive and apparent power for R-C series circuit and verify the same.	7	Determination of active, reactive and apparent power consumed in a given R-C series circuit.	2	CO1
LLO 8.1 Measure voltage, current and draw phasor diagram to find pf and verify the same. LLO 8.2 Observe the nature of current with respect to voltage for $X_L > X_C$ or $X_L < X_C$ and interpret about the nature of the circuit.	8	*Determination of voltage, current and pf in a given R-L-C series circuit. Draw phasor diagram.	2	CO1
LLO 9.1 Measure active power and calculate reactive and apparent power for R-L-C series circuit and verify the same.	9	*Determination of active, reactive and apparent power consumed in given R-L-C series circuit.	2	CO1
LLO 10.1 Measure the resonant frequency and verify it by calculation. LLO 10.2 Using variable frequency supply obtain resonant condition for R-L-C series circuit	10	Resonance in given R-L-C series circuit using variable frequency supply.	2	CO1
LLO 11.1 Measure the inductance and capacitance to obtain the resonant condition. LLO 11.2 Measure current, voltage and draw vector diagram to obtain pf at resonance in R-L-C series circuit	11	*Resonance in given R-L-C series circuit using variable inductor or capacitor.	2	CO1
LLO 12.1 Measure voltage, current and draw phasor diagram to find pf and verify the same. LLO 12.2 Measure active power and calculate reactive and apparent power for R-L-C parallel circuit and verify the same.	12	*Determination of voltage, current, p.f., active, reactive and apparent power for given R-L-C parallel circuit.	2	CO2
LLO 13.1 Measure the resonant frequency and verify it by calculation. LLO 13.2 Obtain resonant condition for R-L-C parallel circuit by varying frequency or inductance and capacitance. LLO 13.3 Measure current, voltage and draw vector diagram to obtain pf at resonance in R-L-C parallel circuit.	13	Resonance in given parallel R-L-C circuit using variable frequency supply or variable inductor and capacitor.	2	CO2
LLO 14.1 Identify phase sequence of the 3-phase supply system and draw the waveforms.	14	*Phase sequence of 3-phase supply system.	2	CO3
LLO 15.1 Measure line and phase values for both balance and unbalance star connected load. LLO 15.2 Draw phasor diagram with the help of phase values and verify the line values.	15	*Determination of line and phase quantities of voltage and current for balanced & unbalanced three phase star connected load. Draw phasor diagram.	2	CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 16.1 Measure line and phase values for both balance and unbalance delta connected load. LLO 16.2 Draw phasor diagram with the help of phase values and verify the line values.	16	*Determination of line and phase values of voltage and current for balanced & unbalanced three phase delta connected load. Draw phasor diagram.	2	CO3
LLO 17.1 Measure active, reactive, and apparent power for balanced three phase star connected inductive / capacitive load.	17	*Determination of active, reactive, and apparent power for balanced three phase star connected inductive / capacitive load.	2	CO3
LLO 18.1 Measure active, reactive, and apparent power for balanced three phase delta connected inductive / capacitive load.	18	Determination of active, reactive, and apparent power for balanced three phase delta connected inductive / capacitive load.	2	CO3
LLO 19.1 Measure active, reactive, and apparent power for unbalanced three phase star connected inductive / capacitive load.	19	Determination of active, reactive, and apparent power for unbalanced three phase star connected inductive / capacitive load.	2	CO3
LLO 20.1 Measure active, reactive, and apparent power for unbalanced three phase delta connected inductive / capacitive load	20	Determination of active, reactive, and apparent power for unbalanced three phase delta connected inductive / capacitive load.	2	CO3
LLO 21.1 Measure current through the branch for given electric network and verify by applying mesh analysis.	21	*Verification of Mesh analysis method.	2	CO4
LLO 22.1 Measure current through the branch for given electric network and verify by applying node analysis.	22	*Verification of Node analysis method.	2	CO4
LLO 23.1 Measure current through the branch for a given DC electric network and verify by applying superposition theorem.	23	*Verification of Superposition theorem.	2	CO5
LLO 24.1 Measure Thevenin's equivalent circuit parameter for a given DC circuit and verify by applying Thevenin's theorem. LLO 24.2 Draw the Thevenin's equivalent circuit and verify the load current.	24	*Verification of Thevenin's theorem.	2	CO5
LLO 25.1 Measure Norton's equivalent circuit parameter for a given DC circuit and verify by applying Norton's theorem. LLO 25.2 Draw the Norton's equivalent circuit and verify the load current.	25	*Verification of Norton's theorem.	2	CO5
LLO 26.1 Measure load resistance to transfer maximum power for a given DC circuit and verify by applying maximum power transfer theorem.	26	*Verification of Maximum Power Transfer theorem.	2	CO5
LLO 27.1 Measure current through the branch for a given AC electric network and verify by applying superposition theorem.	27	*Verification of Superposition theorem for AC network.	2	CO5

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING) : NOT APPLICABLE

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Digital Storage Oscilloscope: Dual Trace 50Mhz	1,2,3
2	Inductor 1.3 H, suitable range	1,3,4,5,8,9,10,12,13,27
3	Variable Frequency Generator	10,13
4	Capacitor Bank 5A, 250 V suitable range	10,13,17,18,19,20
5	Inductor Bank 5A, 250 V suitable range	10,13,17,18,19,20
6	Phase Sequence Indicator as per availability in the lab	14
7	Load Bank: Resistive, 3-Phase, 5 kW, 415 V	15,16
8	Dimmer: 3-Phase, 5 kVA	15,16,17,18,19,20
9	Capacitor 10 µF (micro-Farad) 250 V suitable range	2,3,6,7,9,10,12,13,27
10	DC Regulated Power Supply	21,22,23,24,25,26
11	Trainer Kit for Theorems	23,24,25,26
12	Load Bank: Resistive, 1-Phase, 1 kW, 230 V	26
13	Low Power Factor Wattmeter: Single Phase, 5/10 Amp, 250/500 V	5,17,18,19,20
14	Wattmeter: Single Phase 2.5/5 Amp, 200/400 V, Single Phase 5/10 Amp, 250/500 V	5,7,9,12,17,18,19,20
15	Rheostat- 18 ohm /10A, 250 ohm / 2A, 500 ohm /1 A, 720 ohm / 0.8A, suitable range	All
16	Ammeters MI Type: AC/DC, 0-5-10Amp,0-1.5 Amp,0-2.5Amp,0-0.5-1Amp	All
17	Voltmeter MI Type: AC/DC, 0-150/300V, 0-250/500V,0-75/150V	All
18	Dimmer: 1-Phase,1kVA, 230V	All
19	Multimeter suitable range	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Single Phase A.C Series Circuits	CO1	14	2	6	8	16
2	II	Single Phase A.C Parallel Circuits	CO2	12	2	4	6	12
3	III	Three Phase Circuits	CO3	8	2	4	6	12
4	IV	Network Reduction Methods for DC Circuits.	CO4	10	2	4	6	12
5	V	Network Theorems	CO5	16	4	4	10	18
Grand Total				**60**	**12**	**22**	**36**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two unit tests of 30 marks will be conducted and average of two unit tests considered. For formative assessment of laboratory learning 25 marks. Each practical will be assessed considering appropriate % weightage to process and product and other instructions of assessment.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks through offline mode of examination. End semester summative assessment of 50 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	3	2	3	-	-	3			
CO2	3	3	2	3	-	-	3			
CO3	3	3	1	3	-	-	3			
CO4	3	3	2	2	-	-	3			
CO5	3	3	3	3	-	-	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Gupta, B. R. Singhal, Vandana	Fundamentals of Electrical Networks	S.Chand and Co., New Delhi, 2005 ISBN : 978-81-219-2318-7
2	Theraja, B. L. ; Theraja, A. K.	A Text Book of Electrical Technology Vol-I	S. Chand and Co. Ramnagar, New Delhi, 2012; ISBN : 9788121924405
3	Saxena, S.B lal ; Dasgupta, K.	Fundamentals of Electrical Engineering	Cambridge university press pvt. Ltd., New Delhi, 2016, ISBN : 978-11-0746-435-3
4	Mittle, V.N. ; Mittle, Arvind	Basic Electrical Engineering	McGraw Hill Education, Noida, 2005 ISBN: 978-00-705-9357-2
5	Sudhakar, A Shyammohan, S.Palli	Circuit and network	McGraw Hill Education, New Delhi, 2015, ISBN : 978-93-3921-960-4
6	Mahmood Nahvi, Joseph Edminister	Schaum online series- Theory and problems of electric circuits	McGraw Hill Education, Newyork, 2013, ISBN: 978-00-701-8999-7
7	David A. Bell	Electric Circuits	Oxford University Press New Delhi, 2009; ISBN : 978-01-954-2524-6
8	M.E. Van Valkenburg	Network Analysis	Pearson Education ISBN: 9789353433123

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	www.cesim.com/simulations	Graphical representation of series and parallel resonance
2	https://ndl.iitkgp.ac.in/	NeworkTheorems
3	https://nptel.ac.in/	Single phase Series and Parallel Circuit, Three Phase Circuit

Sr.No	Link / Portal	Description
4	http://vlabs.iitkgp.ac.in/asnm/	Series and Parallel Resonance, Network Theorems, Reduced Network Methods
5	https://vlab.amrita.edu	Single phase Series and Parallel Circuit, Three Phase Circuit, Series and Parallel Resonance
6	www.dreamtechpress.com /ebooks	Free reference books for more practice
7	www.nptelvideos.in/electrical engineering/ circuit theory	Network Circuit Theory

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

Programme Name/s : **Electrical Engineering/ Electrical Power System**
Programme Code : **EE/ EP**
Semester : **Third**
Course Title : **ELECTRICAL POWER GENERATION,TRANSMISSION AND DISTRIBUTION**
Course Code : **313333**

I. RATIONALE

Electrical power system plays a significant role in the development of Urban, Rural, Industries and Agriculture Sector. This course aims to develop the basic knowledge and required skills to maintain the proper functioning of the power system.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Maintain the functioning and operation of the electrical power generation, transmission and distribution systems.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Maintain the optimised working of the thermal power plant and hydro power plant.
- CO2 - Select the relevant power generation technology based on economic operation.
- CO3 - Interpret the normal operation and parameters of the electric transmission system.
- CO4 - Interpret the parameters of the extra high voltage transmission system.
- CO5 - Maintain the functioning and operation of electric power distribution system.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
313333	ELECTRICAL POWER GENERATION,TRANSMISSION AND DISTRIBUTION	GTD	DSC	4	-	2	2	8	4	3	30	70	100	40	25	10	25@	10	25	10	175

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe the layout of the electric power generating process with a labeled block diagram of the specified power plant. TLO 1.2 State the functions of a given type of major auxiliaries of specified power plant. TLO 1.3 Distinguish between Thermal Power Plant and Hydro Power Plant. TLO 1.4 Describe the specified safe practices to be followed for a specified power plant.	**Unit - I Thermal Power Plant and Hydro Power Plant** 1.1 Classification of various energy sources (Renewable and Non-Renewable). 1.2 Site selection, Layout and working of a typical Thermal Power Plant. 1.3 Functions of the following major auxiliaries used in Thermal Power Plant: Coal fired boilers: fire tube and water tube and Heat recovery system (Super heater, Economiser and Air pre-heater). 1.4 Site selection, Layout and working of a typical Hydro power plant. 1.5 Classification of hydro power plant: Run off river Power Plant without Pondage, Run off river Power Plant with Pondage, Reservoir Power Plant and Pumped Storage Power Plant. 1.6 Comparison between Thermal Power Plant and Hydro Power Plant. 1.7 Locations of these different types of Large and Micro-Hydro Power Plants in Maharashtra. 1.8 Safe Practices of Thermal Power Plants and Hydro Power Plants (Large and Micro)	Chalk-Board Presentations Model Demonstration Demonstration Video Flipped Classroom
2	TLO 2.1 Interpret the given Load curve, Load duration curve, Integration duration curve. TLO 2.2 Interpret the given values of the demand factor, plant capacity factor, plant use factor. TLO 2.3 Interpret the given values of the diversity factor, load factor and plant load factor. TLO 2.4 State the causes and impact of the given grid system fault.	**Unit - II Economics of Power Generation and Interconnected Power System** 2.1 Base load and Peak load Plants: Load curve, Load duration curve, Integrated Load duration curve. Related terms: connected load, firm power, cold reserve, hot reserve, spinning reserve. 2.2 Cost of generation: average demand, maximum demand, demand factor, plant capacity factor, plant use factor, diversity factor, load factor and plant load factor. 2.3 Choice of size and number of Generator units, combined operation of power station. 2.4 Causes, Impact and reasons of Grid system fault: State Grid, National Grid, brownout and black out; sample blackouts at National and International level	Chalk-Board Presentations Model Demonstration Video Demonstrations Flipped Classroom
3	TLO 3.1 Classify the given Transmission Line. TLO 3.2 Describe the construction and functioning of the given Transmission Line Components. TLO 3.3 Explain the concept of the given Transmission Line parameters. TLO 3.4 Evaluate the performance of short transmission Line based on the given criteria. TLO 3.5 Explain the given method(s) for representation of Medium Transmission Line. TLO 3.6 Describe the need for Transposition of Conductors.	**Unit - III Transmission Line Components, Parameters and Performance** 3.1 Electric power transmission systems: Single line diagrams. 3.2 Classification of transmission lines: Primary and Secondary transmission; standard voltage level used in India. 3.3 Transmission line Components: Types of Line supports, Line Insulators and Overhead/ Underground Conductors with their function. 3.4 Method of construction of electric supply transmission system – 110 kV, 220 kV, 400 kV. 3.5 Transmission Line Parameters: R, L and C and types of lines. 3.6 Performance of short line: Efficiency, Regulation and its derivation, Effect of Power Factor, Vector Diagram for different Power Factor. 3.7 Representation of medium line: Nominal ‘T’, Nominal ‘Pi’ and End condenser methods. 3.8 Skin effect and Proximity Effect, Transposition of conductors and its necessity.	Chalk-Board Presentations Model Demonstration Demonstration Video Flipped Classroom

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 State the Rating and functions of the given type of transmission line. TLO 4.2 State the Rating and functions of the given High voltage Substation component(s). TLO 4.3 Explain the specified effects occurring in the given type of high voltage transmission line. TLO 4.4 Explain the importance of line compensation in High voltage transmission line. TLO 4.5 Describe the layout of the given HVDC transmission lines with sketches. TLO 4.6 Explain the concept of wireless transmission of electrical power.	**Unit - IV Extra High Voltage Transmission (HVAC and HVDC)** 4.1 Extra High Voltage AC (EHVAC) transmission line: 4.1.1 Necessity of UHV, EHV AC/ DC lines. 4.1.2 High voltage substation components: Transformers, Bus, Circuit breaker, Reactor, Lightning arrester, Relays, FACTs Devices. 4.1.3 High Temperature Low Sag (HTLS) Conductor in High voltage transmission lines: Features. 4.1.4 Ferranti and Corona effect 4.1.5 Line compensation: Need and benefits. 4.2 High Voltage DC (HVDC) Transmission Line: 4.2.1 Necessity and HVDC Lines in India. 4.2.2 HVDC Transmission lines: Components, applications, advantages, and limitations 4.2.3 Monopolar, bi-Polar and homo-polar transmission lines: Layout 4.3 EHVAC and HVDC transmission line: Features and Comparison. 4.4 Wireless transmission of electrical power.	Chalk-Board Presentations Model Demonstration Video Demonstrations Flipped Classroom
5	TLO 5.1 Classify the given Distribution line. TLO 5.2 Describe the Distribution line erection and functioning of the given components. TLO 5.3 Explain the concept of the given Distribution line Components. TLO 5.4 Elaborate the specified Distribution schemes. TLO 5.5 Evaluate the performance of the Distribution line based on the given criteria. TLO 5.6 Describe the given distribution substation layout and components.	**Unit - V Distribution Line Components, Parameters and Performance** 5.1 Electric power Distribution systems: Single line diagrams 5.2 Classification of Distribution lines: Primary and Secondary Distribution; standard voltage level used in India. 5.3 Distribution line Components: Types of Line supports, Line Insulators and Overhead/ Underground Conductors (ACSR/ Insulated Power Cables) with their function. 5.4 Method of Distribution line erection of electric supply – 220 V, 400V, 11 kV, 33 kV 5.5 Distribution line Feeder and Distributor Schemes: Radial, Ring, and Grid. 5.6 Distribution Performance of Distributor: voltage drop, sending end and receiving end voltage. 5.7 Distribution Substation: classification, site selection, advantages, disadvantages and applications. 5.8 Single Line Diagram (layout) of 33/11kV Sub-Station, 11kV/400V substation, symbols and functions of their components.	Chalk-Board Presentations Model Demonstration Video Demonstrations Flipped Classroom

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Draw layout of the typical Thermal Power Plant LLO 1.2 Identify the different components of typical Thermal Power Plant LLO 1.3 Observe the operation of Thermal Power Plant	1	*Demonstration of a Thermal Power Plant using Visit/Animations/ Video programme.	2	CO1
LLO 2.1 Identify components of the Heat Recovery System. LLO 2.2 Describe the function of Components of the Heat Recovery System.	2	Process of Heat Recovery System in Thermal Power Plant.	2	CO1

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 3.1 Draw layout of the typical Hydro Power Plant. LLO 3.2 Identify the different components of typical Hydro Power Plant. LLO 3.3 Observe the operation of Hydro Power Plant.	3	*Demonstration of a Hydro Power Plant using Visit/Animations/ Video programme.	2	CO1
LLO 4.1 Draw layout of the typical Hydro Power Plant	4	Demonstration of a Pumped storage Hydro Power Plant using Visit/Animations/ Video programme.	2	CO1
LLO 5.1 Draw layout of the typical Hydro Power Plant	5	*Demonstration of Different types of Hydro Power Plant using Animations/ Video Programme.	2	CO1
LLO 6.1 Draw load curve of of Campus/ Institute building(s) LLO 6.2 Calculate various economic factors from the above load curve.	6	*Load curve of Campus/ Institute building(s) and calculation of following economical factors: Maximum demand, Average load, Load Factor, Reserve capacity, Plant capacity factor, utilization factor, Plant use factor and Diversity factor.	2	CO1 CO2
LLO 7.1 Select appropriate power generation technology as per variation in load demand.	7	*Selection of power generation technology as per variation in load demand of a given load curve	2	CO1 CO2
LLO 8.1 Draw Load Duration curve and Integrated load curve from a given load curve.	8	Load Duration curve and Integrated load curve.	2	CO2
LLO 9.1 List the components of the electric supply system. LLO 9.2 Prepare a single line diagram with vertical and horizontal clearances of the Electric supply system.	9	*Single line diagram of the Electric supply system.	2	CO3 CO5
LLO 10.1 Prepare single line diagram of 400 kV transmission line substation. LLO 10.2 Prepare plan and elevation diagram of 400 kV transmission line substation.	10	*Layout of 400kV transmission line substation.	2	CO3
LLO 11.1 Prepare single line diagram of 132 kV transmission line substation. LLO 11.2 Prepare plan and elevation diagram of 132 kV transmission line substation.	11	Layout of 132 kV transmission line substation.	2	CO3
LLO 12.1 Identify the components of Ultra High Voltage (UHV) Transmission lines.	12	*Demonstration of an Ultra High Voltage (UHV) Transmission lines using Animations/ Video Programme.	2	CO4
LLO 13.1 Identify the components of Extra High Voltage (EHV) Transmission lines.	13	Demonstration of Extra High Voltage (EHV) Transmission lines using Visit/Animations/ Video Programme.	2	CO4
LLO 14.1 Prepare single line diagram of HVDC transmission line. LLO 14.2 Prepare plan and elevation diagram HVDC transmission line.	14	*Layout of HVDC transmission line.	2	CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 15.1 Prepare list of components of the distribution substation. LLO 15.2 Prepare a single line diagram of the distribution substation. LLO 15.3 Prepare plan and elevation diagram with clearances of distribution substation.	15	*Components of Distribution Substation.	2	CO5
LLO 16.1 Calculate load for Commercial and Residential Consumers. LLO 16.2 Prepare a feeder scheme for consumers.	16	*Distribution scheme for Commercial and Residential Consumers.	2	CO5
LLO 17.1 Calculate load for Industrial Consumer. LLO 17.2 Prepare a feeder scheme foIndustrial Consumer.	17	Distribution scheme for Industrial Consumer.	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Visit

- Visit your Institute or nearby Distribution Substation and observe the Layout and write the technical details about Main transformer, CT, PT, Lightning arrester, Earthing System etc.
- Visit nearby Pumped Storage Hydro Power station (if any) and observe the Layout and write the technical details of Generator, working cycles of Turbine, Reservoir, Penstock etc.
- Visit nearby Hydro Power station and observe the Layout and write the technical details of Generator, working cycles of Turbine, Reservoir, Penstock etc.
- Visit nearby Thermal Power station and observe the Layout and write the technical details of Boiler, generator, Turbine, Super heater, Economiser Air Preheater, Cooling Tower etc.
- Visit nearby Transmission line and observe the Layout and write the technical details about Main transformer, CT, PT, Lightning arrester, Earthing System etc.

Assignment

- Calculate various Economical factors from the given Load Curve.
- Prepare list of material used for Transmission line.
- Calculation on Commercial and Residential Consumers Load Demand
- Prepare list of material used for Transmission line.
- Prepare list of material used for Distribution line/ substation.
- Prepare list of material used for Transmission line substation.
- Calculation on Industrial Consumers Load Demand.
- Numericals on Economics of Power generation.

Micro project

- Prepare a 3D model of Pumped storage Hydro power Station.
- Prepare a 3D model of Hydro power Station.
- Prepare a 3D model of Thermal power Station.
- Prepare a comparative chart for UHVAC and HVAC Transmission line considering their Strength, Limitations, Capital cost involvement, Running Cost, Losses, Voltage regulation, Constructional details etc.
- Prepare a comparative chart for HVAC and HVDC Transmission line on the basis of their Strength, Limitations, Capital cost involvement, Running Cost, Losses, Voltage regulation, Constructional details etc.

- Write Detail complete technical specification of all the elements of Ultra high voltage AC (UHVAC) Transmission line. Also write the functions of each element of the UHVAC Transmission line and submit the report.

Survey

- Collect information and prepare a report on Gas Insulated Substation (GIS).
- Collect information and prepare a report on Hydro Power Plants in Maharashtra/ India.
- Collect information and prepare a report on Thermal Power Plants in Maharashtra/ India.
- Collect information and prepare a report on latest technology used in Transmission Line.
- Collect information and prepare a report on latest technology used in Distribution Substation and Distribution lines.
- Collect information and prepare a report on Nearby Transmission Substation.
- Collect information and prepare a report on High Temperature Low Sag (HTLS) Conductor use in transmission lines.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Video Programme/Animation/Demonstration Model of Thermal Power Plant.	1,2
2	Video Programme/Animation/Demonstration Model of Transmission/Distribution Substation.	10,11,15
3	Video Programme/Animation/Demonstration Model of Hydro Power Plant.	3,4,5
4	Video Programme/Animation/Demonstration Model/Chart Demonstration of Electric Power System.	9
5	Video Programme/Animation/Demonstration Model of different Supporting structures / Insulators/ Conductors of Transmission Line.	9,10,13,14,16,17

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Thermal Power Plant and Hydro Power Plant	CO1	12	2	8	6	16
2	II	Economics of Power Generation and Interconnected Power System	CO2	10	2	4	4	10
3	III	Transmission Line Components, Parameters and Performance	CO3	14	2	8	6	16
4	IV	Extra High Voltage Transmission (HVAC and HVDC)	CO4	10	2	6	4	12
5	V	Distribution Line Components, Parameters and Performance	CO5	14	2	6	8	16
Grand Total				**60**	**10**	**32**	**28**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two unit tests of 30 marks will be conducted and average of two unit tests considered.
- For formative assessment of laboratory learning 25 marks.
- Each practical will be assessed considering appropriate % weightage to process and product and other instructions of assessment.

Summative Assessment (Assessment of Learning)

- End semester summative assessment of 25 marks for laboratory learning.

- End semester assessment of 70 marks through offline mode of examination.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	2	1	3	2	3	2			
CO2	3	3	3	2	2	3	2			
CO3	3	2	1	2	3	2	2			
CO4	3	2	1	2	3	2	2			
CO5	3	3	1	2	2	2	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Nag P K	Power Plant Engineering	McGraw Hill, New Delhi, 2017 ISBN: 978-9339204044
2	Gupta J.B.	A course in Electrical Power.	S. K Kataria and sons, New Delhi. 2014, ISBN: 9789350143742
3	Mehta V.K., Rohit Mehta	Principles of Power System	S.Chand & Co. New Delhi, 2005, ISBN: 9788121924962
4	Gupta B.R.	Generation of electrical Energy	S.Chand & Co. New Delhi, 2010, ISBN: 9788121901024
5	Sivanagaraju S.; Satyanarayana S.	Electrical Power Transmission and Distribution	Pearson ISBN : 8131707911, 9788131707913
6	Gupta B.R.	Power System Analysis and Design	S.Chand and Co. New Delhi ISBN : 9788121922388
7	Kamraju V.	Electrical Power Distribution System	Tata Mc.GrawHill, New Delhi ISBN : 9780070151413

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	www.ntpc.co.in	National Thermal Power Corporation is authority who control India's Thermal Power Sector.
2	https://www.powergrid.in	Power Grid Corporation of India Limited (POWERGRID), a Schedule 'A', 'Maharatna' Public Sector Enterprise of the Government of India.
3	https://www.electrical4u.com/electrical-engineering-articles/transmission/	Information about Electric Power Grid System.
4	www.meda.com	Maharashtra Energy Development Agency working under BEE for spreading Energy conservation awareness in maharashtra.
5	https://energy.gov/sites/prod/files/2013/07/f2/Transmission_Woodall_0.pdf	Transmission Line Basics
6	https://www.electrical4u.com/performance-of-transmission-line/	Performance of Transmission Line
7	https://youtu.be/IdPTuwKEfmA?si=CfpZgHlEgrk5_YvW	Thermal Power Plant.

Sr.No	Link / Portal	Description
8	https://youtu.be/lidARL1w88Q?si=HXc3J4ISMTwHAMMw	Thermal Power Plant.

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

Programme Name/s : **Electrical Engineering/ Electrical Power System**
Programme Code : **EE/ EP**
Semester : **Third**
Course Title : **ELECTRICAL AND ELECTRONIC MEASUREMENT**
Course Code : **313334**

I. RATIONALE

Industry comprises of a number of electrical, electronic instruments and transducers for measuring precisely various electrical and mechanical parameters. The diploma students passing this course will possess the required knowledge and skill set not only to use but to calibrate and troubleshoot these measuring instruments.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Troubleshoot electrical and electronics measuring instruments used for laboratory and industrial measurements.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Apply the basics of measurement to the measuring instruments.
- CO2 - Measure precisely electrical power and energy using appropriate meters.
- CO3 - Use digital measuring instruments for different applications.
- CO4 - Maintain required pressure for given application using pressure transducer.
- CO5 - Use appropriate transducer for maintaining required flow, level and temperature in given application.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme										
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical					
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
313334	ELECTRICAL AND ELECTRONIC MEASUREMENT	EEM	DSC	3	-	4	1	8	4	3	30	70	100	40	25	10	25#	10	25	10	175

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Define static and dynamic characteristics of measuring instruments. TLO 1.2 Explain types of errors in a measuring instrument and their compensation. TLO 1.3 Write the classification of measuring instrument. TLO 1.4 Explain different types of torques in measuring instruments. TLO 1.5 Describe the procedure for calibration of given device. TLO 1.6 Describe construction and working of PMMC and PMMI meter. TLO 1.7 Extend the range of given DC/AC ammeter and voltmeter. TLO 1.8 Classify different types of resistance.	**Unit - I Fundamentals of Measurement** 1.1 Measurement: Definition, need and significance. 1.2 Static and dynamic characteristics of measuring instruments. 1.3 Types of errors in measurement and compensation. 1.4 Classification of Instruments. 1.5 Deflecting, controlling and damping torque. 1.6 Calibration: Need, significance and general procedure. 1.7 Construction and working principle of Permanent magnet moving coil (PMMC) and Permanent magnet moving iron (PMMI) meter. 1.8 Range Extension of ammeter and voltmeter- a) Shunt and multiplier (for DC), b) CT and PT (for AC) 1.9 Classification of resistance: Low, Medium and High.	Chalk-Board Flipped Classroom Video Demonstrations Model Demonstration Presentations
2	TLO 2.1 Describe the working of the dynamometer wattmeter with the help of neat sketch. TLO 2.2 Describe the procedure for measuring power using appropriate method. TLO 2.3 Justify the effect of Power factor on wattmeter reading in two wattmeter method. TLO 2.4 Describe the working of MDI and four quadrant meter with neat labelled sketch. TLO 2.5 5 Describe the working of a given type of energy meter with help of block diagram. TLO 2.6 Describe the working of a given digital energy meter and smart energy meter with neat sketch.	**Unit - II Measurement of Power and Energy.** 2.1 Construction and working of dynamometer wattmeter, Multiplying factor. 2.2 Active and reactive power measurement: One, two and three wattmeter methods. 2.3 Effect of Power factor on wattmeter reading in two wattmeter method. 2.4 Construction and working of maximum Demand indicator (MDI), four quadrant meters. 2.5 Construction and working of Induction type single phase energy meter, types of errors and compensation. 2.6 Single and three phase digital energy meter: Block diagram, constructional features and working principle. 2.7 Smart energy meter: Basic concept, block diagram, operation and working principle.	Chalk-Board Flipped Classroom Video Demonstrations Model Demonstration Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Explain the merits of digital measuring instruments. TLO 3.2 Describe the construction and working of a given digital meter with neat sketch. TLO 3.3 Describe the construction and working of a given resistance measurement meters with neat sketch. TLO 3.4 Describe the working of a given meter used for synchronization with neat sketch. TLO 3.5 Describe the working of function generator with neat sketch. TLO 3.6 Describe the working of CRO, Digital storage oscilloscope with neat sketch.	**Unit - III Digital Measuring Instruments.** 3.1 Digital measuring instruments-Essentials and advantages. 3.2 Construction and working of digital Meters-Ammeter, Voltmeter and Multimeter, Clamp-on meter, L-C-R meter, Power factor meter and Tachometer (Contact and Non-contact). 3.3 Construction and working of Resistance measurement meters: Ohm meter, Digital Megger, Digital earth tester. 3.4 Construction and working of meter used for synchronization: Frequency meter, Synchroscope and Phase sequence indicator. 3.5 Function generator: Basic block diagram, function of each block and applications. 3.6 CRO: Basic block diagram, function of each block. 3.7 Digital storage Oscilloscope: Basic block diagram, function of each block.	Chalk-Board Flipped Classroom Video Demonstrations Model Demonstration Presentations
4	TLO 4.1 Describe the working of instrumentation system with neat sketch. TLO 4.2 State the difference between sensors and transducer. TLO 4.3 Write the classification of transducer. TLO 4.4 Describe the working of given electrical transducer with neat sketch. TLO 4.5 Describe the working of piezoelectric transducer with neat sketch. TLO 4.6 Classify pressure transducer. TLO 4.7 Describe the working of bourdon tube with LVDT as secondary transducer with neat sketch.	**Unit - IV Transducer and Pressure Measurement** 4.1 Instrumentation System-Block diagram, function of each block. 4.2 Difference between sensors and transducer with examples. 4.3 Classification of transducer. 4.4 Electrical Transducers: a) Resistive transducers- Linear and Angular potentiometers, strain gauge, load cell. b) Capacitive transducer. c) Inductive transducer –LVDT, RVDT. 4.5 Working of piezoelectric transducer, classification, examples. 4.6 Pressure measurement: Pressure and its units, types - Absolute, Gauge, Atmospheric, Vacuum. 4.7 Classification of Pressure measuring devices. 4.8 Method of pressure measurement- Bourdon tube with LVDT as secondary transducer.	Chalk-Board Flipped Classroom Video Demonstrations Model Demonstration Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Classify flow transducer. TLO 5.2 Describe the working of given electrical flow meter with neat sketch. TLO 5.3 Classify level transducer. TLO 5.4 Describe the working of given level transducer with neat sketch. TLO 5.5 Classify temperature transducer. TLO 5.6 Describe the working of given temperature transducer with neat sketch.	**Unit - V Flow, Level and Temperature Measurement** 5.1 Flow measurement -Flow and its units, classification of flow transducers -Variable head flow meter, Variable area flow meter. 5.2 Methods of measurement of electrical flow meter: a) Electromagnetic Flow meter. b) Ultrasonic flow meter. 5.3 Level measurement-Level and its units classification of level measurement transducer-Resistive, Inductive and Capacitive. 5.4 Method level measurement: Capacitive, Ultrasonic and Radiation. 5.5 Temperature Measurement-Temperature and its Units, classification -Thermistors, Resistance Temperature Detector (RTD) and Thermocouple. 5.6 Methods of temperature measurement- RTD and thermocouple.	Chalk-Board Flipped Classroom Video Demonstrations Model Demonstration Presentations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify measuring instruments on the basis of symbols on dial, type, accuracy, class, position and scale.	1	*Identification of measuring instruments on the basis of symbols on dial, type, accuracy, class, position and scale.	2	CO1
LLO 2.1 Identify the components of PMMC and PMMI instruments.	2	*Identification of the components of PMMC and PMMI instruments.	2	CO1
LLO 3.1 Troubleshoot PMMC and MI instruments.	3	Troubleshooting of PMMC and PMMI instruments.	2	CO1
LLO 4.1 Calibrate the ammeter /voltmeter for measurement.	4	Calibration of the ammeter /voltmeter for measurement of electrical parameters.	2	CO1
LLO 5.1 Extend the range of voltmeter and ammeter by using shunt and multiplier.	5	Extension of the range of voltmeter and ammeter using shunt and multiplier.	2	CO1
LLO 6.1 Extend the range of ammeter by using CT, take the safety Precautions while using CT.	6	*Extension of the range of ammeter using Current Transformer (CT).	2	CO1
LLO 7.1 Extend the range of ammeter by using CT, take the safety Precautions while using CT	7	*Extension of the range of ammeter using Current Transformer (CT).	2	CO1
LLO 8.1 Measure power in a single-phase circuit by electro-dynamic watt-meter and determining the multiplying factor of a wattmeter also change the current range of wattmeter by making changes in the current	8	*Measurement of power in a single-phase circuit using electro-dynamic watt-meter.	2	CO2
LLO 9.1 Carry out troubleshooting of electro-dynamic watt-meter.	9	Troubleshoot of electro-dynamic watt-meter for measurement.	2	CO2
LLO 10.1 Measure active power in three phase balanced load by using one wattmeter method.	10	*One wattmeter method of measurement of active power in a three-phase balanced load.	2	CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 11.1 Measure reactive power in three phase balanced load by using one wattmeter method	11	One wattmeter method of measurement of reactive power in a three-phase balanced load.	2	CO2
LLO 12.1 Measure active power in three phase balanced load by using two wattmeter method.	12	*Two watt-meters method of measuring active power in a three-phase balanced load.	2	CO2
LLO 13.1 Calibrate single phase energy meter by direct loading.	13	*Calibration of single-phase energy meter by direct loading.	2	CO2
LLO 14.1 Carry out troubleshooting of single-phase energy meter.	14	Troubleshoot of single-phase energy meter.	2	CO2
LLO 15.1 Demonstrate the working of smart energy meter.	15	*Demonstration of smart energy meter.	2	CO2
LLO 16.1 Measure low resistance by using bridges.	16	Measurement of low resistance using bridges.	2	CO3
LLO 17.1 Measure medium and high resistance by using bridges.	17	Measurement of medium and high resistance using bridges.	2	CO3
LLO 18.1 Measure of supply voltage, frequency, peak value in single-phase circuit by using CRO/DSO.	18	*Measurement of supply voltage, frequency, peak value in single-phase circuit using CRO/DSO.	2	CO3
LLO 19.1 Measure linear displacement by using potentiometer.	19	*Measurement of linear displacement using potentiometer.	2	CO4
LLO 20.1 Measure the angular displacement by using potentiometer.	20	Measurement of angular displacement using potentiometer.	2	CO4
LLO 21.1 Measure displacement by using LVDT.	21	Measurement of displacement using LVDT.	2	CO4
LLO 22.1 Measure weights by using strain gauge.	22	Measurement of weights using strain gauge.	2	CO4
LLO 23.1 Measure pressure by using Bourdon tube pressure gauge.	23	*Measurement of pressure using bourdon tube pressure gauge.	2	CO4
LLO 24.1 Measure flow by using orifice meter.	24	*Measurement of flow using orifice meter.	2	CO5
LLO 25.1 Measure flow by using venturi meter.	25	Measurement of flow by using venturi meter.	2	CO5
LLO 26.1 Measure flow by using rotameter.	26	Measurement of flow using rotameter.	2	CO5
LLO 27.1 Measure level by using capacitance transducer.	27	*Measurement of level using capacitance transducer.	2	CO5
LLO 28.1 Measure temperature by using RTD.	28	*Measurement of temperature using RTD.	2	CO5
LLO 29.1 Measure temperature by using thermocouple.	29	Measurement of temperature using Thermocouple.	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- Write the industrial applications of level transducer.

- Write the industrial applications of pressure transducer.
- Write the industrial applications of RTD, thermistor and thermocouple.
- Convert a given temperature scale into another scale.
- Compare analog and digital meters.
- Compare PMMC with PMMI meters.
- Determine earth resistance using digital earth tester and compare with the ideal earth resistance.
- Compare analog with digital energy meter.
- Determine multiplying factor of a wattmeter.
- Write the industrial applications of flow meter.

Suggested Student Activity

- Prepare chart showing real-life examples indicating various types of electrical measuring equipment.
- Collect photographs of PMMC and MI instrument showing internal parts.
- Prepare power point presentation for different types of wattmeters.
- Collect photographs of electronic energy meter and prepare report on it.
- Prepare the report on smart energy meter.
- Collect photographs of CRO and see the practical utilization.
- Prepare charts for measurement system using temperature, pressure, flow, level system.
- Prepare specification broad for basic transducers of temperature, level, pressure and flow.

Micro project

- Electronic energy meter: Collect data of power consumption of the equipment in the departmental laboratories/workshops of your polytechnic using electronic energy meter.
- Prepare a report on usage of level, pressure and flow sensors used in industry.
- Prepare a report on usage of IC LM35 temperature sensor.
- Prepare a report on usage of temperature sensors in mobile, laptop, domestic and consumer appliances.
- DMM: Use DMM for measurement of current, voltage, resistance of different range and check the continuity.
- CRO: Draw the front panel of CRO and write the function of each control on the panel.
- Wattmeter: Dismantle a wattmeter available in the laboratory identify the pressure coil, current coil, spring, magnets, former, dial scale etc. and again assemble the same.
- PMMC and MI instrument: Dismantle any PMMC and MI instrument each available in the laboratory/workshop and identify different parts, material and function i.e. coil, spring, magnets, former, dial scale etc. and again assemble the same.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Model of PMMC and PMMI type instrument (up to 50A)	1,2,3
2	Energy meter (analog/digital) (15A/230V)	13,14
3	Smart energy meter.	15
4	Wheatstone bridge, Mega ohm bridge	16,17
5	CRO (up to 100 MHz)	18
6	Signal Generator (up to 100MHz)/ Function Generator (up to 100MHz)	18

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
7	Linear potentiometer, angular potentiometer	19,20
8	LVDT trainer kit- Displacement range +/- 20 mm. Accuracy of +/- 2% Primary Excitation 4 KHz and 1 Volt, RMS Output: Digital display of +/- 20mm	21
9	Strain gauge trainer kit: Strain gages of 350 ohms, Accuracy: +/- 1% Power Supply 230 V AC, maximum of 5-kg load, Digital indication	22
10	Bourdon tube pressure gauge: Input pressure range 0 – 50 psi. Accuracy of +/- 2%. Dial gauge indication in the range 0 to 50 psi.	23
11	Orifice meter measurement setup: concentric type, stainless steel, U tube manometer 400 mm height, Range 0-1000LPH, Digital display	24
12	Venturi flow measurement setup: stainless steel, U tube manometer 400 mm height, Range 0-1000LPH, Digital display	25
13	Rotameter flow measurement setup: Range 0-1000 LPH, Glass tube body, Bob Material-stainless steel, mounting inlet bottom top outlet	26
14	Capacitance level measurement: Input range 0 to 500 mm, power supply 230 V AC, 2 wire capacitance type, top mounted, Digital display indication of 0 to 500mm	27
15	RTD temperature measurement: Temp range 0-100^{0}C, temperature bath, RTD Type pt100, accuracy +/- 1%, power supply 230V AC	28
16	Thermocouple temperature measurement: Temp range 0-1260^{0}C, temp bath, Thermocouple K Type, accuracy of +/- 1%, power supply 230V AC, digital indication of temperature	29
17	Voltmeter Range (0-110V), Ammeter (0 to 5A)	4,5
18	Voltmeter, Ammeter, CT (15/5, 25/5), PT (230/110, 440/110)	6,7
19	Wattmeter (5/10A, 110/ 230V), Wattmeter (5/10A, 300/ 600V)	8,9,10,11,12

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Fundamentals of Measurement	CO1	7	2	4	4	10
2	II	Measurement of Power and Energy.	CO2	9	4	6	4	14
3	III	Digital Measuring Instruments.	CO3	10	4	6	6	16
4	IV	Transducer and Pressure Measurement	CO4	9	4	4	6	14
5	V	Flow, Level and Temperature Measurement	CO5	10	2	6	8	16
Grand Total				**45**	**16**	**26**	**28**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two unit tests of 30 marks will be conducted and average of two unit tests considered. For formative assessment of laboratory learning 25 marks. Each practical will be assessed considering appropriate % weightage to process and product and other instructions of assessment.

Summative Assessment (Assessment of Learning)

- End semester summative assessment of 25 marks for laboratory learning. End semester assessment of 70 marks through offline mode of examination.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	-	1	-	1	1			
CO2	3	2	1	2	1	1	2			
CO3	3	2	2	2	1	1	3			
CO4	3	2	1	2	2	1	2			
CO5	3	1	1	2	2	1	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	A.K.Sawhney	Electrical and Electronic Measurement and Instrumentation	Dhanpai Rai and Sons, New Delhi, 2014; ISBN: 9780000279744
2	J.B.Gupta	Electronics and Electrical Measurements and Instrumentation	S.K.Katariya and Sons, 2013, ISBN: 8188458937
3	Rajput R.K.	Electrical and Electronic Measurement and Instrumentation	S.Chand and Co. New Delhi, 2015, ISBN: 9789385676017
4	A.J.Baowens	Digital Instrumentation	Tata Mc-Graw Hill Publication ISBN: 9780074630488
5	Patranabis D.	Principles of Industrial Instrumentation	Tata Mc-Graw Hill Publication Co. Ltd, New Delhi 2010; ISBN:9780070699717
6	H.S.Kalsi	Electronic Instrumentation and Measurement.	Tata Mc-Graw Hill Publication Co. Ltd, New Delhi 2019; ISBN:9353162513
7	Theraja B.L., TherajaA.K.	A Text Book of Electrical Technology Vol-I (Basic Electrical Engineering)	S.Chand and Co. New Delhi, 2014, ISBN: 9788121924405

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.electrical4u.com/	Digital electronics measurement
2	https://iitb.vlabs.co.in/	Digital measurement concept.
3	https://ndl.iitkgp.ac.in/	Free source of reference books of electrical measurement and instrumentation.
4	www.dreamtechpress.com /ebooks	Free reference books for more practices.
5	https://nptel.ac.in/	Fundamentals of Measurement.
6	https://swayam.gov.in/nc_details/NPTEL	Concepts of electrical and electronics measurements.

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

Programme Name/s : **Electrical Engineering/ Electrical Power System**
Programme Code : **EE/ EP**
Semester : **Third**
Course Title : **FUNDAMENTALS OF POWER ELECTRONICS**
Course Code : **313335**

I. RATIONALE

Power Electronics finds extensive applications in domestic, commercial, industrial front and electric utilities particularly in terms of efficient conversion, control and conditioning of electric power from its available input into the desired electrical output form. This course will enable the diploma students to develop the knowledge and skill sets of operating and testing different power electronic devices and their applications.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Test the Performance of Power Electronic Devices and Circuits.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Test the functionality of a given power electronic device.
- CO2 - Test the switching performance of a thyristor.
- CO3 - Test the performance of given controlled converter.
- CO4 - Test the performance of given chopper.
- CO5 - Use suitable power electronic circuit for given application.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											Total Marks
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
313335	FUNDAMENTALS OF POWER ELECTRONICS	FPE	SEC	3	-	4	1	8	4	3	30	70	100	40	25	10	25@	10	25	10	175

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Illustrate the power electronic system using block diagram. TLO 1.2 Solve simple numerical on losses in the given switch. TLO 1.3 Explain the general characteristics of the given power electronic switch. TLO 1.4 Describe the construction of the given power electronic device. TLO 1.5 Explain the working principle of the given power electronic device. TLO 1.6 State the applications of the given power electronic device.	**Unit - I Power Electronic Devices** 1.1 Power electronic system: general block diagram, need, advantages and disadvantages 1.2 Switching in power electronic circuit: Need and its importance; Ideal switch and practical switch: concept, general characteristics, conduction losses, switching losses 1.3 SCR: Construction, working principle, Static V-I characteristics, switching characteristics, and applications 1.4 IGBT: Construction, working principle, Static V-I characteristics, switching characteristics, and applications 1.5 Power MOSFET: Construction, working principle, Static V-I characteristics, and applications 1.6 TRIAC: Construction, working principle, Static V-I characteristics, and applications	Lecture Using Chalk-Board Demonstration Video presentations Flipped Classroom
2	TLO 2.1 Explain the need of the given protection for SCR TLO 2.2 Describe the given protection scheme of SCR TLO 2.3 Explain the given turn-on method of SCR TLO 2.4 Illustrate the given firing circuit of SCR TLO 2.5 Explain the given commutation technique of SCR	**Unit - II Protection and Firing Circuit of Thyristor** 2.1 di/dt protection: need, snubber circuit 2.2 dv/dt protection: need, snubber circuit 2.3 Overvoltage protection: need, internal & external overvoltage, voltage clamping device 2.4 Overcurrent protection: need, electronic crowbar circuit 2.5 Thermal Protection of SCR: Need, thermal resistance, and heat sink specification 2.6 Firing circuit: Features and general layout of firing scheme 2.7 SCR turn-on methods: forward voltage triggering, gate triggering, dv/dt triggering, temperature triggering, and light triggering 2.8 SCR Firing circuit: resistance firing circuit (no derivation), RC firing circuit (no derivation), pulse transformer based triggering 2.9 SCR commutation techniques: load commutation (Class A), line commutation (Class F)	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Define the given term(s) related to controlled converter. TLO 3.2 Illustrate the working of the given single phase controlled rectifier. TLO 3.3 Derive equation of DC output voltage of the given controlled converter. TLO 3.4 Compare voltage source inverter and current source inverter on the basis of the given criteria. TLO 3.5 Explain working of the given single phase inverter. TLO 3.6 Explain working principle of sinusoidal pulse width modulation.	**Unit - III Controlled Converters** 3.1 Basic terminologies: conduction angle, firing angle, output voltage, output current, voltage across switch, source current, source voltage 3.2 Single phase half wave controlled rectifier with R, RL load: Circuit diagram, working, input-output waveforms, derivation for average output voltage, equations for output currents, voltages & power, and effect of freewheeling diode 3.3 Single phase full wave controlled bridge rectifier with R, RL load: Circuit diagram, working, input-output waveforms, derivation for average output voltage, equations for output currents, voltages & power 3.4 Three phase full wave controlled bridge rectifier: working principle with R load, input-output waveforms 3.5 Inverters: concept of voltage source inverter and current source inverter 3.6 Single phase half wave bridge inverter with R, RL load: Circuit diagram, working, input-output waveforms 3.7 Single phase full wave bridge inverter with R, RL load: Circuit diagram, working, input-output waveforms 3.8 Pulse width modulation: importance/need, types; Sinusoidal pulse width modulation: concept, working principle and waveforms	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom
4	TLO 4.1 Explain the given terminology related to chopper. TLO 4.2 Explain control strategies of chopper. TLO 4.3 Illustrate working of the given chopper. TLO 4.4 Calculate output voltage of the given chopper.	**Unit - IV DC-DC Converters** 4.1 Basic terminologies: duty ratio, turn on period, turn off period, chopping period 4.2 Control strategies of chopper: Constant frequency system, variable frequency system 4.3 Step up chopper: circuit diagram, working, waveforms and output voltage equation 4.4 Step down chopper: circuit diagram, working, waveforms and output voltage equation 4.5 Buck-Boost chopper: circuit diagram, working, waveforms and output voltage equation	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom
5	TLO 5.1 Explain the operation of charge controller used in the photovoltaics (PV) system. TLO 5.2 Explain speed control of ceiling fan using TRIAC. TLO 5.3 Explain AC to AC converter used in Wind Power Generation. TLO 5.4 Explain the function of converter station in HVDC.	**Unit - V Applications of Power Electronics** 5.1 Charge Controller: Concept, types, applications in Photovoltaics (PV) system with block diagram 5.2 Speed control of ceiling fan using TRIAC: Working, Block Diagram, advantages 5.3 AC to AC converter using DC link: Concept, applications in Wind Power Generation 5.4 HVDC converter station: Concept, Circuit Diagram	Lecture Using Chalk-Board Presentations Video Demonstrations Site/Industry Visit Case Study

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify given power electronic device	1	*Power Electronic Devices.	2	CO1
LLO 2.1 Test the performance of SCR.	2	*V-I Characteristics of SCR.	2	CO1
LLO 3.1 Test the proper functioning of the power MOSFET.	3	*Testing of power MOSFET	2	CO1
LLO 4.1 Test the proper functioning of the IGBT.	4	*Testing of IGBT	2	CO1
LLO 5.1 Test the proper functioning of the TRIAC.	5	Testing of TRIAC.	2	CO1
LLO 6.1 Test the performance of Snubber circuit.	6	*Performance of Snubber circuit.	2	CO2
LLO 7.1 Test the effect of variation of resistance in R triggering circuit on the firing angle of SCR.	7	*Resistance triggering circuit of SCR.	2	CO2
LLO 8.1 Test the effect of variation of resistance and capacitance in RC triggering circuit on the firing angle of SCR.	8	RC triggering circuit of SCR	2	CO2
LLO 9.1 Perform the triggering of SCR using Pulse transformer	9	Triggering of SCR using Pulse transformer	2	CO2
LLO 10.1 Perform the operation of Class A commutation circuit.	10	*Class A (Load Commutation) commutation circuit.	2	CO2
LLO 11.1 Perform the operation of Class F commutation circuit.	11	Class F (Line Commutation) commutation circuit	2	CO2
LLO 12.1 Measure output voltage of single phase half wave controlled rectifier by using CRO/DSO. LLO 12.2 Use various controls of the CRO/DSO	12	*Operation of single phase half wave controlled rectifier with resistive load.	2	CO2 CO3
LLO 13.1 Measure output voltage of single phase half wave controlled rectifier by using CRO/DSO. LLO 13.2 Use various controls of the CRO/DSO	13	Operation of single phase half wave controlled rectifier with RL load without freewheeling diode.	2	CO2 CO3
LLO 14.1 Measure output voltage of single phase half wave controlled rectifier by using CRO/DSO. LLO 14.2 Use various controls of the CRO/DSO	14	*Operation of single phase half wave controlled rectifier with RL load with freewheeling diode.	2	CO2 CO3
LLO 15.1 Measure output voltage of single phase full wave controlled rectifier by using CRO/DSO. LLO 15.2 Use various controls of the CRO/DSO	15	Operation of single phase full wave controlled rectifier with R load.	2	CO2 CO3
LLO 16.1 Measure output voltage of single phase full wave controlled rectifier by using CRO/DSO. LLO 16.2 Use various controls of the CRO/DSO	16	*Operation of single phase full wave controlled rectifier with RL load.	2	CO2 CO3
LLO 17.1 Measure output voltage of three phase full wave controlled rectifier by using CRO/DSO. LLO 17.2 Use various controls of the CRO/DSO	17	Operation of three phase full wave controlled rectifier with R load.	2	CO2 CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 18.1 Measure the output voltage with different firing angles of the controlled rectifier available in your laboratory	18	*Voltage control using controlled rectifier.	2	CO2 CO3
LLO 19.1 Measure output voltage of single phase half wave bridge inverter by using CRO/DSO. LLO 19.2 Use various controls of the CRO/DSO	19	*Operation of single phase half wave bridge inverter with resistive load.	2	CO2 CO3
LLO 20.1 Measure output voltage of single phase full wave bridge inverter by using CRO/DSO. LLO 20.2 Use various controls of the CRO/DSO	20	Operation of single phase full wave bridge inverter with resistive load.	2	CO2 CO3
LLO 21.1 Measure output voltage of single phase half wave bridge inverter by using CRO/DSO. LLO 21.2 Use various controls of the CRO/DSO	21	Operation of single phase half wave bridge inverter with RL load.	2	CO2 CO3
LLO 22.1 Measure output voltage of single phase full wave bridge inverter by using CRO/DSO. LLO 22.2 Use various controls of the CRO/DSO	22	Operation of single phase full wave bridge inverter with RL load	2	CO2 CO3
LLO 23.1 Measure the output voltage of chopper by varying duty cycle. LLO 23.2 Use various controls of the CRO/DSO	23	Operation of step-up chopper.	2	CO2 CO4
LLO 24.1 Measure the output voltage of chopper by varying duty cycle. LLO 24.2 Use various controls of the CRO/DSO	24	*Operation of step-down chopper.	2	CO2 CO4
LLO 25.1 Test the performance of charge controller in PV system.	25	Charge controller in PV system	2	CO4 CO5
LLO 26.1 Observe the operation of AC to AC converter (with DC link). LLO 26.2 Interpret the input and output profile of the AC to AC converter (with DC link).	26	*Demonstration of AC to AC converter (with DC link) used in wind power plant.	2	CO3 CO4 CO5
LLO 27.1 Control the speed of fan using TRIAC.	27	*Speed control of fan using TRIAC.	2	CO3 CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Build a power electronic circuit to produce variable voltage for a given application using following steps. 1) Identify voltage range for a given application. 2) Select circuit components suitable for the identified voltage range. 3) Connect circuit components to build power electronic circuit controlling voltage. 4) Test the circuit for the production of variable voltage. 5) Prepare a report on the circuit built and submit the same.

- Prepare a report on commercial or industrial applications of power electronics devices by performing following activities. 1) Identify 3 to 5 relevant applications. 2) Visit site and understand role of power electronic devices in identified applications. 3) Write the specifications of major components in the applications. 4) Prepare block diagram or process flow diagram of the applications.
- Prepare a report on the ratings/specifications and applications of various power electronic devices. 1) Select any 3 to 5 power electronic devices. 2) Visit manufacturers' site or official websites of power electronic devices manufacturers and note the specifications or ratings of the selected power electronic devices. 3) Compare selected power electronics devices based on collected information along with their applications.
- Build a circuit of charge controller for a given battery using following steps. 1) Write specifications of a given battery. 2) Select circuit components required for charge controller circuit suitable for given battery. 3) Connect circuit components to build charge controller. 4) Test change controller for controlling power flow through battery. 5) Prepare a report on the charge controller and submit the same.
- Any other relevant microproject assigned by subject teacher.

Assignment

- Numerical on losses in power electronic device.
- Prepare a report on evolution of power electronic devices.
- Numerical on output voltage of given controlled converter.
- Numerical on DC output voltage of given chopper.
- Prepare a report on testing the performance of GTO.
- Any other relevant assignment given by subject teacher.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	SCR: Irms = 16A, IH = 100mA, IL = 200mA, IGT = 90 to 35 mA, VGT = 3 to 1 V, Vrms = 1600V	1,2,6,7,8,10,11,9,12,13,14,15,16,17,18
2	Power MOSFET: Vds-400V, ID-10A-6.3A Pd-125W	1,3,23,24
3	IGBT: Vces = 1200V, VGE = 20V, IC = 139 to 93A, PD = 650 to 300W	1,4,19,20,21,22
4	TRIAC: It = 4A, IGT = 10mA, Vt = 600V.	1,5
5	Rheostat: Nicrome wire, 300ohm, 10A, 400V	12,13,14,15,16,17,19,20,21,22
6	Variable inductive load: Single phase,250V, 2.5kW continuously variable core type	12,13,14,15,16,17,19,20,21,22
7	CRO/Digital Oscilloscope with probes: 20MHz, dual channel, sensitivity = 1mV/div., Max Input = 400V, Power supply = 230VAC.	12,13,14,15,16,17,19,20,21,22
8	Clamp on meter: Current = 0 to 400A, Voltage = 0 to 600V	2,3,4,5,25,27
9	AC and DC Ammeter: Range = 0 to 20A, Sensitivity = 0.5A/div.	25,27
10	AC and DC Voltmeter: 0 to 300V, Sensitivity = 1V/div.	25,27
11	Multimeter: 2000 count digital display, 1000V DC/750 V AC ranges, 10 A AC/DC ranges	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification

Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Power Electronic Devices	CO1	8	2	6	4	12
2	II	Protection and Firing Circuit of Thyristor	CO1,CO2	11	4	10	4	18
3	III	Controlled Converters	CO2,CO3	14	2	14	6	22
4	IV	DC-DC Converters	CO2,CO4	7	2	4	4	10
5	V	Applications of Power Electronics	CO3,CO4,CO5	5	2	4	2	8
Grand Total				**45**	**12**	**38**	**20**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- 30 Marks of Theory FA shall be obtained from an average mark of two unit tests (each of 30 marks) held in the semester. At least 2 COs should be covered in each unit test.
- Continuous assessment shall be based on process and product related performance indicators and laboratory experiences. Each practical shall be assessed for 25 marks considering 60% weightage to process and 40% weightage to product.
- Rubrics of continuous assessment of practical, including performance indicators, shall be designed by concerned course teacher.

Summative Assessment (Assessment of Learning)

- End semester, theory summative assessment of 70 marks shall be based on offline mode of written examination.
- End semester, practical summative assessment of 25 marks shall be based on student's performance in end semester practical exam.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	2	-	3	-	-	3			
CO2	3	2	1	3	-	-	2			
CO3	3	2	2	3	-	1	2			
CO4	3	2	2	3	-	1	2			
CO5	2	3	2	2	2	2	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Muhammad H. Rashid	Power Electronics Handbook	Butterworth-Heinemann Inc, ISBN:978-0128114070

Sr.No	Author	Title	Publisher with ISBN Number
2	P S. Bimbhra	Power Electronics	KHANNA PUBLISHERS, ISBN:978-8174092793
3	Muhammad H. Rashid	Power Electronics: Devices, Circuits, and Applications	Pearson Education, ISBN:978-8120345317
4	M D Singh, K B Khanchnadani	Power Electronics	McGraw Hill Education, ISBN:9780070583894

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://nptel.ac.in/courses/108102145	Course on Power Electronics by IIT Delhi
2	https://nptel.ac.in/courses/108105066	Course on Power Electronics by IIT Kharagpur
3	https://nptel.ac.in/courses/108101038	Course on Power Electronics by IIT Bombay
4	https://ocw.mit.edu/courses/6-334-power-electronics-spring-2007/	Course on Power Electronics by MIT Opencourseware
5	https://youtube.com/playlist?list=PLSnw1KE0TFkVu05Ws0Ax143gZYmxPMCoY&si=FWLw-jfnLxC_l-4j	Laboratory course on Power Electronics by RGUKT Basar
6	https://www.youtube.com/playlist?list=PL4emuJKx0B8aREwkC5BEOw2OZ48puPyOG	Videos on Power Electronics
7	https://3dcircuits.engineering.dartmouth.edu/powani.html	Animation on Chopper and Rectifier

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

Maharashtra State Board Of Technical Education, Mumbai

Learning and Assessment Scheme for Post S.S.C Diploma Courses

Programme Name : Diploma In Electrical Engineering / Electrical Power System

Programme Code : EE / EP **With Effect From Academic Year** : 2023-24

Duration Of Programme : 6 Semester **Duration** : 16 WEEKS

Semester : Fourth **NCrF Entry Level : 3.5** **Scheme** : K

Sr No	Course Title	Abbrevation	Course Type	Course Code	Total IKS Hrs for Sem.	Learning Scheme					Credits	Assessment Scheme											
						Actual Contact Hrs./Week			Self Learning (Activity/ Assignment /Micro Project)	Notional Learning Hrs /Week		Paper Duration (hrs.)	Theory				Based on LL & TL				Based on Self Learning		Total Marks
																	Practical						
						CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
													Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
(All Compulsory)																							
1	ENVIRONMENTAL EDUCATION AND SUSTAINABILITY	EES	VEC	314301	2	3	-	-	1	4	2	1.5	30	70*#	100	40	-	-	-	-	25	10	125
2	D.C. MACHINES AND TRANSFORMERS	DMT	DSC	314322	-	4	-	4	-	8	4	3	30	70	100	40	25	10	25#	10	-	-	150
3	UTILIZATION OF ELECTRICAL ENERGY	UEE	DSC	314323	-	4	-	2	2	8	4	3	30	70	100	40	25	10	25@	10	25	10	175
4	DIGITAL ELECTRONICS AND MICROCONTROLLER APPLICATIONS	DEM	SEC	314324	-	3	-	4	1	8	4	3	30	70	100	40	25	10	25@	10	25	10	175
5	ELECTRICAL ESTIMATING AND CONTRACTING	EEC	DSC	314325	-	3	-	4	1	8	4	3	30	70	100	40	25	10	25#	10	25	10	175
6	COMPUTER AIDED DRAWING AND SIMULATION	CDS	SEC	314008	-	-	-	4	-	4	2	-	-	-	-	-	25	10	25@	10	-	-	50
Total					**2**	**17**		**18**	**5**		**20**		**150**	**350**	**500**		**125**		**125**		**100**		**850**

Sr No	Course Title	Abbrevation	Course Type	Course Code	Total IKS Hrs for Sem.	Learning Scheme					Credits	Assessment Scheme											
						Actual Contact Hrs./Week			Self Learning (Activity/ Assignment /Micro Project)	Notional Learning Hrs /Week		Paper Duration (hrs.)	Theory				Based on LL & TL				Based on Self Learning		Total Marks
																	Practical						
						CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
													Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	

Abbreviations : CL- Classroom Learning , TL- Tutorial Learning, LL-Laboratory Learning, FA - Formative Assessment,SA -Summative Assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends : @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

Course Category : Discipline Specific Course Core (DSC) , Discipline Specific Elective (DSE) , Value Education Course (VEC) , Intern./Apprenti./Project./Community (INP) , AbilityEnhancement Course (AEC) , Skill Enhancement Course (SEC) , GenericElective (GE)

COMPUTER AIDED DRAWING AND SIMULATION **Course Code : 314008**

Programme Name/s : Electrical Engineering/ Electrical Power System

Programme Code : EE/ EP

Semester : Fourth

Course Title : COMPUTER AIDED DRAWING AND SIMULATION

Course Code : 314008

I. RATIONALE

It is the need of the industry to draw electrical engineering drawings and use CAD software effectively as per the requirement. In this course, students will practice to interpret drawings, communicate ideas, and turn concepts into practical designs. They gain skills in navigating CAD software and using its tools efficiently to draw electrical drawings. This course is designed in such a way that practical performed in this course will enhance their skills to compete in fast growing electrical industry and understand different circuits by simulation.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Draw electrical drawings using CAD and simulate basic Electrical circuits using simulation software(s).

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Comprehend Electrical Drawings.
- CO2 - Locate various components of CAD software.
- CO3 - Use relevant CAD Tools and Commands for Electrical Drawings.
- CO4 - Draw different Electrical Drawings using CAD software.
- CO5 - Simulate Basic Electrical and Electronic circuits.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
314008	COMPUTER AIDED DRAWING AND SIMULATION	CDS	SEC	-	-	4	-	4	2	-	-	-	-	-	25	10	25@	10	-	-	50

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Sketch the electrical symbols as per requirement in electrical drawings. TLO 1.2 Interpret given electrical power/control wiring diagram. TLO 1.3 Identify types of electrical panel. TLO 1.4 Sketch GA Diagram of Electrical control panel (Assume suitable dimensions).	**Unit - I Electrical Drawings.** 1.1 Symbols: Electrical and Electronic as per SP 30: 2023 Part 1, section 3. 1.2 Types of electrical drawings (a) Power wiring diagram (single line diagram (SLD) or Multiline diagram) (b) Control wiring diagram (Schematic diagram) (c) Block diagrams (d) Pictorial diagrams. 1.3 Types of Electrical panels (a) MCC (Motor control center) Panel (b) PCC (Power control center) panel (c) APFC (Automatic Power Factor Controller) Panel (d) PLC (Programmable logic controller) Panel. 1.4 General Arrangement (GA) diagram of Electrical control panel.	Hands-on Presentations Lecture Using Chalk-Board
2	TLO 2.1 Identify the function of the given components of CAD classic screen. TLO 2.2 Identify the given components of CAD screen. TLO 2.3 Identify the given toolbar and commands.	**Unit - II Computer Aided Design (CAD) Introduction.** 2.1 Components of CAD classic screen. 2.2 Menu bar and status bar. 2.3 Open and Save file. 2.4 CAD Toolbars. 2.5 Command Box. 2.6 Zoom in and Zoom out.	Hands-on Presentations Demonstration

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Use the coordinate methods and practice basic commands. TLO 3.2 Practice Draw, Modify and Annotation toolbar commands. TLO 3.3 Practice Important CAD Modes.	**Unit - III CAD Tools and Commands.** 3.1 Coordinate Method: Absolute, Relative, Polar. Basic commands: Limits, Units. 3.2 Draw Toolbar: Line, Polyline, Circle, Arc, Rectangle, Ellipse, Polygon, Hatch. 3.3 Modify Toolbar: Move, Rotate, Trim, Erase, Copy, Cut, Mirror, Fillet, Chamfer, Offset, Explode, Strech, Scale. 3.4 Annotation Toolbar: Multiline Text, Single Line Test, Linear dimension, Aligned dimension, Angular Dimension, Arc Length Dimension, Radius Dimension, Diameter Dimension 3.5 Important CAD Modes : Grid, Ortho, Snap, Polar Tracking, Object Snap Tracking.	Hands-on Demonstration Presentations
4	TLO 4.1 Sketch the power wiring diagram, control wiring diagram and GA Diagram of Electrical control panel using CAD TLO 4.2 Sketch the Single line diagram (SLD) of the 11 kV/433 V distribution substation using CAD TLO 4.3 Sketch the Single line diagram (SLD) of residential/commercial unit using CAD TLO 4.4 Sketch the Single line diagram (SLD) of any industrial plant using CAD	**Unit - IV Use of CAD in Real World Electrical Engineering Drawings.** 4.1 Applications of electrical CAD software to: (a)Draw power wiring diagram of electrical control panel. (b)Draw control wiring diagram of electrical control panel. (c)Draw GA diagram of electrical control panel. 4.2 Applications of electrical CAD software to Single line diagram (SLD) of the 11 kV/433 V distribution substation. 4.3 Prepare Single line diagram (SLD) of residential/commercial unit using CAD. 4.4 Draw the Single line diagram (SLD) of any industrial electrical installation using CAD.	Hands-on Demonstration Presentations
5	TLO 5.1 Select and use softwares for Electrical and electronic circuit simulations. TLO 5.2 Build, Simulate and Test Basic electric circuits. TLO 5.3 Build, Simulate and Test Basic electronic circuits. TLO 5.4 Measure various electrical parameters and Generate or plot relevant Waveforms/Graphs. TLO 5.5 Develop P.C.B. layout for a given electrical circuit using software.	**Unit - V Simulation of Electrical and Electronic Circuits.** 5.1 Voltage, current, power across (a)Series R-L circuit (b)Series R-C circuit (c)Series R-L-C circuit. 5.2 Rectifier circuit, KVL and KCL simulation. 5.3 Triac Lamp Dimmer Circuit simulation. 5.4 Basic Logic Gate and adder circuit simulation. 5.5 Printed Circuit Board (PCB) preparation basic information.	Hands-on Demonstration Presentations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Draw symbols of different electrical and electronic components using drawing instruments.	1	*Symbols of Electrical and Electronic Components as per SP 30: 2011(NEC 2011) part 1, section 3 or new equivalent IS on sketch book.	2	CO1
LLO 2.1 Draw Power and control wiring diagram for DOL starter.	2	*Power and Control wiring diagram of DOL Starter on sketch book.	2	CO1

COMPUTER AIDED DRAWING AND SIMULATION **Course Code : 314008**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 3.1 Draw Power and control wiring diagram for Star Delta starter.	3	*Power and Control wiring diagram of Star Delta Starter on sketch book.	2	CO1
LLO 4.1 Draw General Arrangement (GA) Diagram for DOL/Star delta starter panel or any other electrical panel.	4	General Arrangement Diagram for Electrical Panel on sketch book (Assume suitable dimensions).	2	CO1
LLO 5.1 Install CAD software. LLO 5.2 Create new drawing. LLO 5.3 Locate components of CAD Classic Screen (CAD screen layout, Drawing area, Menu and Toolbars, Status bar).	5	*Different components of CAD classic screen.	2	CO2
LLO 6.1 Create and Save drawing. LLO 6.2 Set the drawing Limits and Units of the file. LLO 6.3 Perform Zoom in and Zoom out functionality.	6	*CAD file operations and Limits & Units of Drawing.	2	CO2
LLO 7.1 Use Draw Toolbar of CAD for drawing basic geometrical shapes.	7	* Basic geometrical shapes using Draw Toolbar commands (Line, Polyline, Circle, Arc, Rectangle, Ellipse, Polygon, Hatch).	2	CO2 CO3
LLO 8.1 Use Modify Toolbar of CAD for modifying or editing CAD drawing.	8	Modifying or editing basic geometrical shapes using modify commands (Move, Rotate, Trim, Erase, Copy, Cut, Mirror, Fillet, Chamfer, Offset, Explode, Stretch, Scale).	2	CO2 CO3
LLO 9.1 Use Annotation Toolbar of CAD for writing Text and measuring dimensions.	9	*Annotation Toolbar commands (Multiline Text, Single Line Test, Linear dimension, Aligned dimension, Angular Dimension, Arc Length Dimension, Radius Dimension, Diameter Dimension).	2	CO2 CO3
LLO 10.1 Use Important CAD modes for drawing: Grid, Ortho, Snap, Polar Tracking, Object Snap Tracking.	10	*Important CAD Modes for drawing: Grid, Ortho, Snap, Polar Tracking, Object Snap Tracking.	2	CO2 CO3
LLO 11.1 Draw symbols of different electrical and electronic components using CAD.	11	*Symbols of Electrical and Electronic Components as per SP 30: 2011(NEC 2011) part 1, section 3 or new equivalent IS using CAD.	2	CO1 CO2 CO3
LLO 12.1 Draw Power and control wiring diagram for DOL starter using CAD.	12	*Power and Control wiring diagram of DOL Starter using CAD.	2	CO2 CO3
LLO 13.1 Draw Power and control wiring diagram for Star Delta starter using CAD.	13	*Power and Control wiring diagram of Star Delta Starter using CAD.	2	CO2 CO3
LLO 14.1 Draw General Arrangement (GA) Diagram for DOL/Star delta starter panel or any other electrical panel using CAD.	14	*General Arrangement Diagram for Electrical Panel (Assume suitable dimensions) using CAD.	2	CO2 CO3
LLO 15.1 Draw Single Line Diagram (SLD) of the 11kV/433V distribution substation using CAD software.	15	*Single Line Diagram (SLD) of the 11kV/433V distribution substation using CAD.	2	CO2 CO3 CO4

COMPUTER AIDED DRAWING AND SIMULATION **Course Code : 314008**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 16.1 Draw Single Line Diagram (SLD) of any Industrial Electrical Installation using CAD Software. LLO 16.2 Plot and print drawings to produce hard copies or digital outputs.	16	*Single Line Diagram (SLD) of any Industrial Electrical Installation using CAD Part I.	2	CO2 CO3 CO4
LLO 17.1 Draw Single Line Diagram (SLD) of any Industrial Electrical Installation using CAD Software. LLO 17.2 Plot and print drawings to produce hard copies or digital outputs.	17	*Single Line Diagram (SLD) of any Industrial Electrical Installation using CAD Part II.	2	CO2 CO3 CO4
LLO 18.1 Install simulation software. LLO 18.2 Create new simulation worksheet. LLO 18.3 Use different tools available in software.	18	*Use of simulation software.	2	CO5
LLO 19.1 Build ohms law, series & parallel circuit using simulation software. LLO 19.2 Measure different electrical parameters using software tools.	19	*Simulation for verification of Ohm's law and series & parallel resistances in circuit.	2	CO5
LLO 20.1 Build KCL and KVL Circuit using software. LLO 20.2 Measure electrical parameters using software.	20	*Simulation of Kirchoff's Current Law and Kirchoff's Voltage Law.	2	CO5
LLO 21.1 Build R-L series circuit using software. LLO 21.2 Measure electrical parameters using software. LLO 21.3 Observe Relevant waveforms across each components.	21	*Simulation of R-L series circuit.	2	CO5
LLO 22.1 Build R-C series circuit using software. LLO 22.2 Measure electrical parameters using software . LLO 22.3 Observe Relevant waveforms across each components.	22	Simulation of R-C series circuit.	2	CO5
LLO 23.1 Build PN junction diode circuit using software. LLO 23.2 Observe Diode characteristics.	23	Simulation of VI Characteristics of diode.	2	CO5

COMPUTER AIDED DRAWING AND SIMULATION **Course Code : 314008**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 24.1 Build half-wave rectifier circuit using software. LLO 24.2 Measure different parameters using software. LLO 24.3 Develop P.C.B. layout for a given electrical circuit using software.	24	*Simulation of single phase half-wave rectifier circuit.	2	CO5
LLO 25.1 Build full-wave rectifier circuit using software. LLO 25.2 Measure different parameters using software. LLO 25.3 Develop P.C.B. layout for a given electrical circuit using software.	25	Simulation of single phase full-wave rectifier circuit.	2	CO5
LLO 26.1 Build basic logic gates circuit using software. LLO 26.2 Observe different parameters using software.	26	*Simulation of Basic Logic Gates.	2	CO5
LLO 27.1 Build Triac Lamp Dimmer circuit using software. LLO 27.2 Observe different parameters using software.	27	*Simulation of Triac Lamp Dimmer circuit.	2	CO5
LLO 28.1 Build Half and Full Adder Logic circuit using software. LLO 28.2 Observe different parameters using software. LLO 28.3 Develop P.C.B. layout for a given electrical circuit using software.	28	Simulation of Half and Full Adder Logic circuit.	2	CO5
LLO 29.1 Build Half and Full Subtractor circuit using software. LLO 29.2 Observe different parameters using software.	29	Simulation of Half and Full Subtractor circuit.	2	CO5
LLO 30.1 Build any circuit using software. LLO 30.2 Develop P.C.B. layout for a given electrical circuit using software.	30	P.C.B. Layout Preparation for electrical circuit using software.	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- Simulate stair case wiring circuit
- Simulate one switch one bulb house wiring diagram circuit
- Simulate Op-Amp integrator circuit design
- Simulate & Measure average power and power factor with a wattmeter

- Simulate series and parallel RLC circuit
- Study EPLAN software

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	A4 Sketch Book Drawing Material	1,2,3,4
2	Simulation Software List 1) Any Open-Source Software like Scilab. 2) Multisim Educational Version 14.3 3) PSIM 11.1	18,19,20,21,22,23,24,25,26,27,28,29,30
3	CAD Software List 1) Any Open-Source Computer Aided Design (CAD) Software. 2) LibreCAD. 3) AutoCAD Electrical Student Version.	5,6,7,8,9,10,11,12,13,14,15,16,17
4	Computer Sysytem Operating System: 64-bit Windows 8 or higher Processor: 2.5–2.9 Ghz processor / Recommended: 3+ Ghz processor RAM: 8 GB as a minimum, with 16GB being recommended GPU: 1GB of VRAM as a minimum with DirectX 11 support; Recommended: 4 GB of VRAM with DirectX 12 support Storage: 10 GB.	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table) : NOT APPLICABLE

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Teacher should prepare rubrics for Formative assessment
- Each Practical will be assessed for 25 Marks and average of all marks obtained will be considered.

Summative Assessment (Assessment of Learning)

- End Semester assessment of 25 marks for laboratory learning.
- Teacher should prepare rubrics for Summative Assessment.

XI. SUGGESTED COS - POS MATRIX FORM

COMPUTER AIDED DRAWING AND SIMULATION **Course Code : 314008**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	1	3	2	-	2			
CO2	3	-	-	3	-	-	2			
CO3	3	-	2	3	1	-	2			
CO4	3	1	3	3	1	2	2			
CO5	3	1	3	3	1	2	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Cornel Barbu	Electrician's Book how to Read Electrical Drawings	Lulu.com, ISBN-13: 9781435713208
2	Prof. Sham Tickoo	AutoCAD Electrical 2021: A Tutorial Approach, 2nd Edition	CADCIM Technologies, ISBN-13 9781640571006, 1640571000
3	John Reeder, Reeder	Using Multisim 9 Troubleshooting DC/AC Circuits	Delmar Cengage Learning, ISBN-13 9781111322137, 1111322139

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.kicad.org/	Kicad : This link download Open Source PCB Design Kicad Software
2	https://www.autodesk.com/education/students	AutoCAD : Register and get free student version of LATEST AutoCAD software
3	https://law.resource.org/pub/in/bis/S05/is.sp.30.2011.pdf	This link downloads IS SP:30 2011 (NEC 2011)
4	https://powersimtech.com/products/	PSIM : This link downloads PSIM software demo version
5	https://powersimtech.com/wp-content/uploads/2021/01/PSIM-User-Manual.pdf	This link downloads PSIM software user Manual
6	https://scilab.in/DownloadScilab	Scilab : This link downloads Scilab software
7	https://librecad.org/	LibreCAD : This link downloads Open Source LibreCAD software
8	https://www.falstad.com/circuit/	Falstad : This is an electronics circuit simulator applet
9	https://www.ni.com/en/support/downloads/software-products/download.multisim.html#452133	NI Multisim : This is an electrical and electronics circuit simulator
10	https://www.youtube.com/watch?v=GH-JFXbOcZg&t=71s	Hartley Oscillator circuit simulation on Multisim software

COMPUTER AIDED DRAWING AND SIMULATION **Course Code : 314008**

Sr.No	Link / Portal	Description
11	https://www.youtube.com/watch?v=mzglU-tMgXY	Simulating halfwave and full wave rectifier circuit in multisim
12	https://www.youtube.com/watch?v=szfgbN0GD5A	AutoCAD practice exercise
13	https://www.youtube.com/watch?v=_2d_Tb9bzsQ&t=10s	Series RLC Circuit Simulation using Multisim
14	https://www.youtube.com/watch?v=UKpIGwto47U	Triac Lamp Dimmer Circuit
15	https://youtu.be/9m8ABCSKTec?si=Kuf6ryURVs9hpK49	VI Characteristics of PN junction diode 1N4007

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

Programme Name/s	**: Architecture Assistantship/ Automobile Engineering./ Artificial Intelligence/ Agricultural Engineering/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Architecture/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Fashion & Clothing Technology/ Dress Designing & Garment Manufacturing/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Food Technology/ Computer Hardware & Maintenance/ Instrumentation & Control/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Instrumentation/ Interior Design & Decoration/ Interior Design/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Medical Laboratory Technology/ Medical Electronics/ Production Engineering/ Printing Technology/ Polymer Technology/ Surface Coating Technology/ Computer Science/ Textile Technology/ Electronics & Computer Engg./ Travel and Tourism/ Textile Manufactures/**
Programme Code	**: AA/ AE/ AI/ AL/ AN/ AO/ AT/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CW/ DC/ DD/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ FC/ HA/ IC/ IE/ IF/ IH/ IS/ IX/ IZ/ LE/ ME/ MK/ ML/ MU/ PG/ PN/ PO/ SC/ SE/ TC/ TE/ TR/ TX**
Semester	**: Fourth**
Course Title	**: ENVIRONMENTAL EDUCATION AND SUSTAINABILITY**
Course Code	**: 314301**

I. RATIONALE

The survival of human beings is solely depending upon the nature. Thus, threats to the environment directly impact on existence and health of humans as well as other species. Depletion of natural resources and degradation of ecosystems is accelerated due to the growth in industrial development, population growth, and overall growth in production demand. To address these environmental issues, awareness and participation of individuals as well as society is necessary. Environmental education and sustainability provide an integrated, and interdisciplinary approach to study the environmental systems and sustainability approach to the diploma engineers.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Resolve the relevant environmental issue through sustainable solutions

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Identify the relevant Environmental issues in specified locality.
- CO2 - Provide the green solution to the relevant environmental problems.
- CO3 - Conduct SWOT analysis of biodiversity hotspot
- CO4 - Apply the relevant measures to mitigate the environmental pollution.
- CO5 - Implement the environmental policies under the relevant legal framework.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

ENVIRONMENTAL EDUCATION AND SUSTAINABILITY **Course Code : 314301**

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
314301	ENVIRONMENTAL EDUCATION AND SUSTAINABILITY	EES	VEC	3	-	-	1	4	2	1.5	30	70*#	100	40	-	-	-	-	25	10	125

Total IKS Hrs for Sem. : 2 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Explain the need of studying environment and its components. TLO 1.2 Investigate the impact of population growth and industrialization on the relevant environmental issues and suggest remedial solutions TLO 1.3 Explain the Concept of 5 R w.r.t. the given situation TLO 1.4 Elaborate the relevance of Sustainable Development Goals in managing the climate change TLO 1.5 Explain the concept of zero carbon-footprint with carbon credit	**Unit - I Environment and climate change** 1.1 Environment and its components, Types of Environments, Need of environmental studies 1.2 Environmental Issues- Climate change, Global warming, Acid rain, Ozone layer depletion, nuclear accidents. Effect of population growth and industrialization 1.3 Concept of 5R, Individuals' participation in i) 5R policy, ii) segregation of waste, and iii) creating manure from domestic waste 1.4 Impact of Climate change, Factors contributing to climate change, Concept of Sustainable development, Sustainable development Goals (SDGs), Action Plan on Climate Change in Indian perspectives 1.5 Zero Carbon footprint for sustainable development, (IKS-Enviornment conservation in vedic and pre-vedic India)	Lecture Using Chalk-Board Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Justify the importance of natural resources in sustainable development TLO 2.2 Explain the need of optimum use of natural resources to maintain the sustainability TLO 2.3 Differentiate between renewable and non-renewable sources of energy TLO 2.4 Suggest the relevant type of energy source as a green solution to environmental issues	**Unit - II Sustainability and Renewable Resources** 2.1 Natural Resources: Types, importance, Causes and effects of depletion. (Forest Resources, Water Resources, Energy Resources, Land resources, Mineral resources), (IKS- Concepts of Panchmahabhuta) 2.2 Impact of overexploitation of natural resources on the environment, optimum use of natural resources 2.3 Energy forms (Renewable and non-renewable) such as Thermal energy, nuclear energy, Solar energy, Wind energy, Geothermal energy, Biomass energy, Hydropower energy, biofuel 2.4 Green Solutions in the form of New Energy Sources such as Hydrogen energy, Ocean energy & Tidal energy	Lecture Using Chalk-Board Presentations
3	TLO 3.1 Explain the characteristics and functions of ecosystem TLO 3.2 Relate the importance of biodiversity and its loss in the environmental sustainability TLO 3.3 Describe biodiversity assessment initiatives in India TLO 3.4 Conduct the SWOT analysis of the biodiversity hot spot in India TLO 3.5 Explain the need of conservation of biodiversity in the given situation	**Unit - III Ecosystem and Biodiversity** 3.1 Ecosystem - Definition, Aspects of ecosystem, Division of ecosystem, General characteristics of ecosystem, Functions of ecosystem 3.2 Biodiversity - Definitions, Levels, Value, and loss of biodiversity 3.3 Biodiversity Assessment Initiatives in India 3.4 SWOT analysis of biodiversity hot spot in India 3.5 Conservations of biodiversity - objects, and laws for conservation of biodiversity	Lecture Using Chalk-Board Presentations Video Demonstrations
4	TLO 4.1 Classify the pollution based on the given criteria TLO 4.2 Justify the need of preserving soil as a resource along with the preservation techniques TLO 4.3 Maintain the quality of water in the given location using relevant preventive measures TLO 4.4 State the significance of controlling the air pollution to maintain its ambient quality norms TLO 4.5 Compare the noise level from different zones of city with justification TLO 4.6 Describe the roles and responsibilities of central and state pollution control board	**Unit - IV Environmental Pollution** 4.1 Definition of pollution, types- Natural & Artificial (Man- made) 4.2 Soil / Land Pollution – Need of preservation of soil resource, Causes and effects on environment and lives, preventive measures, Soil conservation 4.3 Water Pollution - sources of water pollution, effects on environment and lives, preventive measures, BIS water quality standards for domestic potable water, water conservation 4.4 Air pollution - Causes, effects, prevention, CPCB norms of ambient air quality in residential area 4.5 Noise pollution - Sources, effects, prevention, noise levels at various zones of the city 4.6 Pollution Control Boards at Central and State Government level: Norms, Roles and Responsibilities	Lecture Using Chalk-Board Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Explain Constitutional provisions related to environmental protection TLO 5.2 Explain importance of public participation (PPP) in enacting the relevant laws TLO 5.3 Use the relevant green technologies to provide sustainable solutions of an environmental problem TLO 5.4 Explain the role of information technology in environment protection	**Unit - V Enviornmental legislation and sustainable practices** 5.1 Article (48-A) and (51-A (g)) of Indian Constitution regarding environment, Environmental protection and prevention acts 5.2 Public awareness about environment. Need of public awareness and individuals' participation. Role of NGOs 5.3 Green technologies like solar desalination, green architecture, vertical farming and hydroponics, electric vehicles, plant-based packaging 5.4 Role of information technology in environment protection and human health	Lecture Using Chalk-Board Presentations Video Demonstrations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES : NOT APPLICABLE.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

•

Suggest the steps to implement (or improve the implementation) of the 5R policy in your home/institute stating your contribution
Draft an article on India's Strategies to progress across the Sustainable Development Goals
Make a chart of Renewable and non-renewable energy sources mentioning the advantages and disadvantages of each source
Conduct the SWOT analysis of biodiversity hotspot in India
Prepare a mind-mapping for the zero carbon footprint process of your field
Prepare a chart showing sources of pollution (air/water/ soil), its effect on human beings, and remedial actions
Any other assignment on relevant topic related to the course suggested by the facilitator

UNICEF Certification(s)

- Students may complete the self-paced course launched by Youth Leadership for climate Exchange under UNICEF program on portal www.mahayouthnet.in . The course encompasses five Modules in the form of Units as given below: -

Unit 1: Living with climate change
Unit 2 : Water Management and Climate Action
Unit 3: Energy Management and Climate Action
Unit 4 : Waste Management and Climate Action
Unit 5 : Bio-cultural Diversity and Climate Action
If students complete all the five Units they are not required to undertake any other assignment /Microproject/activities specified in the course. These units will suffice to their evaluations under SLA component

Micro project

•

Technical analysis of nearby commercial RO plant.
Comparative study of different filters used in Household water filtration unit
Evaluate any nearby biogas plant / vermicomposting plant or any such composting unit on the basis of sustainabilityand cost-benefit
IKS-Study and prepare a note on Vedic and Pre-Vedic techniques of environmental conversion

Visit a local polluted water source and make a report mentioning causes of pollution
Any other activity / relevant topic related to the course suggested by the facilitator

Activities

•

Prepare a report on the working and functions of the PUC Center machines and its relavance in pollution control.
Prepare and analyse a case study on any polluted city of India
Prepare a note based on the field visit to the solid waste management department of the municipal corporation / local authority
Record the biodiversity of your institute/garden in your city mentioning types of vegetation and their numbers
Visit any functional hall/cultural hall /community hall to study the disposal techniques of kitchen waste and prepare a report suggesting sustainable waste management tool
Watch a video related to air pollution in India and present the summary
Any other assignment on relevant topic related to the course suggested by the facilitator

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Nil	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Environment and climate change	CO1	8	4	4	4	12
2	II	Sustainability and Renewable Resources	CO2	10	4	4	8	16
3	III	Ecosystem and Biodiversity	CO3	8	4	4	4	12
4	IV	Environmental Pollution	CO4	12	4	8	6	18
5	V	Enviornmental legislation and sustainable practices	CO5	7	4	4	4	12
Grand Total				**45**	**20**	**24**	**26**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two-unit tests (MCQs) of 30 marks will be conducted and average of two-unit tests considered. Formative assessment of self learning of 25 marks should be assessed based on self learning activity such as UNICEF Certification(s)/Microproject/assignment/activities. (60 % weightage to process and 40 % to product)

Summative Assessment (Assessment of Learning)

- Online MCQ type Exam

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	-	1	-	-	3	2	3			
CO2	-	2	2	-	3	2	3			
CO3	-	-	-	-	3	1	2			
CO4	1	-	-	-	3	2	2			
CO5	1	-	2	-	3	2	3			
Legends :- High:03, Medium:02,Low:01, No Mapping: - *PSOs are to be formulated at institute level										

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Y. K. Singh	Environmental Science	New Age International Publishers, 2006, ISBN: 81-224-2330-2
2	Erach Bharucha	Environmental Studies	University Grants Commission, New Delhi
3	Rajagopalan R.	Environmental Studies: From Crisis to Cure.	Oxford University Press, USA, ISBN: 9780199459759, 0199459754
4	Shashi Chawla	A text book of Environmental Science	Tata Mc Graw-Hill New Delhi
5	Arvind Kumar	A Text Book of Enviornmental science	APH Publishing New Delhi (ISBN 978-8176485906)

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://sdgs.un.org/goals	United Nation’s website mentioning Sustainability goals
2	http://www.greenbeltmovement.org/news-and-events/blog	Green Belt Movement Blogs on various climatic changes and other issues
3	http://www.greenbeltmovement.org/what-we-do/tree-planting-fo r-watersheds	Green Belt Movement's work on tree plantation, soil conservation and watershed management techniques
4	https://www.youtube.com/@ierekcompany/videos	International Experts For Research Enrichment and Knowledge Exchange – IEREK's platform to exchange the knowledge in fields such as architecture, urban planning, sustainability
5	www.mahayouthnet.in	UNICEF Intiative for youth leadership for climate action

ENVIRONMENTAL EDUCATION AND SUSTAINABILITY **Course Code : 314301**

Sr.No	Link / Portal	Description
6	https://eepmoefcc.nic.in/index1.aspx?lsid=297&lev=2&lid=1180&langid=1	GOI Website for public awareness on enviornmetal issues
7	https://egyankosh.ac.in/handle/123456789/61136	IGNOU's Intiative for online study material on Enviornmental studies
8	https://egyankosh.ac.in/handle/123456789/50898	IGNOU's Intiative for online study material on sustainability
9	https://sustainabledevelopment.un.org/content/documents/11803Official-List-of-Proposed-SDG-Indicators.pdf	Final list of proposed Sustainable Development Goal indicators
10	https://sustainabledevelopment.un.org/memberstates/india	India’s Strategies to progress across the SDGs.
11	https://www.un.org/en/development/desa/financial-crisis/sustainable-development.html	Challenges to Sustainable Development
12	https://nptel.ac.in/courses/109105190	NPTEL course on sustainable development
13	https://onlinecourses.swayam2.ac.in/cec19_bt03/preview	Swayam Course on Enviornmetal studies (Natural Resources, Biodiversity and other topics)
14	https://onlinecourses.nptel.ac.in/noc23_hs155/preview	NPTEL course on enviornmental studies which encomopasses SDGs, Pollution, Cliamate issues, Energy, Policies and legal framework
15	https://www.cbd.int/development/meetings/egmbped/SWOT-analysis-en.pdf	SWOT analysis of Biodiversity
16	https://www.sanskrit.nic.in/SVimarsha/V2/c17.pdf	Central sanskrkit university publication on Vedic and pre vedic enviornmetal conservation

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

D.C. MACHINES AND TRANSFORMERS **Course Code : 314322**

Programme Name/s	**: Electrical Engineering/ Electrical and Electronics Engineering/ Electrical Power System**
Programme Code	**: EE/ EK/ EP**
Semester	**: Fourth**
Course Title	**: D.C. MACHINES AND TRANSFORMERS**
Course Code	**: 314322**

I. RATIONALE

Despite advancements in electrical technology, D.C. machines still find applications in various industries and commercial sectors. Further the Transformers are essential components of power systems. This course is to equip students with fundamental knowledge, practical skills and a strong foundation in electrical power system and related fields.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Maintain D.C. Machines and Transformers used in Industry and related field.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Test the performance of D.C. Generators.
- CO2 - Test the performance of D.C. Motors
- CO3 - Test the performance of Single phase transformers
- CO4 - Use three phase transformer for different applications.
- CO5 - Use relevant special purpose transformers for different applications.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
314322	D.C. MACHINES AND TRANSFORMERS	DMT	DSC	4	-	4	-	8	4	3	30	70	100	40	25	10	25#	10	-	-	150

Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe the constructional details of the D.C. Machine. TLO 1.2 Explain the principle of working of the given D.C. Generator. TLO 1.3 Derive EMF equation and calculate the parameters of the given D.C. Generator. TLO 1.4 Identify the given type of D.C. Generator. TLO 1.5 Interpret the characteristics of the given D.C. Generator.	**Unit - I D.C. Generator** 1.1 D.C. Machine: construction, parts-function and material, types of winding (lap and wave) 1.2 D.C. Generator: Principle of operation, Faraday's law of electromagnetic induction, Fleming's right hand rule. 1.3 E. M. F. equation of D.C. Generator (derivation) 1.4 Types of D.C. Generator and it's applications. 1.5 Characteristics -internal and external.	Chalk-Board Flipped Classroom Video Demonstrations Model Demonstration Presentations
2	TLO 2.1 Explain the working principle of D.C. Motor. TLO 2.2 Apply the back emf equation in the given situation. TLO 2.3 Select relevant D.C. Motor for given application with justification. TLO 2.4 Calculate the torque, speed, output power and efficiency of the given D.C. Motor. TLO 2.5 Explain the various speed control methods of the given D.C. Motor. TLO 2.6 Describe with sketch the working of the starter for the given type of D.C. Motor. TLO 2.7 Describe the procedure of testing a D.C. Motor for the given condition. TLO 2.8 Explain with a diagram the working of the brushless D.C. Motor.	**Unit - II D.C. Motor** 2.1 D.C. Motor: Principle of operation, Lorentz force, Fleming's Left hand rule, Back emf and it's significance, Armature reaction. 2.2 Types of D.C. Motors, Torque: armature torque, shaft torque, Break Horse Power (BHP). 2.3 D. C. Motor characteristics- speed-armature current, torque- armature current, speed-torque. 2.4 Speed control: D.C. shunt and series motor- flux and armature control. 2.5 Starters, necessity of starters, two-point starters, three-point starters and four-point starters. 2.6 Testing: Break load test, Different types of losses, efficiency. 2.7 D.C. Motors applications, advantages and disadvantages 2.8 Brushless D.C. Motor: construction working, applications, advantages and disadvantages	Chalk-Board, Flipped Classroom Video, Demonstrations Model, Demonstration Presentations.

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Describe the constructional details of the single-phase transformer. TLO 3.2 Explain the working principle of single-phase transformer. TLO 3.3 Derive the EMF equation of transformer and calculate parameter for the given situations. TLO 3.4 Identify the type of single-phase transformer based on the given criterion. TLO 3.5 Interpret the name plate rating of the given transformer. TLO 3.6 Explain phasor diagram for no load/on load condition for the given type of transformer. TLO 3.7 Calculate regulation and efficiency by O.C. / S.C. tests and direct loading for the given type of transformer.	**Unit - III Single Phase Transformer** 3.1 Single phase transformer: Introduction, construction, parts-functions and material. 3.2 Principle of operation, EMF equation, voltage transformation ratio, turns ratio. 3.3 Types and losses, significance of transformer ratings. 3.4 No-load and On-load test on transformer and it's phasor diagram, Leakage reactance. 3.5 Equivalent circuit of transformer with equivalent resistances and reactances. 3.6 Voltage regulation and Efficiency: Direct loading. O.C. / S.C. method. All day efficiency, applications.	Chalk-Board, Flipped Classroom Video, Demonstrations Model, Demonstration Presentations.
4	TLO 4.1 Describe the constructional details of the three -phase transformer. TLO 4.2 Identify the given type of transformer. TLO 4.3 Describe with diagrams various connections of the given three phase transformers. TLO 4.4 Select appropriate transformer on the given application. TLO 4.5 Describe the requirements for the parallel operation of the transformer. TLO 4.6 Describe the procedure for the given type of test on three phase transformer. TLO 4.7 Explain the importance of 'K' factor of transformers.	**Unit - IV Three Phase Transformer** 4.1 Three phase transformer: Introduction, construction, bank of three single phase transformers. Single unit of three phase transformer. 4.2 Working principle of three phase transformer. Types of transformers. 4.3 Connections as per IS: 2026 (part IV)-1977. Three phase to two phase conversion (Scott Connection). 4.4 Selection criteria as per IS: 10028 (Part I)-1985 of distribution transformer and power transformer, amorphous core type distribution transformer, specifications of three-phase distribution transformers as per IS:1180 (part I)-1989. 4.5 Need of parallel operation, conditions for parallel operation. 4.6 Polarity tests on mutually inductive coils, Phasing out test on Three- phase transformer. 4.7 Harmonics and their effects on transformer operation. 4.8 'K' factor of transformers: overheating due to non-linear loads and harmonics.	Chalk-Board Flipped Classroom Video, Demonstrations Model, Demonstration Presentations.

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Describe the constructional details of the given type of special purpose transformer. TLO 5.2 Explain the Working principle of the given type of special purpose transformer. TLO 5.3 State the applications of the given type of special purpose transformer.	**Unit - V Special Purpose Transformer** 5.1 Auto transformer: Construction, working and applications for single and three phases. 5.2 Instrument Transformers: Construction, working and applications of current transformer and potential transformer. 5.3 Isolation transformer: Construction, features and applications. 5.4 Single phase welding transformer: Construction, features and applications. 5.5 Pulse transformer: Construction, features and applications.	Chalk-Board, Flipped Classroom Video, Demonstrations Model, Demonstration Presentations.

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify different parts of the D.C. machine.	1	*Dismantling of a D.C. machine.	2	CO1
LLO 2.1 Verify generated output of the D.C. Shunt Generator.	2	*Measurement of D.C. Shunt Generator voltage by changing flux and speed.	2	CO1
LLO 3.1 Test the performance of D.C. Shunt generator.	3	*Load test on D.C. Shunt Generator.	2	CO1
LLO 4.1 Test the performance of D.C. Compound generator.	4	Load test on D.C. Compund Generator.	2	CO1
LLO 5.1 Test the performance of D.C. Shunt generator by Hopkinson's Test .	5	Testing the performance of D.C. Shunt generator by Hopkinson's Test .	2	CO1
LLO 6.1 Reverse the direction of rotation of the D.C. shunt motor.	6	*Reversal of rotation of D.C. shunt motor.	2	CO2
LLO 7.1 Perform brake test on D.C. shunt motor.	7	*Speed torque characteristics of D.C. shunt motor.	2	CO2
LLO 8.1 Control the speed of D.C. shunt motor by different methods.	8	*Speed control of D.C. shunt motor using Armature control & flux control method.	2	CO2
LLO 9.1 Reverse the direction of rotation of the D.C. series motor.	9	*Reversal of rotation of D.C. series motor.	2	CO2
LLO 10.1 Control the speed of the D.C. series motor by different methods.	10	Speed control of D.C. series motor using Armature control & flux control method.	2	CO2
LLO 11.1 Perform brake test on a D.C. series motor.	11	Brake test on D.C. series motor.	2	CO2
LLO 12.1 Reverse the direction of rotation of the D.C. compound motor.	12	*Reversal of rotation of D.C. compound motor.	2	CO2
LLO 13.1 Identify different parts of a three point starter of a D.C. Shunt Motor. LLO 13.2 Check the function of the various parts of three point starter.	13	*Demonstration of operating mechanism of three point starter of a D.C. Shunt Machine.	2	CO2
LLO 14.1 Identify different parts of a four point starter of a D.C. Compound Motor. LLO 14.2 Check the function of the various parts of four point starter.	14	*Demonstration of operating mechanism of four point starter of a D.C. Compound Machine.	2	CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 15.1 Identify different parts of a two point starter of a DC series Motor. LLO 15.2 Check the function of the various parts of two point starter.	15	*Demonstration of operating mechanism of two point starter of a DC series Machine.	2	CO2
LLO 16.1 Identify the different parts of single phase & Three phase transformer.	16	*Demonstration of a single phase & Three phase transformer construction.	2	CO3 CO4
LLO 17.1 Find the transformation ratio of single phase transformer.	17	* Transformation ratio of single phase transformer.	2	CO3
LLO 18.1 Test the performance of single phase transformer.	18	*Direct load test of single phase transformer.	2	CO3
LLO 19.1 Test the performance of single phase transformer.	19	*Open circuit and short circuit test on single phase transformer to determine equivalent circuit parameters.	2	CO3
LLO 20.1 Test the performance of single phase transformer.	20	*Open circuit and short circuit test on single phase transformer to determine voltage regulation and efficiency.	2	CO3
LLO 21.1 Perform parallel operation of two single phase transformers.	21	*Perform parallel operation of two single phase transformers to determine the load current sharing.	2	CO3
LLO 22.1 Perform parallel operation of two single phase transformers.	22	*Perform parallel operation of two single phase transformers to determine the apparent and real power load sharing.	2	CO3
LLO 23.1 Perform polarity test on a single phase transformer.	23	*Perform polarity test on a single phase transformer whose polarity markings are masked.	2	CO3
LLO 24.1 Convert three phase to two phase conversion by Scott-Connection.	24	Scott-Connection of three phase transformer.	2	CO4
LLO 25.1 Perform Back to Back test on single phase transformer.	25	*Back to Back test on single phase transformer.	2	CO4
LLO 26.1 Connect the auto-transformer in step-up and step-down modes, measure input and output voltage.	26	*Connection of the auto-transformer.	2	CO5
LLO 27.1 Verify the Current transformer (CT) ratio.	27	Functioning of the Current transformer (CT).	2	CO5
LLO 28.1 Verify the Potential Transformer (PT) ratio.	28	Functioning of the Potential Transformer (PT).	2	CO5
LLO 29.1 Verify turns ratio of the isolation transformer.	29	*Functioning of the isolation transformer.	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

NO SLA

- Not applicable for this course

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	DC series and shunt machines (up to 230 V, 4 kW).	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15
2	Three point starter.	13
3	Four point starter.	14
4	Two point starter.	15
5	Single phase transformer of suitable size (500 VA to 1 kVA).	16,17,18,19,20,21,22,23
6	Three phase transformer of suitable size (1 kVA to 3 kVA).	16,24,25
7	AC Ammeter range (0-2.5-5-10A). Portable analog MI type as per relevant BIS standard.	17,18,19,20,21,22,23,24,25,26,27,28,29
8	AC Voltmeter Range (0-75/150/300V), Portable analog MI type as per relevant BIS standard.	17,18,19,20,21,22,23,24,25,26,27,28,29
9	Wattmeter 0-300/600 V, 5/10 A, for use in A.C. circuits.	18,19,20,22
10	L.P.F. Wattmeter, 0-300/600 V, 1A to 2A, for use in A.C. circuits.	19,20
11	Lamp load of 10-20 A.	2,3,4,5,13,14,15,17,18,21,22,29
12	DC Supply, 230 V, 25 A.	2,3,4,5,6,7,8,9,10,11,12,13,14,15,23
13	Rheostat (0-500 Ohm. 1.2A), Nichrome wire wound rheostat on epoxy resin or class F insulating tube with two fixed and one sliding contact.	2,3,4,5,7,8,10,11
14	Tachometer(0-10,000 RPM).	2,3,4,5,7,8,10,11
15	DC Ammeter range (0-5-10A), Portable analog PMMC type as per relevant BIS standard.	2,3,4,5,7,8,10,11,12
16	DC Voltmeter Range (0-150/300V), Portable analog PMMC type as per relevant BIS standard.	2,3,4,5,7,8,10,11,12
17	Rheostat (0-400 Ohm, 1.5A). Nichrome wire wound rheostat on epoxy resin or class F insulating tube with two fixed and one sliding contact.	2,5,7,8,10,11
18	Single phase auto transformer 0-270 V, 15 A.	26
19	CT of suitable ratio.	27
20	PT of suitable ratio.	28
21	Isolation transformer of suitable ratio.	29
22	Rheostat (0-100 Ohm, 5A), Nichrome wire wound rheostat on epoxy resin or class F insulating tube with two fixed and one sliding contact.	7,8,10
23	Rheostat (0-50 Ohm, 10A), Nichrome wire wound rheostat on epoxy resin or class F insulating tube with two fixed and one sliding contact.	7,8,10,11

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

D.C. MACHINES AND TRANSFORMERS **Course Code : 314322**

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	D.C. Generator	CO1	8	2	0	6	8
2	II	D.C. Motor	CO2	16	6	4	10	20
3	III	Single Phase Transformer	CO3	17	2	8	10	20
4	IV	Three Phase Transformer	CO4	13	2	8	6	16
5	V	Special Purpose Transformer	CO5	6	2	0	4	6
Grand Total				**60**	**14**	**20**	**36**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two unit tests of 30 marks will be conducted and an average of two unit tests considered.
- For formative assessment of laboratory learning 25 marks.
- Each practical will be assessed considering appropriate % weightage to process and product and other instructions of assessment.

Summative Assessment (Assessment of Learning)

- End semester summative assessment of 25 marks for laboratory learning.
- End semester assessment of 70 marks through offline mode of examination.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	1	2	1	1	1			
CO2	3	2	2	2	3	1	2			
CO3	3	1	1	2	2	1	1			
CO4	3	2	2	2	3	1	1			
CO5	3	1	1	2	2	1	1			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Bhattacharya,S. K	Electrical Machines	McGraw Hill Education, New Delhi ISBN-13:978-0070669215
2	Mehta, V. K. and Mehta, Rohit	Principles of Electrical Machines	S.Chand and Co.Ltd., New Delhi ISBN-13: 978-8121921916
3	Theraja B. L.	Electrical Technology Vol-II (AC and DC machines)	S.Chand and Co.Ltd., New Delhi ISBN-13: 978-8121924375
4	Bandyopadhyay M. N.	Electrical Machines Theory and Practice	PHI Learning Pvt. Ltd., New Delhi ISBN-13:978-8120329973

Sr.No	Author	Title	Publisher with ISBN Number
5	Mittle, V.N. and Mittle, Arvind	Basic Electrical Engineering	McGraw Hill Education, New Delhi ISBN-13: 978-0070593572
6	Kothari, D. P. and Nagrath, I. J.	Electrical Machines	McGraw Hill Education, New Delhi ISBN-13:978-9352606405
7	Murugesh Kumar K.	DC Machines and Transformers	S. Chand, ISBN-13: 978-8125916055
8	J. B. Gupta	Theory & Performance of Electrical Machine	S-K-Kataria, ISBN-13: 978-9350142776

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://youtu.be/D4RFFnzRdkk?si=d5iNRWSZbl01NvT3	Construction & Working Principle of a D.C. Machine.
2	https://youtu.be/1OfLgpFq6Rc?si=bwN9d7ESlV2Utzb6	D.C. Motors.
3	https://youtu.be/6dF3LDzb-tE?si=OYZMdgs2I5d7bqAa	D.C. Generator.
4	https://youtu.be/qmcriUdYBW0?si=ea5Sa1G9R9m7aRTm	Transformer.
5	www.nptel.ac.in	About construction, working principle and operation of D.C. Machine, single phase transformer, three phase transformer and special purpose transformer.
6	www.electricaltechnology.org	About construction, working principle and operation of D.C. Machine, single phase transformer, three phase transformer and special purpose transformer.
7	www.electrical4u.com	About construction, working principle and operation of D.C. Machine, single phase transformer, three phase transformer and special purpose transformer.

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

Programme Name/s : **Electrical Engineering/ Electrical Power System**
Programme Code : **EE/ EP**
Semester : **Fourth**
Course Title : **UTILIZATION OF ELECTRICAL ENERGY**
Course Code : **314323**

I. RATIONALE

Electrical energy is the most widely used form of energy by every sector. The generated power before being utilized by the consumer has to pass through various stages. One of the important aspect of electrical power system is efficient utilization of electrical energy. The electrical engineering diploma pass outs are therefore required to posses knowledge and skills of operation and use of electrical drives, electrical furnaces, and traction systems. Essential theoretical and practical knowledge will be achieved by learning this course. Contents of course are designed essentially keeping in mind the job profile of electrical engineer handling electrical utilities.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Operate various electrical utilities used for industrial and commercial applications.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Design simple lighting scheme..
- CO2 - Select type of electric furnaces according to applications
- CO3 - Operate the different electric welding system
- CO4 - Select suitable electric drive for a particular application
- CO5 - Maintain different electric traction system.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
314323	UTILIZATION OF ELECTRICAL ENERGY	UEE	DSC	4	-	2	2	8	4	3	30	70	100	40	25	10	25@	10	25	10	175

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Define the given term(s) as related to illumination. TLO 1.2 Explain the construction and working of the given type of lamp(s) and lamp fittings. TLO 1.3 State the laws of illumination TLO 1.4 Select the relevant lamp for the specified application with justification. TLO 1.5 Design simple lighting scheme for the given data. TLO 1.6 Explain factors affecting on quality of lighting system	**Unit - I ILLUMINATION** 1.1 Definitions of various illumination terminology- Luminous flux, Lumens, Candela, solid angle, luminous intensity, lux, candlepower, MHCP, MSCP, MHSCP, illumination, lamp efficacy, glare, shadow. Brightness 1.2 Various types of Lamps :Fluorescent Tube, CFL, Metal Halide and LED. 1.3 Laws of illumination: Inverse squares and Lambert's Cosine law. 1.4 Various lighting schemes: Direct, Indirect , Semidirect and Semi indirect :features and application. 1.5 Design of Lighting Scheme: Factors considered designing such as- Space height ratio, Utilization factor, depreciation factor, reflection factor, Waste light factors, coefficient of utilization (Numerical on design of indoor lighting scheme) 1.6 Domestic and industrial lamp fittings. 1.7 Factors affecting on quality of lighting system	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Explain construction, working principle and classification of the specified electrical heating system. TLO 2.2 Recommend the relevant heating system for the given application with proper justification. TLO 2.3 Design the heating element of the given type of furnace from the specified data. TLO 2.4 Solve simple numerical on estimation of size of induction furnace TLO 2.5 Estimate voltage and power requirement in dielectric heating	**Unit - II ELECTRIC HEATING** 2.1 Concept of electrical heating, Advantages and classification of electric heating, modes of heat transfer. 2.2 Resistance Heating: Construction and Operation of Direct Resistance Heating - Salt Bath Furnace, Indirect Resistance Heating: Resistance Ovens, Requirements of Heating Element Material, Causes Heating Elements, Methods of Temperature Control, Applications of Resistance Heating, Design of Heating Element. (Simple Numerical problems on heating elements)of Failure of 2.3 Arc Heating - Construction and Operation of Direct Arc Furnace, Indirect Arc Furnace. Applications of Arc Heating. 2.4 Induction Heating - Construction and Operation of Core Type Induction Furnaces: Ajax Wyatt Furnace, Coreless Induction Furnace, Applications of Induction Heating, High frequency eddy current heating. Radiant and infrared heating, Estimation of Heat data (Simple Numerical to estimate rating of furnace). 2.5 Dielectric Heating: Principle of Dielectric Heating, Advantages of Dielectric Heating 2.6 Limitations of Dielectric Heating, Applications of Dielectric Heating (Simple Numericals)	Lecture Using Chalk-Board Video Demonstrations Site/Industry Visit Case Study
3	TLO 3.1 Select the relevant welding system for the specified application with justification. TLO 3.2 Describe the working principle and construction of special type of transformer used in welding. TLO 3.3 Describe the working principle of Electric Welding and its types TLO 3.4 State the applications of modern welding techniques	**Unit - III ELECTRIC WELDING** 3.1 Electric Welding: Principles of electric resistance welding. 3.2 Methods of Electric Welding – Electric arc welding, resistance welding. 3.3 Resistance Welding – Principles, Advantages, types of resistance welding. 3.4 Electric Arc Welding- Formation and Characteristics of electric arc, effects of arc length. 3.5 Principle of electric arc welding: Types, advantages, disadvantages and applications of all types. 3.6 Comparison with resistance welding and Electric Arc Welding 3.7 2.7 Modern welding techniques like Ultrasonic, Laser, under water welding, IGBT controlled welding.	Lecture Using Chalk-Board Video Demonstrations Presentations Site/Industry Visit

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Differentiate the salient features between the given types of electric drives. TLO 4.2 Recommend the relevant motor for the given application with justification. TLO 4.3 Select the relevant enclosure for the given atmospheric condition with justification. TLO 4.4 Select the power transmission drive of the electric motor for the given application with justification. TLO 4.5 Estimate the relevant size and rating of electric motor for the specified load cycles. TLO 4.6 Select relevant elevator machine and electric motor for the specified application with justification. TLO 4.7 Describe the procedure to maintain the given electric drive and elevator.	**Unit - IV ELECTRIC DRIVES AND ELEVATORS** 4.1 Electric drives : Concept, factors governing selection of electric drives(motor). 4.2 Types of electrical drives : Individual and Group drive, Applications. 4.3 Mechanical features of drives: Types and applications various types of enclosures. 4.4 Transmission of Mechanical Power: Direct and Indirect drive (Belt, Rope, Chain, Gear), Vertical drives and its applications. 4.5 Bearing: Types and applications. 4.6 Size and Rating of motor : (Simple numerical on this topic) 4.7 Load Cycles : Concept with graphical representation. 4.8 Load Equalization : Concept , and methods and condition of load equalization. 4.9 Elevators: Function, Application, types, safety and precautions, case study of latest Elevator. 4.10 Factors on which shape and size of car depends.	Lecture Using Chalk-Board Video Demonstrations Site/Industry Visit Case Study

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Recommend relevant traction system for the given application with justification. TLO 5.2 Select the relevant track electrification system for the specified traction services with justification. TLO 5.3 Differentiate the salient features between the given types of track electrification system. TLO 5.4 Draw the speed -time curve for the specified electric traction application. TLO 5.5 Differentiate between the given types of traction services based on the given criteria . TLO 5.6 Determine average and schedule speed for the given traction service.	**Unit - V ELECTRIC TRACTION** 5.1 Introduction of electric traction system, Requirements of ideal traction system 5.2 System of Track Electrification: DC; Single phase 25kV AC, Composite system. 5.3 Traction Mechanics : Block diagram of AC electric locomotive and function of each part, Nomenclature of Locomotivesiv 5.4 Crest, Average and Schedule Speed; definition and factors affecting them. 5.5 Traction services : Urban, suburban, main line service (Main features and comparison between the three of them),Speed Time curve, Concept and applications of Trapezoidal and quadrilateral speed time curve(simple numerical based on Trapezoidal speed time curve) 5.6 Concept and function of Catenary wire ,Contact wire and Dropper, Material used for them, Simple Catenary construction, Definition and Need of Neutral Section, Current Collecting system: Diamond type pantograph and Faiveley type pantograph(Construction and Working) 5.7 Introduction of Metro and Mono Rail (main features between the two of them).	Lecture Using Chalk-Board Video Demonstrations Site/Industry Visit Presentations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify the different lighting accessories required for various types of lamps.	1	*Identification of different lighting accessories required for various types of lamps.	2	CO1
LLO 2.1 To compare the Lumen output of various lamps.	2	*Comparision of Lumen output of Fluorescent tube , Metal Halide, CFL and LED.	2	CO1
LLO 3.1 To measure illumination at different locations in college using luxmeter and compare with standard illumination level as per SP 72 : 2023 (National lighting code)	3	*Measurement of illumination at different locations in college using luxmeter and compare with standard illuminationlevel as per SP 72: 2023.(National Lighting code).	2	CO1
LLO 4.1 Design a heating element as per the given parameters.	4	*Design a heating element as per the given parameters .	2	CO2
LLO 5.1 Identify the different electrical and safety equipment used for Arc welding	5	*Demonstation of different electrical and safety equipments used for arc welding.	2	CO2
LLO 6.1 Identify the different components required for various heating furnaces .	6	*Identification of different components required for various heating furnaces.	2	CO2
LLO 7.1 Write specification of Welding generator set and welding transformer.	7	*Selection of suitable current range of Welding generator set and Welding transformer for various thickness of metal job.	2	CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 8.1 Identify the different defects in arc welding job.	8	*Identification of different defects in arc welding job.	2	CO3
LLO 9.1 Identify the different electrodes in arc welding.	9	*Identification of different electrodes used in arc welding.	2	CO3
LLO 10.1 To estimate the size of motor as per the specified load cycle.	10	*Estimatiom of size of motor as per the specified load cycle.	2	CO4
LLO 11.1 To identify the different components of elevator.	11	Identification of the different components of an Elevator.	2	CO4
LLO 12.1 To identify the different components of Escalator.	12	Identification of different components of Escalator.	2	CO4
LLO 13.1 To observe the different types of signals used in traction system. LLO 13.2 To observe the raising and lowering of Faiveley type pantograph. LLO 13.3 To observe the different parts of E.M.U	13	Visit to a traction loco shed and observe various types of system used in traction.	6	CO5
LLO 14.1 Write the specification of oven. LLO 14.2 Measure elimination of moisture from substance.	14	*Demonstrate indirect resistance Oven used in Laboratory.	2	CO2

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- Prepare power point presentation related to heating furnaces.
- Prepare power point presentation related to welding equipment and accessories.
- Prepare power point presentation on Mono and Metro rail systems in India.
- Collect Bombay Lift Act and understand rules to inspect electrical components.
- Select any one electric drive. Explain its suitability for any one industrial application through power point presentation.(Electrical and Mechanical Characteristics)

Micro project

- Prepare report on market survey of various types of lamps(specification, manufacturer, application and cost) and do the comparative analysis.
- Prepare a market survey of various drives(specification, manufacturer, application and cost).
- Design suitable lighting scheme for a laboratory or class room.
- Prepare market survey on Lift and Escalator (specification, manufacturer, application and cost)

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Fluroscent Tube light, CFL and LED (Bulb and Tube Light) of different suitable ratings	1,2
2	Suitable data to be given to calculate the size of motor for specified load cycle.	10
3	Visit to a Elevator company/You Tube videos/Concerned learning software and Website	11
4	Visit to a Escalator company/ YouTube videos/ concerned learning website or related software.	12
5	Loco shed/ Track Electrification system visit for observing components /equipment related to traction .	13
6	Digital Lux Meter (Upto LUX-100K)	3
7	Heating furnace/Oven of suitable ratings	4,6
8	Electrical welding machine of suitable rating	5,7
9	Welding workshop of Institute / Any small scale industry (Welding) visit to observe the various defects in arc welding and the different electrodes used for arc welding.	8,9

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	ILLUMINATION	CO1	12	4	4	6	14
2	II	ELECTRIC HEATING	CO2	14	4	6	6	16
3	III	ELECTRIC WELDING	CO3	8	2	4	4	10
4	IV	ELECTRIC DRIVES AND ELEVATORS	CO4	14	4	6	6	16
5	V	ELECTRIC TRACTION	CO5	12	2	6	6	14
Grand Total				**60**	**16**	**26**	**28**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two unit tests of 30 marks will be conducted and average of two unit tests are conducted. For formative assessment of Laboratory learning 25 marks. Each practicle will be assessed considering appropriate % weightage to process and product and other instructions of assessment.

Summative Assessment (Assessment of Learning)

- End semester summative assessment of 25 marks for laboratory learning. End semester assessment of 70 marks through offline mode of examination.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	3	2	3	2	3			
CO2	3	2	3	2	2	3	3			
CO3	3	1	2	3	3	2	3			
CO4	3	3	1	1	3	3	3			
CO5	3	1	3	3	3	1	3			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	H.Pratab	Art and Science of Utilization of Electrical Energy	Dhanpat Rai & Sons,New Delhi, ISBN: 9788177001440
2	J.B. Gupta	Utilization of Electric Power and Electric Traction.	S.K. Kataria & Sons, New Delhi, ISBN: 978- 9350142585
3	G. C. Garg	Utilization of Electric Power and Electric Traction.	Khanna Publishers, New Delhi, ISBN: 8174091645
4	J. Upadhaya and S.N. Mahendra	Electric Traction	Allied Publisher Ltd., New Delhi, ISBN: 8177640054
5	G.K. Dubey	Fundamentals of Electric Drive	Narosa Publishing House, New Delhi, ISBN: 8173190410 , 9788173190414
6	V. K. Mehta	Principles of Power System	S. Chand, New Delhi, ISBN: 9788121924962
7	H.Pratab	Modern Electric Traction	Dhanpat Rai & Sons,New Delhi, ISBN: 1234567147206
8	S. Sivanagaraju & M. Balasubba Reddy & B. Srilatha	Generation and Utilization of Electrical Energy	Personal Education, New Delhi, ISBN: 9789332515673

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=CoHVA7nr82A	Complete description of Arc Welding
2	https://www.youtube.com/watch?v=7GLiBwgVBLQ	Videos on Electric Traction
3	https://www.youtube.com/watch?v=fakGLu03jYg	Videos on Electric Traction
4	https://www.youtube.com/watch?v=BDMFsYnTdVI	Videos on Electric Locomotive with full description
5	https://www.youtube.com/watch?v=49rH3buD0bc	Video showing the working of Diesel Locomotive
6	https://www.youtube.com/watch?v=82EFMvYcbN4	Videos on Electric Multiple Unit
7	https://www.youtube.com/watch?v=AAyLKnz4UJY	Videos to describe Electric Heating system

UTILIZATION OF ELECTRICAL ENERGY **Course Code : 314323**

Sr.No	Link / Portal	Description

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

DIGITAL ELECTRONICS AND MICROCONTROLLER APPLICATIONS **Course Code : 314324**

Programme Name/s : **Electrical Engineering/ Electrical Power System**

Programme Code : **EE/ EP**

Semester : **Fourth**

Course Title : **DIGITAL ELECTRONICS AND MICROCONTROLLER APPLICATIONS**

Course Code : **314324**

I. RATIONALE

In the era of digitization, all the equipment like computers, mobiles, music systems, ATM, automation and control circuits and systems are built on digital circuits. Diploma Electrical pass out plays a key role in control panel operations based on microcontroller systems. This course emphasizes on knowledge of digital electronics required to use microcontroller-based systems.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

• Use microcontroller based systems for various industrial applications.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Apply knowledge of number system and logic circuits in working of digital system.
- CO2 - Build simple combinational and sequential circuits.
- CO3 - Access various registers in 8051 microcontroller.
- CO4 - Develop and execute programs in assembly language for microcontroller.
- CO5 - Use microcontroller in various applications.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
314324	DIGITAL ELECTRONICS AND MICROCONTROLLER APPLICATIONS	DEM	SEC	3	-	4	1	8	4	3	30	70	100	40	25	10	25@	10	25	10	175

Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Recognize and convert the given number into the specified number system. TLO 1.2 Perform the binary and BCD arithmetic operation on the given numbers. TLO 1.3 Develop the basic gates using the given NAND/NOR gate as universal gate. TLO 1.4 Construct adder and subtractor circuit using logic gates.	**Unit - I Number System and Logic Gates** 1.1 Number System : Decimal, Binary, octal, hexadecimal, BCD. Conversion of one system into other. 1.2 Binary Arithmetic: - Addition, Subtraction (1's and 2's complement) Multiplication, Division. BCD addition. 1.3 Logic Gates: Symbol, switch circuit, logical expression, truth table of basic logic gates (AND, OR, NOT), Universal gates (NAND and NOR) and Special purpose gates (EX-OR, EX-NOR). 1.4 Arithmetic Circuits: Half and full Adder, Half and full subtractor with its truth table, boolean expression and circuits using logic gates.	Chalk-Board Presentations Demonstration Flipped Classroom
2	TLO 2.1 Draw MUX/DEMUX tree for the given number of input and output lines. TLO 2.2 Describe the building process of the specified type of flip-flop. TLO 2.3 Use excitation table of the given flip-flop to design asynchronous counter.	**Unit - II Digital Logic Circuits** 2.1 Multiplexer and Demultiplexer: working , truth table and applications of Multiplexers and Demultiplexers. 2.2 SR Flip Flops: SR-flip flop, clocked SR flip flop with preset and clear, drawbacks of SR flip flop. JK Flip Flops: Clocked JK Flip flop with preset and clear, D and T type flip flop, Excitation table of flip flops. 2.3 Counters: Types (Asynchronous, Synchronous) and their applications.,4 bit asynchronous counter – Circuit diagram and truth table.	Chalk-Board Presentations Video Demonstrations Flipped Classroom
3	TLO 3.1 Compare the salient features of microcontroller and microcomputer for the given parameters. TLO 3.2 Compare the given types of architecture on the given parameters. TLO 3.3 Describe the given types of registers of 8051. TLO 3.4 Justify the use of the given type of memory in 8051.	**Unit - III 8051 Microcontroller Architecture** 3.1 Microcomputers and microcontrollers (basic introduction and comparison). 3.2 Types of buses, address bus, data bus and control bus. Harvard and Von-Neumann architecture. 3.3 8051 Microcontroller Architecture: - Pin configuration, Register banks, bit and byte addressable area, Registers: PC, DPTR, A&B, PSW and other Special function registers(SFR), I/O ports, Timers (pins and associated SFRs). 3.4 Stack and stack pointer , memory organization (RAM , ROM).	Chalk-Board Presentations Video Demonstrations Flipped Classroom
4	TLO 4.1 Identify addressing mode of the given instruction with examples. TLO 4.2 Describe function of the given instruction with suitable examples. TLO 4.3 Justify the use of the given assembler directives with examples.	**Unit - IV 8051 Instruction Set and Programming** 4.1 Addressing Modes: Immediate, register, direct, indirect, indexed, relative, absolute, bit inherent, bit direct. 4.2 Instruction Set (with appropriate example) : Data transfer, Logical, Arithmetic, Branching, Machine control, Stack operation, Boolean. 4.3 Assembler Directives: ORG, DB, EQU, END, CODE, DATA .	Chalk-Board Presentations Video Demonstrations Flipped Classroom Hands-on
5	TLO 5.1 Describe with sketches the procedure to interface the given external memory. TLO 5.2 Describe with sketch the interfacing of the given external I/O devices.	**Unit - V 8051 Interfacing and Application** 5.1 Memory interfacing - Program and Data memory 5.2 I/O Interfacing (Diagram and Flowchart) for following applications - LED, Relays, Switch, LCD, Stepper motor.	Lecture Using Chalk-Board Presentations Demonstration Flipped Classroom Hands-on

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs

DIGITAL ELECTRONICS AND MICROCONTROLLER APPLICATIONS **Course Code : 314324**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Build AND, OR, NOT gates to verify its truth table.	1	* Verification of truth table of AND, OR, NOT gates using ICs .	2	CO1
LLO 2.1 Build AND, OR, NOT gates using NAND gate and verify its truth table of NAND gate as universal gate	2	Building of AND, OR, NOT gates using NAND gate.	2	CO1
LLO 3.1 Build AND, OR, NOT gates using NOR gate and verify NOR gate as universal gate.	3	* Building of AND, OR, NOT gates using NOR gate.	2	CO1
LLO 4.1 Build Half adder and Half subtractor.	4	* Building of Half adder and Half subtractor using Boolean expressions.	2	CO1
LLO 5.1 Build Full adder and full subtractor.	5	* Building of Full adder and full subtractor using Boolean expressions.	2	CO1
LLO 6.1 Build a Multiplexer using IC.	6	* Verification of operation of Multiplexer IC 74151	2	CO2
LLO 7.1 Build a Demultiplexer using IC.	7	Verification of operation of Demultiplexer IC 74155	2	CO2
LLO 8.1 Test the function of RS flip flop.	8	Testing the function of RS flip flop using NAND Gate.	2	CO2
LLO 9.1 Test the function of JK flip flop.	9	Testing the function of JK flip flop using 7476.	2	CO2
LLO 10.1 Construct and test the functionality of D flip flop.	10	* Construction and testing the functionality of D flip flop using IC 7476.	2	CO2
LLO 11.1 Construct and test the functionality of T flip flop.	11	* Construction and testing the functionality of T flip flop using IC 7476.	2	CO2
LLO 12.1 Implement 4 bit ripple counter using 7476.	12	Implementation of 4 bit ripple counter using 7476.	2	CO2
LLO 13.1 Develop and execute an assembly language program (ALP) to perform addition of 8-bit data .	13	* Assembly language program (ALP) to perform addition of 8-bit data using various addressing modes.	2	CO3 CO4
LLO 14.1 Develop and execute an assembly language program (ALP) to perform subtraction of 8-bit data.	14	* Assembly language program (ALP) to perform subtraction of 8-bit data using addressing modes.	2	CO3 CO4
LLO 15.1 Develop and execute an assembly language program (ALP) to perform multiplication of 8-bit data.	15	*Assembly language program (ALP) to perform multiplication of 8-bit data , take the input data from port1 and display the output data on port 2	2	CO3 CO4
LLO 16.1 Develop and execute an assembly language program (ALP) to perform division of 8-bit data	16	* Assembly language program (ALP) to perform division of 8-bit data , take the input data from port 2 & display the output data on port 0	2	CO3 CO4
LLO 17.1 Develop and execute an assembly language program to transfer data using internal data memory.	17	* Assembly language program to transfer data from source to destination location of internal data memory.	2	CO3 CO4
LLO 18.1 Develop and execute an assembly language program to transfer data using external data memory.	18	Assembly language program to transfer data from source to destination location of external data memory.	2	CO3 CO4
LLO 19.1 Develop and execute an assembly language program to exchange data of memory locations.	19	* Assembly language program to exchange data from source to destination memory location.	2	CO3 CO4
LLO 20.1 Develop and execute an assembly language programto find smallest number from the given data.	20	Assembly language program to find smallest number from the given data bytes stored in internal / external data memory locations.	2	CO3 CO4
LLO 21.1 Develop and execute an assembly language program to find largest number from the given data.	21	* Assembly language program to find largest number from the given data bytes stored in internal / external data memory locations.	2	CO3 CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 22.1 Develop and execute an assembly language program for arranging numbers in ascending order.	22	* Assembly language program for arranging numbers in ascending order stored in external memory locations.	2	CO3 CO4
LLO 23.1 Develop and execute an assembly language program for arranging numbers in descending order.	23	Assembly language program for arranging numbers in descending order stored in external memory locations.	2	CO3 CO4
LLO 24.1 Develop and execute an assembly language program for masking particular bit of given register. LLO 24.2 Develop and execute an assembly language program to SET particular bit of given register.	24	* Assembly language program MASK and SET particular bit of given register using 1) bit addressable instructions 2) Logical instructions.	2	CO3 CO4
LLO 25.1 Develop and execute an assembly language program to get a rolling display on given I/O port.	25	* Assembly language program to get a rolling display on port 2.	2	CO3 CO4
LLO 26.1 Interface LED with 8051. LLO 26.2 Interface SWITCH with 8051.	26	* Interfacing of LED and switch with 8051 to turn ON / OFF the LED.	4	CO5
LLO 27.1 Interface RELAY with 8051.	27	* Interfacing of RELAY with 8051 to turn ON / OFF the LED.	2	CO5
LLO 28.1 Interface 7-segment display with 8051.	28	Interfacing of 7-segment display with 8051 to give output as decimal number from 0 to 9.	2	CO5
LLO 29.1 Interface 7-segment display with 8051.	29	Interfacing of LCD with 8051 microcontroller to display the alphabets and decimal numbers.	2	CO5
LLO 30.1 Interface 7-segment display with 8051.	30	Interfacing of stepper motor with 8051 microcontroller and write ALP to rotate stepper motor in clockwise and anti-clockwise direction at given angles.	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Following are the suggested student-related co-curricular activities

- Prepare a chart of various logic gates & their truth table.
- Prepare power point presentation on digital circuit microcontroller applications.
- Give seminar on relevant topic.
- Undertake a market survey of different microcontroller ICs and collect information regarding- Nnumber of pins, number of bit, clock frequency of operation etc.

Micro project

- Build a circuit of ALU using IC 74181.
- Build a circuit for decade counter using IC 7490.
- Build a water level controller to indicate overflow & under level of water in a tank.
- Build a dc motor speed controller using 8051.
- Prepare a chart of various features using data sheets of 8051 microcontroller and its derivatives.
- Build a circuit to turn the buzzer ON after 10 seconds.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Digital Multimeter: 3 and ½ digit with R, V, I measurements, diode and BJT testing.	1,2,3,4,5,6,7,8,9,10,11,12
2	DIGITAL IC tester: Provision for testing a wide range of Digital IC's such as 74 Series, 40/45 Series of CMOS IC’s.	1,2,3,4,5,6,7,8,9,10,11,12
3	Bread Board Development System: Bread Board system with DC power output 5V, +/-12V and 0-5V variable , digital voltmeter , ammeter, LED indicators 8 no, logic input switches 8 no, 7 segment display 2 no, clock generator, Manual pulser, Breadboard with about 1,600 points, Potentiometer, relay etc	1,2,3,4,5,6,7,8,9,10,11,12
4	Trainer kits for digital ICs: Trainer kit shall consists of digital ICs for logic gates, flop-flop, shift registers, counter along with toggle switches for inputs and bi-colour LED at outputs, built in power supply.	1,2,3,4,5,6,7,8,9,10,11,12
5	Regulated power supply: Floating DC Supply Voltages Dual DC : 2 x 0 -30V; 0-2 A Automatic Overload (Current Protection) Constant Voltage and Constant Current Operation Digital Display for Voltage and Current Adjustable Current Limiter Excellent Line and Load Regulation	1,2,3,4,5,6,7,8,9,10,11,12
6	Latest Desktop PC compatible with microcontroller IDE simulation software	13,14,15,16,16,17,18,19,20,21,22,23,24,25,26,27,28,29,3
7	Microcontroller kit :-single board systems with 8K RAM,ROM memory with battery back up,16X4,16 X2, LCD display, PC keyboard interfacing facility, Hex keypad facility, single user cross c-compiler,RS-232,USB, interfacing facility with built in power supply.	26,27,28,29,30
8	Relay with driver ,5V	27
9	LCD trainer board	29
10	Stepper Motor, 50/100 RPM with driver circuitry	30

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Number System and Logic Gates	CO1	8	6	6	4	16
2	II	Digital Logic Circuits	CO2	12	2	4	8	14

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
3	III	8051 Microcontroller Architecture	CO3	12	6	6	4	16
4	IV	8051 Instruction Set and Programming	CO4	8	2	6	4	12
5	V	8051 Interfacing and Application	CO5	5	2	2	8	12
Grand Total				**45**	**18**	**24**	**28**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Each practical will be assessed considering : 60 % weightage to process. 40 % weightage to product
- Average of Two unit tests of 30 marks each will be considered.
- Laboratory learning will be of 25 marks.

Summative Assessment (Assessment of Learning)

- End of Term Examination (Lab. performance), Viva-voce

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	-	1	2	-	-	1			
CO2	3	-	2	2	-	1	1			
CO3	3	-	-	1	-	2	1			
CO4	3	3	3	2	1	2	2			
CO5	3	3	3	2	1	2	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	R.P. Jain	Modern Digital Electronics	McGraw-Hill Publishing, New Delhi, 2009; ISBN: 9780070669116
2	V.K.Puri	Digital Electronics	McGraw Hill Education (1 July 2017); ISBN-13 : 978-0074633175
3	Salivahanan S.; Arivazhagan S.	Digital Circuits and Design	Oxford University Press India; 5th edition ; ISBN13- 978-0199488681
4	Malvino, A.P.; Leach, D.P.; Saha G.	Digital Principles and Applications	McGraw Hill Education, New Delhi, 2014, ISBN : 9789339203405
5	V. Udayashankara M. S. Mallikarjuna Swamy	8051 Microcontroller: Hardware, Software and application.	McGraw Hill Education; 1st edition; ISBN-13 : 978-0070086814
6	Kenneth Ayala	8051 Microcontroller Architecture Programming and Application	Cengage Learning India; 3rd edition ; ISBN-13 : 978-8131502006

Sr.No	Author	Title	Publisher with ISBN Number
7	Mazidi, Mohmad Ali; Mazidi, Janice Gelispe; Mckinlay Roline D.	The 8051 Microcontroller and Embedded system	Pearson Education India; 2nd edition; ISBN-13 : 978-0199681273
8	Ajay Deshmukh	Microcontroller Theory and Application	Mc Graw Hill., New Delhi,2011, ISBN- 9780070585959

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.keil.com/download/	Simulation software
2	https://archive.nptel.ac.in/courses/108/105/108105102/	NPTEL course on-Microprocessors and Microcontrollrs
3	https://nptel.ac.in/courses/117104072	NPTEL Course-Microcontrollers and Applications, IIT Kanpur by Dr. S.P. Das
4	https://play.google.com/store/apps/details?id=com.coderbro.tutorial.a8051microcontroller&hl=en_IE	Android App for Microcontroller 8051

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

ELECTRICAL ESTIMATING AND CONTRACTING **Course Code : 314325**

Programme Name/s : **Electrical Engineering/ Electrical Power System**

Programme Code : **EE/ EP**

Semester : **Fourth**

Course Title : **ELECTRICAL ESTIMATING AND CONTRACTING**

Course Code : **314325**

I. RATIONALE

This course thoroughly explores important aspects of wiring installations, covering planning of electrical installation and contracts, adherence to electrical bylaws, understanding supply systems, implementing effective installation methods, and mastering the estimation of electrical wiring, installations, and contracting. This course provides students with holistic knowledge to pursue careers as contractors and entrepreneurs and empowers them to successfully execute a wide range of electrical wiring installation projects with confidence and proficiency.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Carry out estimation and costing of various electrical wiring installations.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Prepare generic tender document, quotation, comparative statement, and supply order.
- CO2 - Prepare estimate of domestic and commercial electrical installations.
- CO3 - Prepare estimate of industrial electrical installations.
- CO4 - Prepare estimate of public lighting installations.
- CO5 - Prepare estimate of overhead and underground distribution lines.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
314325	ELECTRICAL ESTIMATING AND CONTRACTING	EEC	DSC	3	-	4	1	8	4	3	30	70	100	40	25	10	25#	10	25	10	175

Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Apply the principles of NEC 2023 during preparation of the given document. TLO 1.2 State the purpose of preparation of the given type(s) of estimates. TLO 1.3 State the purpose of awarding the given type(s) of contracts. TLO 1.4 Prepare tender documents, quotations, and bills for the specified work.	**Unit - I Estimates and Contracts** 1.1 National Electrical Code 2023 (NEC 2023): Scope and features, Types of electrical installation- Non industrial and industrial, Standard value of voltages and their limits, Fundamental principles for electrical installations, Safety in electrical work, permit to electrical work, safety instruction and safety practices 1.2 Estimating and costing: Purpose, Qualities of good estimator, essential elements of estimating and costing, Meaning and purpose of- Rough estimate, detailed estimate, supplementary estimate, annual maintenance estimate and revised estimate, Factors to be considered while preparation of detailed estimate and economical execution of work. 1.3 Contracts: Concepts, types, roles, and qualities of good contractor 1.4 Tender and Quotation: Types of tenders, tender notice, preparation of tender document, and method of opening of tender, Government e-Market Place (GeM), features and benefits of GeM, Quotation, quotation format, comparison between tender and quotation, Comparative statement, format of comparative statement. Order format, placing of purchasing order, Principles of execution of works, planning, organizing and completion of work, Billing of work.	Lecture Using Chalk-Board Presentations
2	TLO 2.1 Interpret the given electrical installation plan and electrical diagrams. TLO 2.2 Estimate materials required for the given domestic installations. TLO 2.3 Estimate materials required for the given commercial installations. TLO 2.4 Estimate materials required for given type of service connection.	**Unit - II Domestic and Commercial Installations** 2.1 Electrical Drawing: Electrical symbols used in electrical diagrams as per NEC 2023, multiline and single line representation of conductors, Electrical diagrams, their Classification. Methods of representation for the wiring diagram- multiline and single line representation, conversion of multiline representation into single line and vice versa. Necessity and reading of Civil Engineering building drawing. Interpretation of electrical installation plan and electrical diagrams. 2.2 Design of Domestic Installations: Steps to be followed for design and estimation of domestic installations. Design consideration of electrical installation in domestic installations. Design, drawing, estimation, and costing of a domestic installation having maximum 5 kW load. 2.3 Design of Commercial Installations: Steps to be followed for design and estimation of commercial installations. Design consideration of electrical installation in commercial installations. Design electrical installation scheme of small commercial installations of classrooms in educational institutions, small shops, and dispensaries. 2.4 Service Connection: Underground and overhead, it's diagram and description. Calculation of material required for underground and overhead service connection.	Lecture Using Chalk-Board Presentations Case Study Flipped Classroom Site/Industry Visit

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Select wiring types for industrial installations. TLO 3.2 Draw an installation plan, wiring diagrams and single line diagrams for the given industrial installations. TLO 3.3 Describe given design considerations of an industrial installation. TLO 3.4 Carry out estimation for the given industrial installations.	**Unit - III Industrial Installations** 3.1 Classification of industrial installations based on fire safety and power consumption, Difference between non-industrial and industrial installations, General characteristics of industrial installation, selection of wiring system. 3.2 Wiring diagram and single line diagram for single phase and three phase motors. Installation plan. 3.3 Design Considerations: Calculation of Motor current, deciding the cable size, deciding the size of Conduit, deciding the fuse rating, deciding distribution board and main switch/MCB, deciding the starter for Motors. 3.4 Design electrical installation scheme and preparation of estimate of agricultural pump, flourmill and small industrial unit having total aggregate three -phase load less than 30 kW.	Lecture Using Chalk-Board Case Study Flipped Classroom Presentations Site/Industry Visit
4	TLO 4.1 Describe given terms related to public lighting installation. TLO 4.2 Select proper materials for streetlights installation. TLO 4.3 Select proper materials for High-mast lighting installation. TLO 4.4 Carry out estimation of streetlights and High-mast lighting.	**Unit - IV Public Lighting Installation** 4.1 Classification of outdoor installations, streetlight/ public lighting installation, Terminology used according to NEC 2023 – Terms related to highway, lighting installation, photometric terms, luminaries etc. Aim of public lighting installation, classification of roads, standard layout of roads. 4.2 Streetlight pole structures. Selection of equipment, sources used in streetlight installations. Cables, recommended types and sizes of cable. On off Control of equipment of streetlight installation. 4.3 High-mast pole structure, selection of equipment, wiring diagram. 4.4 Design, estimation and costing of streetlights and High-mast lighting.	Lecture Using Chalk-Board Presentations Case Study Flipped Classroom Site/Industry Visit
5	TLO 5.1 Compare the given types of distribution lines. TLO 5.2 Describe the given material required for distribution lines. TLO 5.3 Carry out estimates for the specified distribution lines.	**Unit - V Distribution Lines** 5.1 Block Diagram of Electrical Power system, Types of Distribution lines - Primary and Secondary, Overhead and Underground, and it's comparison. 5.2 Materials used for distribution line HT (11kV) and LT (415 V), Cables used for distribution line, factors determining selection of LT/ HT power cables, and cable termination methods. 5.3 Design, estimation and costing of HT (11kV), LT (415 V) overhead line and underground cabling.	Presentations Lecture Using Chalk-Board Flipped Classroom Case Study Site/Industry Visit

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Prepare a quotation from the given enquiry.	1	*Preparation of a quotation.	2	CO1
LLO 2.1 Prepare a comparative statement from a minimum of three quotations.	2	*Preparation of a comparative statement.	2	CO1
LLO 3.1 Prepare a purchase order from the comparative statement.	3	*Preparation of the purchase order.	2	CO1

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 4.1 Prepare tender document for purchase of electrical machines costing more than five lakhs. LLO 4.2 Use GeM portal for searching of software, tools/equipment for procurement.	4	Preparation of the tender document.	2	CO1
LLO 5.1 Calculate total load for given domestic installation. LLO 5.2 Draw electrical installation plan from given civil engineering drawing. LLO 5.3 Calculate number of subcircuits, ratings of main switch and distribution board. LLO 5.4 Draw single line diagram of distribution board for given installation. LLO 5.5 Carry out estimation for above given domestic installation.	5	*Design an electrical installation system for one BHK domestic unit and carry out an estimation.	8	CO2
LLO 6.1 Draw electrical installation plan from given civil engineering drawing using suitable drawing software. LLO 6.2 Draw single line diagram of distribution board for given installation using suitable drawing software.	6	*Domestic installation drawing using suitable software (mentioned in Practical No. 5).	4	CO2
LLO 7.1 Calculate total load for given commercial installation. LLO 7.2 Draw electrical installation plan from given civil engineering drawing. LLO 7.3 Calculate number of subcircuits, ratings of main switch and distribution board. LLO 7.4 Draw single line diagram of distribution board for given installation. LLO 7.5 Carry out estimation for above given commercial installation.	7	*Design an electrical installation system for a commercial unit and carry out an estimation.	8	CO2
LLO 8.1 Draw electrical installation plan from given civil engineering drawing using suitable drawing software. LLO 8.2 Draw single line diagram of distribution board for given installation using suitable drawing software.	8	*Commercial installation drawing using suitable software (mentioned in Practical No. 7).	4	CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 9.1 Calculate total load for given industrial installation. LLO 9.2 Draw electrical installation plan from given civil engineering drawing. LLO 9.3 Calculate size of cable, ratings of main switch and distribution board. LLO 9.4 Draw single line diagram of distribution board for given installation. LLO 9.5 Carry out estimation for above given industrial installation.	9	*Design an electrical installation system for small industrial installation and carry out an estimation.	8	CO3
LLO 10.1 Draw single line diagram of distribution board for given installation using suitable drawing software.	10	Commercial installation drawing using suitable software (mentioned in Practical No. 9).	2	CO3
LLO 11.1 Draw a layout diagram for streetlights installation from a given civil engineering drawing. LLO 11.2 Draw the details of a streetlight pole and layout as per NEC 2023. LLO 11.3 Select the size of cable by calculating voltage drop. LLO 11.4 Carry out the estimation for given streetlight installation.	11	*Design an electrical installation system for street lights of small premises and carry out an estimation.	6	CO4
LLO 12.1 Draw layout diagram for low-tension (LT) line from given data. LLO 12.2 Carry out the estimation for low-tension (LT) line.	12	*Design an electrical installation system for a low-tension (LT) distribution line (415 volts) and carry out an estimation.	6	CO5
LLO 13.1 Draw layout diagram for high-tension (HT) line from given data. LLO 13.2 Carry out the estimation for high-tension (HT) line.	13	Design an electrical installation system for a high-tension (HT) distribution line (11 kV) and carry out an estimation.	6	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Carry out market survey of electrical materials for comparison of quality and cost.
- Collect an electrical engineering drawing of the existing electrical installation. Interpret it. Prepare a report on it.
- Collect industrial installation plan and prepare estimation for the same using suitable software.
- Collect existing installation plan of distribution lines and prepare an estimation for the same.
- Collect the existing installation plan of the street lighting scheme and prepare an estimation for the same.
- Collect the existing installation plan of the High-mast lighting scheme and prepare an estimation for the same.
- Collect the existing installation plan of the low-tension (LT) line and prepare an estimation for the same.
- Collect the existing installation plan of the high-tension (HT) line and prepare an estimation for the same.
- Collect any tender document related to electrical installation and fill all related documents.
- Collect list of vendors and specifications of electrical goods from GeM portal.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	All In One Computer with following specifications. Processor - 13th Gen Intel® Core™ i5-13500T, OS-Windows 11 Pro, Graphics - Intel® Graphics, Memory - 8 GB: 1 x 8 GB, DDR4 , Storage - 256 GB, M.2 2230, PCIe NVMe, SSD, Class 35 , Display - 60.5-cm. display Full HD (1920X1080)	1,6,8,10
2	Laser jet multifunction printer	1,6,8,10
3	Any proprietary or open-source drawing Software	6,8,10

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Estimates and Contracts	CO1	5	2	4	4	10
2	II	Domestic and Commercial Installations	CO2	12	2	8	8	18
3	III	Industrial Installations	CO3	12	2	8	8	18
4	IV	Public Lighting Installation	CO4	8	2	4	8	14
5	V	Distribution Lines	CO5	8	2	0	8	10
Grand Total				**45**	**10**	**24**	**36**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two unit tests of 30 marks will be conducted and average of marks obtained in these two unit tests will be considered. Each practical will be assessed for 25 marks and average of all marks obtained will be considered.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks for classroom learning. End semester assessment of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

ELECTRICAL ESTIMATING AND CONTRACTING **Course Code : 314325**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	-	-	-	-	1	1			
CO2	3	-	3	2	1	1	1			
CO3	3	-	3	2	1	1	1			
CO4	3	-	3	2	1	1	1			
CO5	3	-	3	2	1	1	1			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	K.B.Raina, S.K.Bhattacharya	Electrical Design Estimating and Costing	New Age International Publisher, First, Reprint 2010, ISBN:13: 978-8122443585
2	Surjit Singh, Ravi Deep Singh	Electrical Estimating and Costing	Dhanpat Rai and Sons, 2014 New Delhi, ISBN:1234567150995
3	J.B. Gupta	A Course in Electrical Installation Estimating and Costing	S.K. Kataria and Sons; New Delhi Reprint Edition, 2013, ISBN: 13: 978-9350142790
4	BIS	SP-30:2023, National Electrical Code, 2023	Bureau of Indian Standards
5	BIS	IS: 732-1989, Code of Practice for Electrical Wiring Installation	Bureau of Indian Standards

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.electricaltechnology.org/2013/09/electrical-wiring.htm	Basics of Electrical wiring system
2	https://www.electrical4u.com/types-of-electrical-insulator-overhead-insulator/	Distribution line materials
3	https://www.electrical4u.com/lamps-types-and-performance-comparison/	Different types of lamps.
4	https://youtu.be/yhzhloBF_eo?si=Esgl05OzWNCOQaiD	High mast light wiring
5	https://www.youtube.com/watch?v=IoMXX6xct1g	Streetlight wiring
6	https://standardsbis.bsbedge.com/	SP:30 NEC 2023
7	https://gem.gov.in/	GeM portal for procurement.

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

Maharashtra State Board of Technical Education, Mumbai

Teaching And Examination Scheme For Post S.S.C. Diploma Courses

Program Name : Diploma in Electrical Engineering

Program Code : EE/EP/EU — **With Effect From Academic Year: 2017 - 18**

Duration of Program : 6 Semesters — **Duration : 16 Weeks**

Semester : Fifth — **Scheme : I**

S. N.	Course Title	Course Abbreviation	Course Code	Teaching Scheme			Credit (L+T+P)	Examination Scheme												Grand Total
								Theory						Practical						
								Exam Duration in Hrs.	ESE		PA		Total		ESE		PA		Total	
				L	T	P			Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
1	Management	MAN	22509	3	-	-	3	90 Min	70*#	28	30*	00	100	40	--	--	--	--	--	--	100
2	Industrial AC Machines	IAM	22523	4	-	2	6	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
3	Switchgear and Protection	SAP	22524	4	-	2	6	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
4	Energy Conservation and Audit	ECA	22525	3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
	Elective (Any One)																				
5	Elements of Industrial Automation	EIA	22526	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
	Power Electronics Application	PEA	22527	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
	Wind Power Technologies	WPT	22528	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
	Power System Analysis	PSA	22529	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
	Illumination and Electrification of Buildings	IEB	22530	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
6	Enterprenureship Development	EDE	22032	2	-	2	4	--	--	--	--	--	--	--	50@	20	50~	20	100	40	100
7	Industrial Training	ITR	22057	-	-	6	6	--	--	--	--	--	--	--	75#	30	75	30	150	60	150
8	Capstone Project Planning	CPP	22058	-	-	2	2	--	--	--	--	--	--	--	25@	10	25	10	50	20	50
			Total	**19**	**-**	**18**	**37**	--	**350**	--	**150**	--	**500**	--	**250**	--	**250**	--	**500**	--	**1000**

Student Contact Hours Per Week: **37 Hrs.** Medium of Instruction: **English**
Theory and practical periods of 60 minutes each. Total Marks **: 1000**
Abbreviations: ESE- End Semester Exam, PA- Progressive Assessment, L - Lectures, T - Tutorial, P - Practical
@ Internal Assessment, # External Assessment, *# On Line Examination, ^ Computer Based Assessment
* Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain LOs required for the attainment of the COs.
~ For the courses having ONLY Practical Examination, the PA marks Practical Part - with 60% weightage and Micro-Project Part with 40% weightage

- **If Candidate not securing minimum marks for passing in the "PA" part of practical of any course of any semester then the candidate shall be declared as "Detained" for that semester.**
- **Evalution of Industrial Training and its reports is to done after completion of Industrial Training. Credits of Industrial Training will not affect the framing of time table.**



Program Name : **Diploma in Information Technology/ Automobile Engineering / Digital Electronics / Medical Electronics / Plastic Engineering / Production Engineering / Fashion & Clothing Engineering / Electrical Engineering Group/ Instrumentation/ Instrumentation & Control**

Program Code : **IF/AE/DE/MU/IS/IC/PS/PG/PT/DC/EE/EP/EU**

Semester : **Fifth**

Course Title : **Entrepreneurship Development**

Course Code : **22032**

1. RATIONALE

Globalisation, liberalization and privatization along with revolution in information technology have opened up new opportunities transforming lives of masses. In this context, there is immense opportunity of establishing manufacturing, service, trading, marketing and consultancy enterprises by diploma engineer. Our fast growing economy provides ample scope for diploma engineers to succeed as an entrepreneur. Entrepreneurship requires distinct skill sets which are attempted to be developed through this course. To begin with, this course aims to develop the competency and the related outcomes in order to start small enterprises.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Develop project proposals to launch small scale enterprises.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a. Identify your entrepreneurial traits.
b. Identify the business opportunities that suits you.
c. Use the support systems to zero down to your business idea.
d. Develop comprehensive business plans.
e. Prepare plans to manage the enterprise effectively.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme													
				Theory							Practical						
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total		
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	
2	-	2	4	--	--	--	--	--	--	--	50@	20	50~	20	100	40	

(\$):*Online Examination;* ***(~)****:PA has two components under practical marks i.e. the assessment of practicals (seen in section 6) has a weightage of 60% (i.e.15 marks) and micro-project assessment (seen in section 12) and the remaining has a weightage 40% (i.e.10*

marks) will be average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.
Legends: ***L****-Lecture;* ***T*** *– Tutorial/Teacher Guided Theory Practice;* ***P*** *- Practical;* ***C*** *– Credit,* ***ESE*** *- End Semester Examination;* ***PA*** *- Progressive Assessment* **$:** Online examination.

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

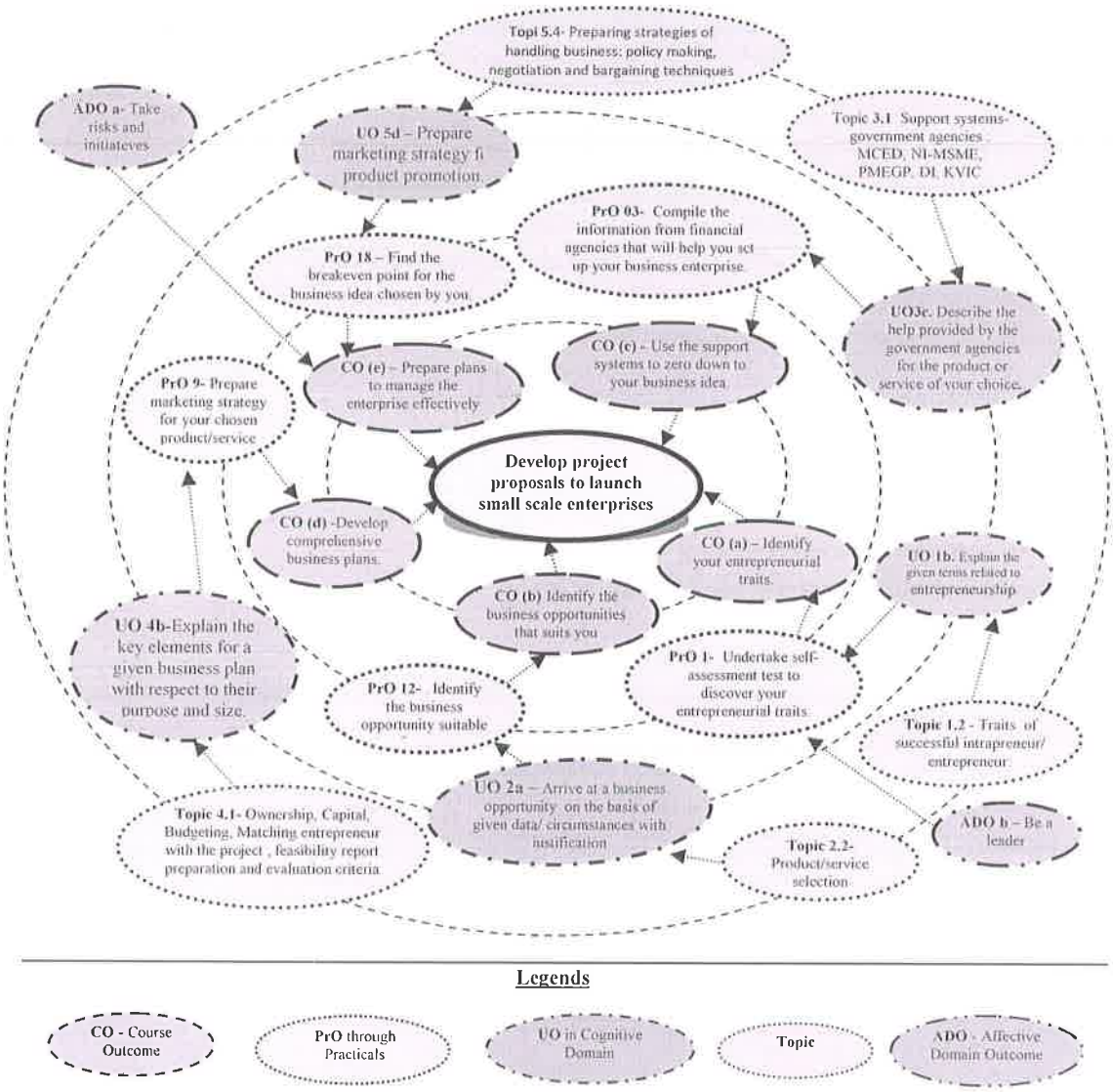


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Submit a profile summary(about500words) of a successful entrepreneur indicating milestone achievements.	I	02*
2	Undertake SWOT analysis to arrive at your business idea of a product/service.	I	02
3	Generate business ideas(product/service) for intrapreneurial and entrepreneurial opportunities through brainstorming.	II	02*
4	Undertake self-assessment test to discover your entrepreneurial traits.	II	02
5	Identify the business opportunity suitable for you.	II	02
6	Arrange an exhibition cum sale of products prepared out of waste.	II	02
7	Survey industries of your stream, grade them according to the level of scale of production, investment, turnover, pollution to prepare a report on it.	II	02
8	Visit a bank/financial institution to enquire about various funding schemes for small scale enterprise.	III	02
9	Collect loan application forms of nationalise banks/other financial institutions.	III	02
10	Compile the information from financial agencies that will help you set up your business enterprise.	III	02*
11	Compile the information from the government agencies that will help you set up your business enterprise.	III	02
12	Prepare Technological feasibility report of a chosen product/service.	III	02
13	Prepare financial feasibility report of a chosen product/service.	III	02
14	Craft a vision statement and enabling mission statements for your chosen enterprise.	III	02
15	Prepare a set of short term,medium and long term goals for starting a chosen small scale enterprise	III	02
16	Prepare marketing strategy for your chosen product/service.	IV	02*
17	Compile information about various insurance schemes covering different risk factors.	IV	02
18	Organize a funfair of your class and write a report of profit/loss	V	02
19	Find the breakeven point for the business idea chosen by you.	V	02
20	Arrange a discussion session with your institute's pass out students who are successful entrepreneurs.	V	02
21	Prepare a business plan for your chosen small scale enterprise	V	02*
	Total		**42**

Note:

i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*



ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

Sample Products that can be manufactured under SME

1. Badges cloth embroidered and metals
2. Bags of all types i.e. made of leather, cotton, canvas and jute etc. including kit bags, mail bags, sleeping bags and water-proof bag
3. Bandage cloth
4. Basket cane (Procurement can also be made from State Forest Corpn. and State Handicrafts Corporation)
5. Bath tubs of plastic
6. Battery Charger
7. Belt leather and straps
8. Bolts and Nuts
9. Boot Polish
10. Brooms
11. Domestic Brushes of different types
12. Buckets of all types of plastic
13. Button of all types
14. Chappals and sandals
15. Cleaning Powder
16. Cloth Covers for domestic use
17. Cloth Sponge
18. Coir mattress cushions and matting
19. Cotton Pouches
20. Curtains mosquito
21. Domestic Electric appliances as per BIS Specifications: Toaster Electric, Elect. Iron, Hot Plates, Elect. Mixer, Grinders Room heaters and convectors and ovens
22. Dust Bins of plastic
23. Dusters Cotton all types except the items required in Khadi
24. Electronic door bell
25. Emergency Light (Rechargeable type)
26. Hand drawn carts of all types
27. Hand gloves of all types
28. Hand numbering machine
29. Hand Pump
30. Hand Tools of all types
31. Handles wooden and bamboo (Procurement can also be made from State Forest Corpn. and State Handicrafts Corporation)
32. Haver Sacks
33. Honey
34. Invalid wheeled chairs.
35. Iron (dhobi)
36. Lamp holders
37. Letter Boxes
38. Nail Cutters
39. Oil Stoves (Wick stoves only)
40. Paper conversion products, paper bags, envelops, Ice-cream cup, paper cup and saucers and paper Plates
41. Pickles, Chutney and Pappads
42. Pouches for various purposes

43. Safe meat and milk
44. Safety matches
45. Safety Pins (and other similar products like paper pins, staples pins etc.)
46. Shoe laces
47. Sign Boards painted
48. Soap Liquid
49. Spectacle frames
50. Steel Chair
51. Umbrellas
52. Utensils all types

Sample Services that can be offered under SME

1. Marketing Consultancy
2. Industrial Consultancy
3. Equipment Rental & Leasing
4. Typing Centres
5. Photocopying Centres (Zeroxing)
6. Industrial photography
7. Industrial R & D Labs.
8. Industrial Testing Labs.
9. Desk Top publishing
10. Advertising Agencies
11. Internet Browsing/Setting up of Cyber Cafes
12. Auto Repair, services and garages
13. Documentary Films on themes like Family Planning, Social forestry, energy conservation and commercial advertising
14. Laboratories engaged in testing of raw materials, finished products
15. 'Servicing Industry' Undertakings engaged in maintenance, repair, testing or electronic/electrical equipment/ instruments i.e. measuring/control instruments servicing of all types of vehicles and machinery of any description including televisions, tape recorders, VCRs, Radios, Transformers, Motors, Watches.
16. Laundry and Dry Cleaning
17. X-Ray Clinic
18. Tailoring
19. Servicing of agriculture farm equipment e.g. Tractor, Pump, Rig, Boring Machines.
20. Weigh Bridge
21. Photographic Lab
22. Blue printing and enlargement of drawing/designs facilities
23. ISD/STD Booths
24. Teleprinter/Fax Services
25. Sub-contracting Exchanges (SCXs) established by Industry Associations.
26. Coloured or Black and White Studios equipped with processing laboratory.
27. Ropeways in hilly areas.
28. Installation and operation of Cable TV Network:
29. Operating EPABX under franchises
30. Beauty Parlours
31. Creches.

S. No.	Performance Indicators	Weightage in %
1	Leadership skills	20

S. No.	Performance Indicators	Weightage in %
2	Team work	20
3	Lateral/creative thinking	10
4	Observations and recording	10
5	Self learning	20
6	Answer the sample questions	10
7	Submission of report in time	10
	Total	**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safe practices
b. Practice good housekeeping
c. Practice energy conservation
d. Demonstrate working as a leader/a team member
e. Maintain tools and equipment
f. Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Seminar Hall equipped with conference table,chairs and multimedia facilities	All
2	Modern desktop Computer with internet connection.	All

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (In cognitive domain)	Topics and Sub-topics
Unit – I Entrepreneurship Development - Concept and Scope	1a. Describe the procedure to evaluate your entrepreneurial traits as a career option for the given product to be manufactured or services to be rendered.	1.1 Entrepreneurship as a career 1.2 Traits of successful intrapreneur/ entrepreneur: consistency, creativity, initiative, independent decision making, assertiveness, persuasion, persistence, information seeking.

Unit	Unit Outcomes (In cognitive domain)	Topics and Sub-topics
	1b. Explain the given terms related to Entrepreneurship 1c. Describe the salient features of the resources required for starting the specified enterprise. 1d. Identify the characteristics for a given type of enterprise.	handling business communication, commitment to work contract, calculated risk taking. 1.3 Entrepreneurship : scope in local and global market. 1.4 Intrapreneur and entrepreneur 1.5 Types of enterprises and their features : manufacturing, service and trading. 1.6 Steps in setting up of a business.
Unit – II Entrepreneurial Opportunities and selection process	2a. Arrive at a business opportunity on the basis of given data/circumstances with justification. 2b. Describe the scheme(s) offered by the government for starting the specified enterprise. 2c. Suggest a suitable place for setting up the specified enterprise on the basis of given data/circumstances with justification. 2d. Suggest the steps for the selection process of an enterprise for the specified product or service with justification. 2e. Describe the market study procedure of the specified enterprise.	2.1 Product/Service selection: Process, core competence, product/service life cycle, new product/ service development process, mortality curve, creativity and innovation in product/ service modification / development. 2.2 Process selection: Technology life cycle, forms and cost of transformation, factors affecting process selection, location for an industry, material handling. 2.3 Market study procedures: questionnaire design, sampling, market survey, data analysis 2.4 Getting information from concerned stakeholders such as Maharashtra Centre for Entrepreneurship Development[MCED], National Institute for Micro, Small and Medium Enterprises [NI-MSME], Prime Minister Employment Generation Program [PMEGP], Directorate of Industries[DI], Khadi Village Instries Commission[KVIC]
Unit – III Support Systems	3a. Describe the support system required for the specified enterprise. 3b. Describe the help provided by the government agencies for the specified product/service. 3c. Describe the help provided by the non-governmental agencies for the specified product/service. 3d. Compute the breakeven	3.1 Categorisation of MSME, ancillary industries 3.2 Support systems- government agencies: MCED, NI-MSME, PMEGP,DI, KVIC 3.3 Support agencies for entrepreneurship guidance, training, registration, technical consultation, technology transfer and quality control, marketing and finance. 3.4 Breakeven point, return on investment and return on sales.

Unit	Unit Outcomes (In cognitive domain)	Topics and Sub-topics
	point for the specified business enterprise, stating the assumptions made.	
UNIT IV Business Plan Preparation	4a. Justify the importance of the business plan for the given product/service. 4b. Explain the key elements for the given business plan with respect to their purpose/size 4c. Prepare the budget for the given venture. 4d. Prepare the details of the given component of the given startup business plan.	4.1 Sources of Product for Business : Feasibility study 4.2 Ownership, Capital, Budgeting, Matching entrepreneur with the project , feasibility report preparation and evaluation criteria 4.3 Business plan preparation
Unit –V Managing Enterprise	5a. Justify the USP of the given product/ service from marketing point of view. 5b. Formulate a business policy for the given product/service. 5c. Choose the relevant negotiation techniques for the given product/ service with justification. 5d. Identify the risks that you may encounter for the given type of business/enterprise with justification. 5e. Describe the role of the incubation centre for the given product/service.	5.1 Unique Selling Proposition [U.S.P.]: Identification, developing a marketing plan. 5.2 Preparing strategies of handling business: policy making, negotiation and bargaining techniques. 5.3 Risk Management: Planning for calculated risk taking, initiation with low cost projects, integrated futuristic planning, angel investors, venture capitalist. 5.4 Incubation centres: Role and procedure.

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' of Bloom's 'Cognitive Domain Taxonomy'.

9. SSUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Develop two products from household waste (attach photographs).
b. Download product development and innovative films from internet.
c. Prepare a collage for 'Traits of successful entrepreneurs'.
d. Invite entrepreneurs, industry officials, bankers for interaction.
e. Identify your hobbies and interests and convert them into business idea.
f. Convert you project work into business.

g. Choose a product and design a unique selling preposition, brand name, logo, advertisement (print, radio, television), jingle, packing, packaging, label for it.
h. Develop your own website. Share your strengths and weakness on it. Declare your time bound goals and monitor them on the website.
i. Choose any advertisement and analyse its good and bad points.
j. Decide any product and analyse its good and bad features.
k. Select any product and prepare its cost sheet.
l. Choose any product and study its supply chain.
m. Arrange brainstorming sessions for improvement of any product.
n. Study schemes for entrepreneurship promotion of any bank.
o. Visit industrial exhibitions, trade fairs and observe nitty-gritty of business.
p. Open a savings account and build your own capital.
q. Organise industrial visit and suggest modifications for process improvement.
r. Interview at least four entrepreneurs or businessman and identify Charms of entrepreneurship and Traits of successful entrepreneurs.
s. Analyse case studies of any two successful entrepreneurs.
t. Perform a survey and identify local resources available for setting up of an enterprise.
u. Engage in marketing of products.
v. Carry out a demand supply gap analysis for a particular product.
w. Organise a prototype development competition.
x. Arrange fairs, events in the institute and try for sponsorships.
y. Select any performance criteria and continuously compete with yourself.
z. On any performance criteria continuously compete with others.
aa. Foresee your dream and make a long term plan for its accomplishment.
bb. Dream for something unique and make a write-up.
cc. Read articles, books on creativity.
dd. Using morphological analysis technique, reduce cost or increase quality of a product.
ee. Conduct a market survey for a project. Collect data on machinery specifications, price, output/hr, power consumption, manpower requirement, wages, raw material requirement, specification, price, competitor's product price, features, dealer commissions, marketing mix.
ff. Prepare a business plan and organize a business plan competition.
gg. Select a social cause, set objectives, plan and work for its accomplishment.
hh. Videograph as many as possible from the above and upload on your website, YouTube, facebook.

10. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs/UOs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Use Flash/Animations to explain various maintenances techniquies.

f. Guide student(s) in undertaking micro-projects.
g. Instructors should emphasise more on deductive learning. Students should learn to recognise, create, shape opportunities, and lead teams for providing economic-social value to society.
h. Business simulations should be used to enhance behavioural traits of successful intrapreneurs and entrepreneurs amongst students. Emphasis should be on creating entrepreneurial society rather than only setting up of enterprise.
i. They must be encouraged to surf on net and collect as much information as possible.
j. Each student should complete minimum twenty activities from the suggested list. Minimum possible guidance should be given for the suggested activities.
k. Students should be promoted to use creative ideas, pool their own resources, finish their presentation, communication and team skills.
l. Alumni should be frequently invited for experience sharing, guiding and rewarding students.
m. Display must be arranged for models, collages, business plans and other contributions so that they motivate others.

11. SUGGESTED MICRO-PROJECTS

One Business Plan as a micro-project is planned to be undertaken by a student assigned to him/her in the beginning of the semester. S/he should submit it by the end of the semester to develop the industry oriented COs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation in the middle of the semester and one at the end of the semester before submission of the project proposal incorporating the concepts taught during semester. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course.

12. SUGGESTED LEARNING RESOURCES

S. No.	Title of Books	Author	Publication
1	The Entrepreneurial Instinct : How Everyone Has the Innate Ability to Start a Successful Small Business	Mehta, Monica	McGraw-Hill Education, New Delhi, 2012, ISBN 978-0-07-179742-9
2	Entrepreneurship	Hisrich, R. D.	McGraw-Hill Education, New Delhi, 2013 ISBN-13: 978-1259001635
3	Part I Readings in Entrepreneurship Education	Sareen, S.B.	Entrepreneurship Development Institute of India (EDI), GOI, Ahmedabad, 2016; ISBN: 978-0078029196 ..
4	Reading Material of Entrepreneurship Awareness Camp	Gujral, Raman	Entrepreneurship Development Institute of India (EDI), GOI, 2016 Ahmedabad,
5	Product Design and Manufacturing	Chitale, A K	PHI Learning, New Delhi, 2014; ISBN: 9788120348738
6	Entrepreneurship Development Small Business Entrepreneurship	Charantimath, Poornima	Pearson Education India, New Delhi; ISBN: 9788131762264
7	Entrepreneurship Development: Special edition for MSBTE	CPSC, Manila	Tata Mc-Graw Hill, New Delhi,
8	Entrepreneurship and Small	Khanka, S.S.	S.Chand and Sons, New Delhi;

S. No.	Title of Books	Author	Publication
	Business Management		ISBN: 978-93-5161-094-6
9	Entrepreneurship Development	S, Anil Kumar	New Age International, New Delhi, ISBN: 9788122414349

13. SUGGESTED SOFTWARE/LEARNING WEBSITES

1	MCED Books links	http://www.mced.nic.in/UdyojakSpecial.aspx?linktype=Udyojak
2	MCED Product and Plan Details	http://www.mced.nic.in/allproduct.aspx
3	The National Institute for Entrepreneurship and Small Business Development Publications	http://niesbud.nic.in/Publication.html
4	Courses : The National Institute for Entrepreneurship and Small Business Development	http://niesbud.nic.in/docs/1standardized.pdf
5	Entrepreneur.com	https://www.entrepreneur.com/lists
6	GOVT. SPONSORED SCHEMES	https://www.nabard.org/content1.aspx?id=23andcatid=23andmid=530
7	NABARD - Information Centre	https://www.nabard.org/Tenders.aspx?cid=501andid=24
8	NABARD – What we Do	http://www.nabard.org/content1.aspx?id=8andcatid=8andmid=488
9	Market Review	http://www.businesstoday.in/markets
10	Start Up India	http://www.startupindia.gov.in/pdffile.php?title=Startup%20India%20Action%20Planandtype=Actionandq=Action%20Plan.pdfandcontent_type=Actionandsubmenupoint=action
11	About - Entrepreneurship Development Institute of India (EDII)	http://www.ediindia.org/institute.html
12	EDII - Centres	http://www.ediindia.org/centres.html
13	EDII - Publications	http://www.ediindia.org/publication.html
14	Business Plans: A Step-by-Step Guide	https://www.entrepreneur.com/article/247574
15	The National Science and Technology Entrepreneurship Development Board (NSTEDB)	http://www.nstedb.com/index.htm
16	NSTEDB - Training	http://www.nstedb.com/training/training.htm
17	Tata Exposures	http://www.tatasocial-in.com/project-exposure
18	Ministry Of Micro, Small And Medium EnterpriseS	http://www.dcmsme.gov.in/schemes/TEQUPDetail.htm
19	List of Business Ideas for Small Scale Industry	https://smallb.sidbi.in/%20/thinking-starting-business/big-list-business-ideas-small-business
20	Thinking of Entrepreneurship	https://smallb.sidbi.in/entrepreneurship-stage/thinking-entrepreneurship
21	List of services for Small Scale Industry	http://www.archive.india.gov.in/business/Industry_services/illustrative.php
22	NSIC Schemes and Services	http://www.nsic.co.in/SCHSERV.ASP

Program Name : **All Branches of Diploma in Engineering and Technology.**

Program Code : **CE/CR/CS/CH/CM/CO/IF/CW/DE/EJ/EN/EQ/ET/EX/IE/ MU/EE/EP/EU/IS/IC/AE/FG/ME/PG/PT/DC/TX/TC**

Semester : **Fifth**

Course Title : **Capstone Project – Planning**

Course Code : **22058**

1. RATIONALE

According to the requirement of National Board of Accreditation (NBA), 'learning to learn' is an important Graduate Attribute (GA No.11). It is required to develop this skill in the students so that they continue to acquire on their own new knowledge and skills from different 'on the job experiences' during their career in industry. An educational 'project' just does that and may be defined as ***'a purposeful student activity, planned, designed and performed by a student or group of students to solve/ complete the identified problem/task, which require students to integrate the various skills acquired over a period to accomplish higher level cognitive and affective domain outcomes and sometimes the psychomotor domain outcomes as well'***. Projects mainly serve this purpose of developing learning-to-learn skills with an aim to develop the following attributes in the students:

a) Initiative, confidence and ability to tackle new problems
b) Spirit of enquiry
c) Creativity and innovativeness
d) Planning and decision making skills
e) Ability to work in a team and to lead a team
f) Ability of self directed learning which is required for lifelong learning
g) Persistence (habit of not giving up quickly and trying different solutions in case of momentary failures, till success is achieved)
h) Resourcefulness
i) Habit of keeping proper records of events and to present a formal comprehensive report of their work.

2. COMPETENCY

The course should be taught and implemented with the aim to develop the required course outcomes (COs) so that students will acquire following competency needed by the industry:

- **Plan innovative/creative solutions independently and/or collaboratively to integrate various competencies acquired during the semesters to solve/complete the identified problems/task/shortcomings faced by industry/user related to the concerned occupation.**

3. COURSE OUTCOMES (COs)

The following could be some of the major course outcomes depending upon the nature of the projects undertaken. However, in case of some projects few of the following course outcomes may not be applicable.

a) Write the problem/task specification in existing systems related to the occupation.
b) Select, collect and use required information/knowledge to solve the problem/complete the task.
c) Logically choose relevant possible solution(s).
d) Consider the ethical issues related to the project (if there are any).
e) Assess the impact of the project on society (if there is any).
f) Prepare 'project proposals' with action plan and time duration scientifically before beginning of project.

g) Communicate effectively and confidently as a member and leader of team.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
-	-	2	2	--	--	--	--	--	--	--	25@	10	25	10	50	20

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment

5. Capstones Project

One of the dictionary meaning is the 'crown' or the stone placed on top of the building structure like 'kalash on top of Temples and Mosques' or 'Cross on top of churches'. Capstone projects are culminating experiences in which students synthesize the competencies acquired over whole programme. In some cases they also integrate cross-disciplinary knowledge. Thus Capstone projects prepare students for entry into a career and can be described as a 'rite of passage' or 'minimal threshold' through which participants change their status from student to graduate. A capstone project therefore should serve as a synthesis — reflection and integration— to bridge the real-world preparatory experience to real life. Thus capstone project should have emphasis on integration, experiential learning, and real-world problem solving and hence these projects are very important for students. To develop the highly essential industry oriented skills and competencies in the students, the capstone projects are offered in the last two semesters to serve for following purposes:

a) Integrate the competencies acquired by the students in the previous and current semesters.
b) Provide opportunities for interdisciplinary work in tackling problems likely to be faced by them in industry which are exciting and challenging.

6. Capstone Project Planning

Students are supposed to find out a suitable project and prepare a detailed plan in fifth semester so that it can be executed smoothly in sixth semester. The main characteristic of any project whether small or big is that it requires simultaneous application of various types of skills in the different domains of learning. Moreover, project normally do not have a predefined single solution, in other words for the same problem different students may come up with different but acceptable solutions. Further, in the process of arriving at a particular solution, the student must be required to make a number of decisions after scrutiny of the information s/he has accumulated from experiments, analysis, survey and other sources.

The projects will have a detailed project proposal, which must be executed or implemented within the time allocated, simultaneously maintaining a logbook periodically monitored by the teacher. A detailed project report is to be prepared as project progresses, which has to be submitted after the project is over. For self assessment and reflection students have to also prepare a portfolio of learning.

During the guidance and supervision of the project work, teachers' should ensure that students acquire following ***learning outcomes*** (depending upon the nature of the project work some of these learning outcomes may not be applicable):

a) Show the attitude of enquiry.
b) Identify the problems in the area related to their programme.
c) Identify the information suggesting the cause of the problem and possible solutions.
d) Assess the feasibility of different solutions and the financial implications.

e) Collect relevant data from different sources (books/internet/market/suppliers/experts etc. through surveys/interviews).
f) Prepare required drawings and detailed plan for execution of the work.
g) Work persistently and participate effectively in group work to achieve the targets.
h) Work independently for the individual responsibility undertaken.
i) Ask for help from others including guide, when required.
j) Prepare portfolio to reflect *(chintan-manan)* on experiences during project work.
k) Prepare seminar presentations to present findings/features of the project.
l) Confidently answer the questions asked about the project.
m) Acknowledge the help rendered by others in success of the project.

If students are able to acquire these *learning outcomes*, then they would be able to acquire the COs as discussed in section 3.

7. Scopes of Projects

Scope of the project work should be decided based on following criteria:

a) Relation to diploma programme curriculum: When students intend to select topics for the project work they need to choose a project which relates well to their curriculum (It may be beyond curriculum, but it should relate to it) and requires implementation of theories already learnt and skills already possessed by them from the previous semesters.

b) Abilities possessed by the group of students: Projects should be chosen so that it can be completed mainly using students' problem solving capabilities and depth of learning. It is natural that highly motivated students or high achievers may come out with projects which are more complex and challenging. Teachers should guide students to choose challenging projects according to the students' ability.

c) Resources Available: Students and Guides should keep in mind the availability of resources while deciding the topic and the scope of the project. Some of the important resources which need consideration are:

i. Time available
ii. Raw Material/Components required
iii. Manufacturing/Fabrication equipment and tools required
iv. Testing/Measuring equipment and instruments required
v. Access to Journals (Library/Digital)
vi. Expertise for theoretical guidance (available in polytechnic, nearby institutes or nearby industries)
vii. Expertise and technology required for fabrication (if required)
viii. Software required.

An important aspect to be considered is to decide who will choose a project. The best practice is that teacher should guide students about the above factors to be considered for choosing the project and based on these factors students should do the ground work and identify the possible projects and teachers should work as only facilitator and Guide in final selection of the project title and its scope.

d) Suggested Type of Capstone Projects

In general, the projects that the students can take up could be of the following types;

i. Feasibility studies.
ii. Design projects
iii. Market surveys about raw material, components or finished products.
iv. Prototype (design, make, test and evaluate).
v. Advanced experimental work requiring the development of existing equipment to be used and developed.
vi. Field works: This could include surveys, using equipment, charting data and information from visual observation.

vii. Comparative Studies: Theoretical study of two systems/mechanisms/ processes in detail and comparing them on the basis of cost/energy conservation/impact on environment/technology used etc.
viii. Application of Emerging technology: Theoretical study of some emerging technology and feasibility of its application in some real life situation in detail.
ix. Fabrication of some equipment/machine etc.
x. Construction of some structure.
xi. Development of software or use of software for solving some broad-based problem.

8. GUIDELINES FOR UNDERTAKING A PROJECT

The selection of the *Capstone Project title* must have emphasis to the Elective courses/ Elective Group taken for the study and exam for 5th and 6th semester. The students will then work on the identified problem/task through a rigorous process of understanding and analyzing the problem, conducting a literature search, deriving, discussing (monitored by the guide every fortnight) and designing the ***Semester V 'Project Proposal'*** with the following ***sub-titles***:

a) Rationale (one page)
b) Introduction
c) Literature Survey
d) Problem Definition
e) Proposed Methodology of solving Identified problem
f) In-case some prototype has to be fabricated then its tentative design and procedure for making it should be part of the proposal.
g) Resources and consumables required.
h) Action Plan (sequential list of activities with probable dates of completion)

As soon as the 'Project Proposal' is approved by the teacher, the student will begin to maintain a dated ***'Project Logbook'*** for the whole semester. This is a sort of a 'weekly diary' indicating all the activities conducted by the student every week in the semester to complete the project. This *'project logbook'* should be got signed by the teacher at regular intervals for progressive assessment to match the project proposal. If this is maintained sincerely and truthfully by the student, it will be very helpful in compiling the 'Project Report' at the end of the semester by him/her.

9. PORTFOLIO FOR SELF-DIRECTED LEARNING

To ensure that students acquire these outcomes, students should also be guided to prepare a **'Portfolio'**, so that they may reflect on their weaknesses/mistakes and learn from them. ***Students should also be encouraged to discuss with their guide and record not only technical problems but also problems related to group work, planning, execution, leadership in the team etc., so that students can also identify their weaknesses in affective domain and take remedial actions to overcome the same.*** If they wish, the students can also show their portfolio to their teachers (whom they trust) for obtaining teachers' comments on their reflection for pointing out their mistakes so that they can improve their performance.

'Portfolio' is the record of the reflection (thinking or *chintan-manan*) on experiences to which students undergo during the different stages of the project. In a portfolio, students record their critical experiences and reflect (think or do *chintan-manan*) on them in writing. This process of reflecting on the experiences make them learn from their mistakes and build on their strengths. To help students in reflection, a Portfolio format with reflective prompts (simple thought provoking questions) for different stages of the project is given as annexure B.

12.1 Purposes of Portfolio Preparation

Reflection by self is important since group work is so complex that it is difficult for teachers to appreciate the real problems amongst the students. In a portfolio, prompts (simple thought provoking questions) are given to trigger reflection on different aspects of project work. Prompts help the students to ask questions from themselves regarding different aspects of the project work and interpersonal relationships. Process of answering these questions forces students to think about behavioral problems and possible remedies/solution to deal with those problems. Portfolio preparation therefore helps in reflection on building the strengths and elimination of the weaknesses of the students pertaining to following qualities which the industry also need.

a) Plan properly for execution of given work.
b) Take appropriate decisions.
c) Arrange resources.
d) Work as member and leader of team.
e) Communicate properly.
f) Resolve the conflicts.
g) Manage the time well.
h) Have concern for ethical, societal and environmental issues.
i) Learn-to-learn from experiences.

It may be seen that these qualities are not directly related with the theoretical subject knowledge and can be developed only through real life experiences. Project work is one such type of experience where opportunity is available to develop all these qualities.

However, even during project work, emphasis of most of the students and teachers remains on development of the technical knowledge and skills while development of above qualities is neglected. Students can develop these qualities if they reflect (do thinking or *Chintan-Manan*) on their experiences from the point of view of these qualities and find out their own weaknesses and strengths. Because if somebody wants to improve his/her abilities then first step for that person is to have self awareness about his/her weaknesses and strengths.

Though portfolio preparation requires considerable time, it is essential, if we want to learn from the experiences and develop these qualities. Writing down reflections helps in better reflection as it is well known that when a person starts writing something he/she becomes more cautious about his/her view and evaluate those views before writing. Thus process of writing improves the quality of reflection or thinking. Moreover, if reflections on different stages of work are written down, over a period of time a large amount of reflection can be generated, and if this reflection is looked back, it may help in identifying some pattern of behaviour in individual which may be improved or rectified latter on as per requirement.

12.2 Guidelines for Portfolio Preparation and assessment

The main purpose of portfolio preparation is learning based on self-assessment and ***portfolio is not to be used for assessment in traditional sense.***

a) Each student has to prepare his/her portfolio separately. However, he/she can discuss with the group members about certain issues on which he/she wants to write in the portfolio.
b) For fifth semester and sixth semester, there will be only one portfolio but it will have two separate parts, first part for project planning (having two sections A and B) second part for project execution. (having two sections C and D)
c) Whatever is written inside the ***portfolio is never to be used for assessment***, because if teachers start giving marks based on whatever is written in the portfolio, then students would hesitate in true self-assessment and would not openly describe their own mistakes or shortcomings.

d) Some marks are allocated for portfolio, these marks are to be given based on how sincerely portfolio has been prepared and not based on what strengths and weaknesses of the students are mentioned in the portfolio.
e) Portfolio has to be returned back to the students after assessing it (assessment is only to see that whether portfolio is completed properly or not) by teachers. Because student is the real owner of the portfolio.
f) Students mainly learn during portfolio preparation, but they can further learn if they read it after a gap. And hence they are supposed to keep the portfolios with them even after completion of the diploma because it is record of their own experiences (it is like diary some people write about their personal experiences), because they can read it again after some time and can revise their learning (about their own qualities)

Even after completion of Diploma programme, students can continue to prepare portfolio related to different experiences in their professional and personal life and by refereeing back to old portfolios after a gap of some years, they can learn that how their personality has evolved over the years. They can also see a pattern of behaviour in their own personality which may be source of their weaknesses or strengths and they can take remedial measures based on this study of their portfolios.

Note

Since some sections of the portfolio are related with interpersonal relationships and student may find it difficult to write these experiences in English. Language should not be the barrier in reflection and hence students should be allowed to prepare the portfolio in their preferred language such as *Marathi* or *Hindi if they find it difficult to write in English.*

The amount and type of mistakes identified by students would not affect the marks received by the students. The total 7 Marks allocated for portfolio (4 marks for PA and 3 for ESE) are only for proper completion of the portfolio.

10. PROJECT REPORT

At the end of fifth Semester, the student will prepare a Semester V 'Project Report' with the following sub-titles:

- Certificate (in the Format given in this document as annexure A)
- Acknowledgements
- Abstract (in one paragraph not more than 150 words)
- Content Page
- Chapter-1 Introduction and background of the Industry or User based Problem
- Chapter-2 Literature Survey for Problem Identification and Specification,
- Chapter-3 Proposed Detailed Methodology of solving the identified problem with action plan
- References and Bibliography

Note: The report should contain relevant diagrams and figures, charts.

11. ASSESSMENT OF CAPSTONE PROJECT – PLANNING

Like other courses, assessment of Project work also has two components, first is progressive assessment, while another is end of the term assessment. The mentor faculty will undertake the progressive assessment to develop the COs in the students. They can give oral informal feedback about their performance and their interpersonal behaviour while guiding them on their project work every week. The following characteristics/ qualities informally or formally should be considered during different phases of the project work which will be assessed thrice as discussed in sub-section.

(A) Initial Phase

i. **Definition of the Problem**
   a) Accuracy or specificity

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b) Appropriateness with reference to desired course outcomes.

ii. **Methodology of Conduction the Project**
   a) Appropriateness
   b) Flexibility
   c) Clarity

iii. **General Behaviour**
   a) Initiative
   b) Resourcefulness
   c) Reasoning ability
   d) Imagination/creativity
   e) Self-reliance

(B) Intermediate Phase

i. **Performance of Student**
   a) Ability to follow correct procedure
   b) Manipulative skills
   c) Ability to collect relevant information
   d) Ability to observe, record & interpret
   e) Ingenuity in the use of material and equipment
   f) Target achievement

ii. **General Behaviour**
   a) Persistence
   b) Interest
   c) Commitment
   d) Confidence
   e) Problem solving ability
   f) Decision making ability
   g) Initiative to act
   h) Team spirit.
   i) Sharing of material etc.
   j) Participation in discussion
   k) Completion of individual responsibilities

(C) Final Phase

i. **Quality of Product**
   a) Dimensions
   b) Shape
   c) Tolerance limits
   d) Cost effectiveness
   e) Marketability
   f) Modernity

ii. **Quality of Report**
   a) Clarity in presentation and organization
   b) Styles and language
   c) Quality of diagrams, drawings and graphs
   d) Accuracy of conclusion drawn
   e) Citing of cross references
   f) Suggestion for further research/project work

iii. **Quality of presentation**
   a) Understanding of concepts, design, methodology, results, implications etc
   b) Communication skills
   c) Ability to draw conclusions and generalization

12. PROGRESSIVE ASSESSMENT (PA) GUIDELINES

15 Marks are allocated for the formal progressive assessment. However, following points need consideration during the three times of formal progressive assessment of the students at the end of 4th, 12th and 14th week.

a) ***Fortnightly monitoring*** by the mentoring teachers is necessary and marks given progressively (even the gradual chapter preparation) so that that students will not copy earlier reports or get things done or reports from the market. The ***students should not be awarded marks*** if they have not done on their own.

b) For progressive assessment at the end of 14th week, students should be asked to give the power point presentation before group of teachers and junior students (so that junior students may also get awareness about the capstone project work they have to carry out in future).

c) Although marks for *portfolio preparation* is to be given at the end of 14th week, students should be asked to bring their partly prepared portfolio (relevant sections prepared) also during their assessment at the end of 4th week and 12th week.

d) Marks for portfolio preparation should be based only on proper preparation of portfolio by writing answers to most of the prompts (self-questions to students) in the portfolio. These marks should not be based on the mistakes indicated by students in their working (while answering the prompts) and corrective actions taken by them.

e) The students would be awarded marks for their efforts (In some cases it may happen that due to some reasons such as unavailability of some material or component or some other resources, students may not be able to complete the project, but they have tried their best, in such cases students would be given appropriate marks if they have done enough efforts.)

f) ***Originality of the report*** (written in own words) would be given more importance rather than use of glossy paper or multi-colour printing.

12.1 Progressive Assessment (PA) Criteria

Allocation Criteria of the ***25 marks*** are for the Progressive Assessment (PA).

S. No.	Criteria	Marks
	First Progressive Assessment at the end of 4th week	
1	**Problem Identification/Project Title** (Innovation /Utility of the Project for industry/ User/Academia) marks to be also given based on (i) Accuracy or specificity of the scope and (ii) Appropriateness of the work with reference to desired course outcomes.	02
2	**Industrial Survey and Literature Review**: marks to be given based on extent/volume and quality of the survey of Industry / Society / Institutes/Literature/Internet for Problem Identification and possible solutions	02
3	**General Behaviour**: initiative, resourcefulness, reasoning ability, imagination/creativity, self-reliance to be assessed **Note:** Oral feedback on general behaviour may also be given whenever relevant/ required during day to day guidance and supervision. **Only written feed-back/suggestions**	**00**
	Second Progressive Assessment at the end of 12th week	
4	**Project Proposal**: Marks to be given also based on appropriateness, flexibility, detail and clarity in methods/planning. (In case of working models, detailed design and planning of fabrication/assembly of the prototype has to be also assessed). This proposal should include whole project including work to be done in sixth semester	**03**

S. No.	Criteria	Marks
5	**Execution of Plan in fifth semester** (Since project is to be fully completed in sixth semester, the part of the project which is planned to be completed in fifth semester is only to be evaluated: marks to be also given based on ability to collect relevant information, ability to follow correct procedure, manipulative skills, ability to observe, record & interpret, ingenuity in the use of material and equipment, target achievement) In case of working models, quality of workman ship (including accuracy in dimensions, shape, tolerance limits), appropriateness of raw materials/components/ technology being used, functioning of the prototype, cost effectiveness, marketability, modernity etc. has to be also assessed.	02
6	**Log book** (for work done in fifth semester, detailed and regular entry would be basis of marks)	02
7	**General Behaviour** (persistence, interest, confidence, problem solving ability, decision making ability, initiative to act, team spirit, sharing of material etc., participation in discussions, completion of individual responsibilities, leadership) **Note:** Oral feedback on general behaviour should also be given whenever relevant/ required during day to day guidance and supervision. **Only written feed-back./suggestions**	00
	Third Progressive Assessment at the end of 14th week	
8	**Portfolio for Self learning and reflection** (marks based on amount of reflection and completion of the portfolio for work done in fifth semester)	**04**
9	**Final Report writing including documentation**. (marks based on: clarity in presentation and organization; styles and language; quality of diagrams, drawings and graphs; accuracy of conclusion drawn; citing of cross references; suggestion for further research/project work) Report has to be prepared for work done in fifth semester and planning for sixth semester work.	**06**
10	**Presentation** (presentation skills including communication skills to be assessed by observing quality of presentations and asking questions during presentation and viva/voce) Report has to be prepared for work done in fifth semester and plan for sixth semester.	**02**
11	**Defence** (ability to defend the methods/materials used and technical knowledge, and involvement of individual to be assessed by asking questions during presentation and viva/voce)	**02**
	Total	**25**

13. END-SEMESTER-EXAMINATION (ESE) ASSESSENT GUIDELINES

The ***remaining 25 marks*** are for the end-semester-examination (ESE). And marks would be given according to following criteria. Moreover, the suggested evaluation scheme can be changed slightly by the external faculty according to nature of problem / project following University guidelines..

a) For each project, the one or two students from the concerned group of students should be asked to present the power point presentation before the external and internal (for about 10 minutes) and then external should ask the questions from each member of the group separately to ascertain the contribution made by each student.

b) The students would be awarded marks for their efforts (In some cases it may happen that due to some reasons such as unavailability of some material or component or some other resources, students may not be able to complete the project, but they have tried their best, in such cases students would be given appropriate marks commensurate with their efforts.)

c) The students would not be awarded marks if they have completed the project by getting done the work from market or some professionals (taking help and guidance is different as compared to getting the work or maximum part of the work completed from others on payment basis).

d) Originality of the report (written in own words, even if there are grammatical and spelling mistakes) would be given more importance rather than quality of printing and use of glossy paper (and preparing report by copy pasting from other reports).

Note: It is very common that people are not able to complete the project in time despite best of their efforts. (Please recall that how many times people are able to complete in time, personal projects such as building own house or professional projects such as developing the lab in the institute). So if students have put in enough genuine efforts but could not complete the project in time then we should consider it sympathetically and they should be given marks based on their efforts and they should get more marks as compared to students who have got their projects completed by taking major help from others/market.

13.1 End-Semester-Examination (ESE) Assessment Criteria.

Allocation Criteria of the ***25 marks*** are for the end-semester-examination (ESE)

S. No.	Description	Marks
1	**Problem Identification/Project Title** (innovation /utility of the project for industry/ user/academia) marks to be also given based on (i) accuracy or specificity of the scope and (ii) appropriateness of the work with reference to desired course outcomes.	**02**
2	**Industrial Survey and Literature Review** (marks to be given based on extent/volume and quality of the survey of industry / society / institutes/literature/internet for problem identification and possible solutions)	**02**
3	**Project Proposal**: Marks to be given also based on appropriateness, flexibility, detail and clarity in methods/planning. (In case of working models, detailed design and planning of fabrication/assembly of the prototype has to be also assessed). This proposal should include whole project including work to be done in sixth semester.	**02**
4	**Execution of Plan in fifth semester** (Since project is to be fully completed in sixth semester, the part of the project which is planned to be completed in fifth semester is only to be evaluated: marks to be also given based on ability to collect relevant information, ability to follow correct procedure, manipulative skills, ability to observe, record & interpret, ingenuity in the use of material and equipment, target achievement) In case of working models, quality of workman ship (including accuracy in dimensions, shape, tolerance limits), appropriateness of raw materials/components/ technology being used, functioning of the prototype, cost effectiveness, marketability, modernity etc. has to be also assessed.	**02**
5	**Log book** (for work during fifth semester, marks to be given based on detailed and regular entry	**03**
6	**Portfolio for Self learning and reflection** (for work during fifth semester) Marks based on amount of reflection and completion of portfolio.	**03**
7	**Project Report including Documentation** (for work during fifth semester and planning for sixth semester) (marks based on: clarity in	**04**

S. No.	Description	Marks
	presentation and organization; styles and language; quality of diagrams, drawings and graphs; accuracy of conclusion drawn; citing of cross references; suggestion for further research/project work)	
8	**Presentation** (presentation skills including communication skills to be assessed by observing the quality of presentations and asking questions during presentation and viva/voce) Presentation should be based on work done in fifth semester and planning for sixth semester.	**03**
9	**Defence** (ability to defend the methods/materials used and technical knowledge, and involvement of individual to be assessed by asking questions during presentation and viva/voce)	**04**
	Total	**25**

14. SPECIAL TEACHING STRETAGIES (If any)

a) Teacher's should not spoon feed the students and let them try on their own at different stages of the project work and even first let them strive hard and only when efforts of students have failed, then teacher should guide them. Guidance should be in initially in the form of clues or hints rather than complete explanation, detailed explanation should be given only when students are not able to work based on clues/hints. The role of teacher should be limited to guide and facilitator

b) Teachers should guide students in selecting a topic which is relevant and challenging (but within capacity) for students according to their abilities.

c) Teachers should ensure that students prepare the project plan in as much detail as possible, since this way only they would learn the importance of planning and how to do the detail planning. Teachers should allow students to proceed ahead only when they have detailed plan with them.

d) Teachers should motivate students to maintain log book and prepare portfolio. They should explain benefits of these activities to students and also train them in these activities, because most of them may be doing this first time.

e) Teachers should also encourage students to openly discuss their weaknesses and shortcomings in portfolio and teachers should develop confidence in students that admitting mistakes and weaknesses helps in improving them and their marks would not be affected by revealing their mistakes. Marks related to portfolio are awarded based only on the sincerity with which it is prepared and not based on strengths and weaknesses of students.

f) Teachers should continuously discuss with students about working of group and progress in the project and from this discussion should identify their personal qualities (both strengths and weaknesses) and suggest to them ways for improving those qualities.

g) Internal as well as external examiners should reward students for original work and efforts of students even if they are not fully successful or not able to complete the project in comparison to those students who have taken paid help from others to complete their project.

Annexure A

CERTIFICATE

This is to certify that Mr./Ms.....

From .....College having Enrolment No: .....

has completed ***Report on the Problem Definition/ Semester V Project Report/ Final Project Report*** having title .....

individually/ in a group consisting of..... persons under the guidance of the Faculty Guide.

.....
The mentor from the industry for the project
Name: .....
Telephone:.....

Annexure B

Portfolio for Self Directed Learning for Major Project Work

Name of Student:.....

Semester:.....Programme/Branch:.....

Roll Number:.....

Title of the Project:.....

Name and Designation of Project Guide:.....

Name of Polytechnic:.....

Part A: Selecting the Project and Team (Answers to the following questions to be included in 'Portfolio' as Reflection related to formation of group and finalization of project topic).

Note: This section has to be prepared just after the finalization of the Project topic and formation of the Project Team .

1. How many alternatives we thought before finalizing the project topic?
2. Did we consider all the technical fields related to branch of our diploma programme?
3. Why we found present project topic as most appropriate?
4. Whether all the group members agreed on the present project topic? If not? What were the reasons of their disagreements?
5. Whether the procedure followed in assessing alternatives and finalizing the project topic was correct? If not, discuss the reasons.
6. What were the limitations in other alternatives of project topic?
7. How we formed our team?
8. Whether we faced any problem in forming the team? If yes, then what was the problem and how was it resolved?

9. Am I the leader of our project team? If yes, then why was I chosen? If not, why I could not become the project team leader?
10. Do I feel that present team leader is the best choice available in the group? If yes, then why? If not, then why?
11. According to me who should be the leader of the team and why?
12. Can we achieve the targets set in the project work within the time and cost limits?
13. What are my significant good/ bad sharable experiences while working with my team which provoked me to think? What I learned from these experiences?
14. Any other reflection which I would like to write about formation of team and finalization of project title, if any?

Part B: Reflection related to project planning (Answers to the following questions to be included in 'Portfolio' as reflection on planning)

Note: This section has to be prepared just after the finalization of the 'Project Proposal'.

1. Which activities are having maximum risk and uncertainty in our project plan?
2. What are most important activities in our project plan?
3. Is work distribution is equal for all project group members? If not? What are the reasons? How we can improve work distribution?
4. Is it possible to complete the project in given time? If not what are the reasons for it? How can we ensure that project is completed within time.
5. What extra precaution and care should be taken in executing the activities of high risk and uncertainty? If possible, how such risks and uncertainties can be reduced?
6. Can we reduce the total cost associated with the project? If yes, then describe the ways?
7. For which activities of our project plan, arrangement of resources is not easy and convenient?
8. Did we make enough provisions of extra time/expenditure etc. to carry out such activities?
9. Did we make enough provisions for time delays in our project activity? In which activities there are more chances of delay?
10. In our project schedule, which are the days of more expenditure? What provisions we have made for availability and management of cash?
11. Any other reflection which I would like to write about project planning?

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION MUMBAI

Teacher Evaluation Sheet (ESE)
for
Capstone Project Planning

Name of Student: .....

Name of Programme..... **Semester:** .....

Course Title and Code:.....

Title of the Capstone Project: .....

A. POs addressed by the Capstone Project (Mention only those predominant POs)

a) .....
b) .....
c) .....
d) .....

B. COs addressed by the Capstone Project (Mention only those predominant POs)

a) .....
b) .....
c) .....
d) .....

C. OTHER LEARNING OUTCOMES ACHIEVED THROUGH THIS PROJECT

a) Unit Outcomes (Cognitive Domain)

i. .....
ii. .....
iii. .....
iv. .....

b) Practical Outcomes (in Psychomotor Domain)

i. .....
ii. .....
iii. .....
.....
iv. .....
.....

c) Affective Domain Outcomes

i. .....
ii. .....
iii. .....
iv. .....

D. SUGGESTED RUBRIC FOR ASSESSMENT OF CAPSTONE PROJECT

(please tick below the appropriate rating i.e. poor, average etc., for each characteristic to be assessed and give marks in the respective cell according to performance of student)

S. No.	Characteristic to be assessed	Poor	Average	Good	Excellent	Max. Marks	marks obtained
First Progressive Assessment (at the end of 4th week)							

S. No.	Characteristic to be assessed	Poor	Average	Good	Excellent	Max. Marks	marks obtained
1	**Problem/Task Identification (Project Title)**	Relate to very few POs Scope of Problem not clear at all	i. Related to some POs ii. Scope of Problem/Task vague	i. Take care of at-least Three POs ii. Scope of Problem/task not very specific	i. Take care of more than three POs ii. Scope of problem/task very clear	02	
2	**Literature Survey /Industrial Survey**	Not more than ten sources (primary and secondary), very old reference	At-least 10 relevant sources, at least 5 latest	At –least 15 relevant sources, most latest	About 20 relevant sources, most latest	02	
	Second Progressive Assessment (at the end of 12th week)						
3	**Project proposal**	Methods are not appropriate, All steps not mentioned, Design of prototype not started (if applicable).	Appropriate plan but not in much detail. Plan B for critical activities not mentioned. Time line is not developed. Design of Prototype is not complete. (if applicable)	Appropriate and detailed plan with Plan B for critical activities mentioned, but clarity is not there in methods, time line is given but not appropriate. Design of prototype is not detailed (if applicable)	Appropriate and detailed plan with Plan B for critical activities mentioned, clarity in methods with time line, Detailed design of prototype (if applicable)	02	
4	**Execution of Plan in fifth semester (please write by hand about students performance in appropriate column)**					02	
5	**Log Book**	Entries for most weeks are missing. There is no proper sequence and details are not correct.	Entries for some weeks are missing, details are not appropriate, not signed regularly by the guide.	Entries were made every week but are not in detail. Signed and approved by guide every week	Entries were made every week in detail, signed and approved by guide every week	03	
	Third progressive Assessment at the end of 14th week						
6	Portfolio Preparation	Answer to only few of the 'questions from self' (prompts)	Answer to only about 50% of the 'questions from self'	Answer to most of the 'questions from self' (prompts) written. Some	Answer to nearly all the 'questions from self' (prompts) written in detail	03	

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S. No.	Characteristic to be assessed	Poor	Average	Good	Excellent	Max. Marks	marks obtained
		written. Answers are not in much detail	(prompts) written. Answers are not in much detail	answers are not in much detail			
7	**Final Report Preparation**	Very short, poor quality sketches, Details about methods, material, precaution and conclusions omitted, some details are wrong Nearly sufficient and correct details about methods, material, precautions and conclusion. but clarity is not there in presentation, not enough graphic description.	Detailed, correct and clear description of methods, materials, precautions and	Conclusions. Sufficient Graphic Description.	Very detailed, correct, clear description of methods, materials, precautions and conclusions. Enough tables, charts and sketches	**04**	
8	**Presentation**	Major information is not included, information is not well organized .	Includes major information but not well organized and not presented well	Includes major information and well organized but not presented well	Well organized, includes major information ,well presented	**03**	
9	**Defense**	Could not reply to considerable number of question.	Replied to considerable number of questions but not very properly	Replied properly to considerable number of question.	Replied to most of the questions properly	**04**	
					Total marks	**25**	

Any Other Comment:

.....

.....

Name and designation of the Faculty Member.....**Signature**.....

.....

Program Name : **Diploma in Mechanical Engineering / Electrical Engineering Group / Chemical Engineering / Plastic Engineering**

Program Code : **ME / EE / EP / EU / CH / PS**

Semester : **Fifth**

Course Title : **Management**

Course Code : **22509**

1. RATIONALE

An engineer has to work in industry with human capital and machines. Therefore, managerial skills are essential for enhancing their employability and career growth. This course is therefore designed to provide the basic concepts in management principles, safety aspects and Industrial Acts.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Use relevant managerial skills for ensuring efficient and effective management.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a. Use basic management principles to execute daily activities.
b. Use principles of planning and organising for accomplishment of tasks.
c. Use principles of directing and controlling for implementing the plans.
d. Apply principles of safety management in all activities.
e. Understand various provisions of industrial acts.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	-	3	90 Min	70*#	28	30*	00	100	40	--	--	--	--	--	--

(*#) Online Theory Examination.

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the Cos.(#): Online examination*

***Legends:** L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, ESE - End Semester Examination; PA - Progressive Assessment*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION MUMBAI

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

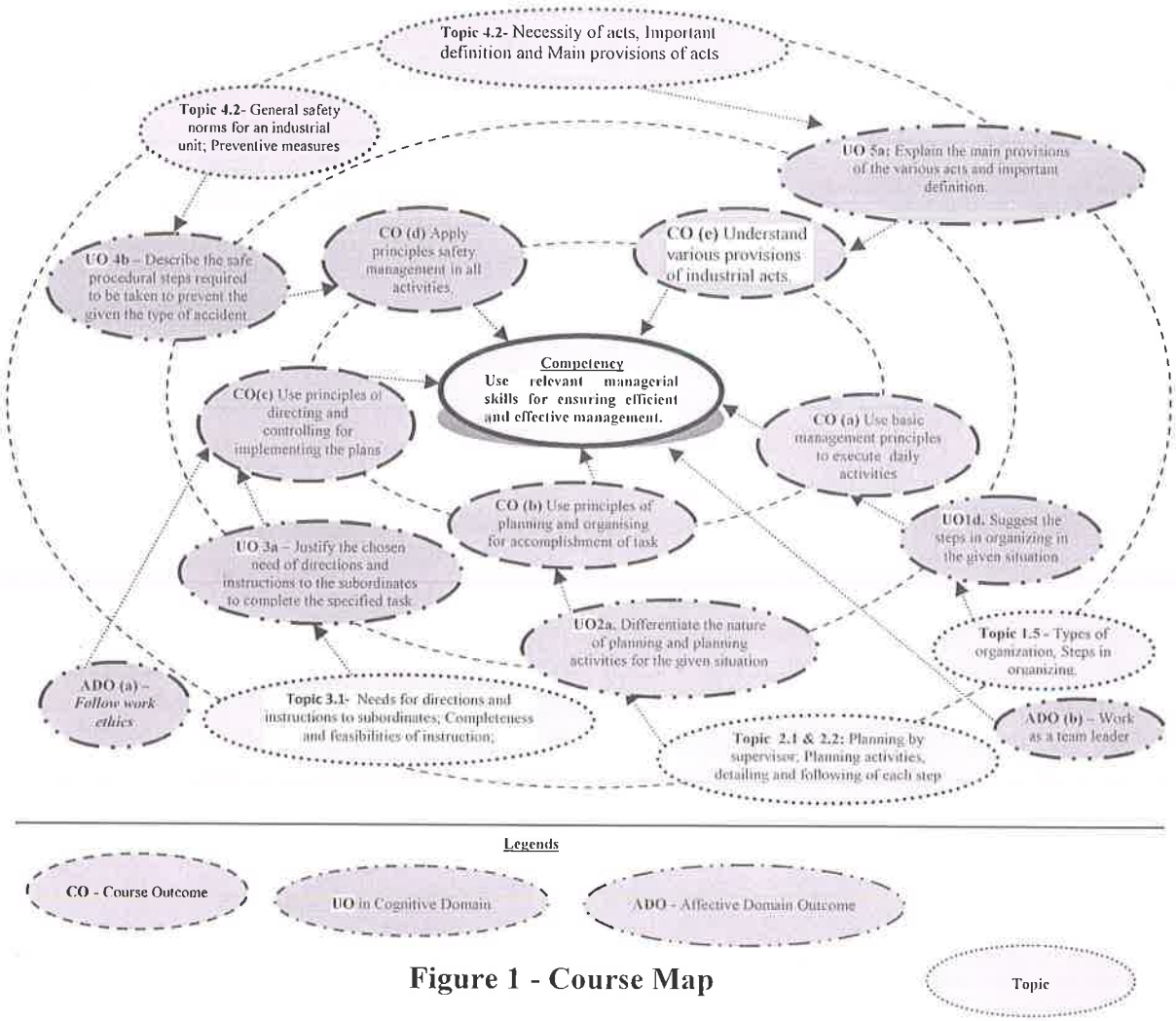


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

- Not applicable -

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

- Not applicable -

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

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Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Introduction to management concepts and managerial skills	1a. Differentiate the concept and principles of management for the given situation. 1b. Explain functions of management for given situation. 1c. Compare the features of the given types of planning 1d. Suggest the steps in organizing in the given situation. 1e. Suggest suitable type of organization for the given example. 1f. Identify the functional areas of management for the given situation 1g. Suggest suitable managerial skills for given situation with justification	1.1 Definitions of management, role and importance of management. 1.2 Management characteristics and principles, levels of management and their functions; management, administration and organization, relation between management and administration. 1.3 Functions of management: planning, organizing, leading/directing, staffing and controlling. 1.4 Types of planning and steps in planning 1.5 Types of organization, Steps in organizing 1.6 Functional areas of management. 1.7 Managerial skills.
Unit – II Planning and organizing at supervisory level	2a. Differentiate the nature of planning and planning activities for the given situation. 2b. Suggest the step wise procedure to complete the given activity in the shop floor. 2c. Prepare materials and manpower budget for the given production activity. 2d. Describe with block diagrams the organization of the physical resources required for the given situation. 2e. Describe the human needs to satisfy the job needs for the specified situation. 2f. List the tasks to be done by the concerned individuals for completing the given activity.	**Planning at supervisory level** 2.1 Planning by supervisor. 2.2 Planning activities, detailing and following of each step. 2.3 Prescribing standard forms for various activities. 2.4 Budgeting for materials and manpower. **Organizing at supervisory level** 2.5 Organizing the physical resources. 2.6 Matching human need with job needs. 2.7 Allotment of tasks to individuals and establishing relationship among persons working in a group
Unit– III Directing and Controlling at supervisory level	3a. Justify the chosen need of directions and instructions to the subordinates to complete the specified task. 3b. Select the feasible set of instructions to complete the given simple task, with justification 3c. Predict the possible mistakes for completing the given simple activity. 3d. Describe the managerial control	**Directing at supervisory level** 3.1 Needs for directions and instructions to subordinates; Completeness and feasibilities of instructions 3.2 Personal counselling advanced predictions of possible mistakes. 3.3 Elaborating decisions, laying disciplinary standards in overall working **Controlling at supervisory level**

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	actions and remedial measures required to be taken for completing the given task successfully.	3.4 Managerial control; Understanding team and link between various departments in respect of process and quality standards; Steps in control process 3.5 Controlling methods; Control over the performance in respect of quality, quantity of production, time and cost. Measuring performance, comparing with standards, correcting unfavorable deviations.
Unit – IV Safety Management	4a. State the general safety norms required to be taken in the given case. 4b. Suggest preventive measures of plant activities in the given situation. 4c. Describe the safe procedural steps required to be taken to prevent the given the type of accident. 4d. Prepare a work permit in to conduct the given maintenance activity. 4e. Explain the causes of the specified type of accident in the given situation. 4f. Prepare the specifications of the firefighting equipment required for the given type of fire.	4.1 Need for safety management measures 4.2 General safety norms for an industrial unit; Preventive measures. 4.3 Definition of accident, types of industrial accident; Causes of accidents; 4.4 Fire hazards; Fire drill. 4.5 Safety procedure 4.6 Work permits.
Unit – V Legislative Acts	5a. Explain the purpose of the act 5b. Explain the main provisions of the various acts and important definition.	5.1 Necessity of acts, Important definition and Main provisions of acts. 5.2 Industrial Acts: a. Indian Factory Act b. Industrial Dispute Act c. Workman Compensation Act d. Minimum Wages Act

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to management	12	06	06	04	16

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
	concepts and managerial skills					
II	Planning and organizing at supervisory level	08	04	06	04	14
III	Directing and controlling at supervisory level	08	04	06	04	14
IV	Safety Management	08	04	06	04	14
V	Legislative Acts	12	02	06	04	12
Total		**48**	**20**	**30**	**20**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Write assignments based on the theory taught in classrooms. Assignments consist of ten questions having long answers including charts, symbols, drawing, observations etc.
b. Prepare/Download information about various industrial acts.
c. Visit to any Manufacturing industry and prepare a report consisting of:
    i. Organization structure of the organization/ Dept.
    ii. Safety measures taken in organization.
    iii. Mechanism to handle the disputes.
    iv. Any specific observation you have noticed.
d. Give seminar on relevant topic.
e. Undertake micro-projects.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Demonstrate students thoroughly before they start doing the practice.

g. Encourage students to refer different websites to have deeper understanding of the subject.
h. Observe continuously and monitor the performance of students in Lab.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. Study of management principles applied to a small scale industry.
b. Study of management principles applied to a medium scale industry.
c. Study of management principles applied to a large scale industry.
d. Prepare case studies of Safety measures followed in different types of organization.
e. Study of measures to be taken for ensuring cyber security.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Management and entrepreneurship	Veerabhadrappa, Havinal	New age international publishers, New Delhi, 2014: ISBN: 978-81-224-2602-1
2	Principles of management	Chaudhry omvir Singh prakash	New Age international publishers, 2012, New Delhi ISBN: 978-81-224-3039-4
3	Industrial Engineering and management	Dr. O. P. Khanna	Dhanpath ray and sons, New Delhi
4	Industrial Engineering and management	Banga and Sharma	Khanna Publication, New Delhi

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. https://www.versesolutions.com/
b. https://www.books.google.co.in/books?isbn=817758412X
c. https://www. www.educba.com › Courses › Business › Management

Program Name : **Electrical Engineering Program Group**

Program Code : **EE/EP/EU**

Semester : **Fifth**

Course Title : **Industrial AC Machines**

Course Code : **22523**

1. RATIONALE

Induction motors are widely used in various industries as drive motors for variety of machines. Due to its rugged construction, smoother and efficient operation, it has replaced dc motors in variety of applications. By reason of the important role played by synchronous machines (alternators and motors) in the electrical generation systems, the electrical technologistsalso need to be well versed in the construction and working of these machines. Further fractional horse power (FHP) machines are used in many control circuits of automation systems. Since technologists are expected to maintain industrial systems involving these machines it is highly essential to provide them necessary knowledge about construction and operation of these machines. This course therefore, aims to equip the students with the fundamental requirements of using these machines in different applications.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Use relevant Induction, Synchronous and FHP Machines for different electrical engineering applications.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Use the relevant three phase induction motor (IM) for different applications.
b) Use the relevant single phase induction motors in different applications.
c) Use the relevant three phase alternator for different load conditions.
d) Use suitable synchronous motors in different applications.
e) Use suitable Fractional HP motors for different applications.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory							Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
4	-	2	6	3	70	28	30*	00	100	40	25#	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

***Legends:* L**-*Lecture;* **T** – *Tutorial/Teacher Guided Theory Practice;* **P** -*Practical;* **C** -*Credit*
ESE -*End Semester Examination;* ***PA*** - *Progressive Assessment*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

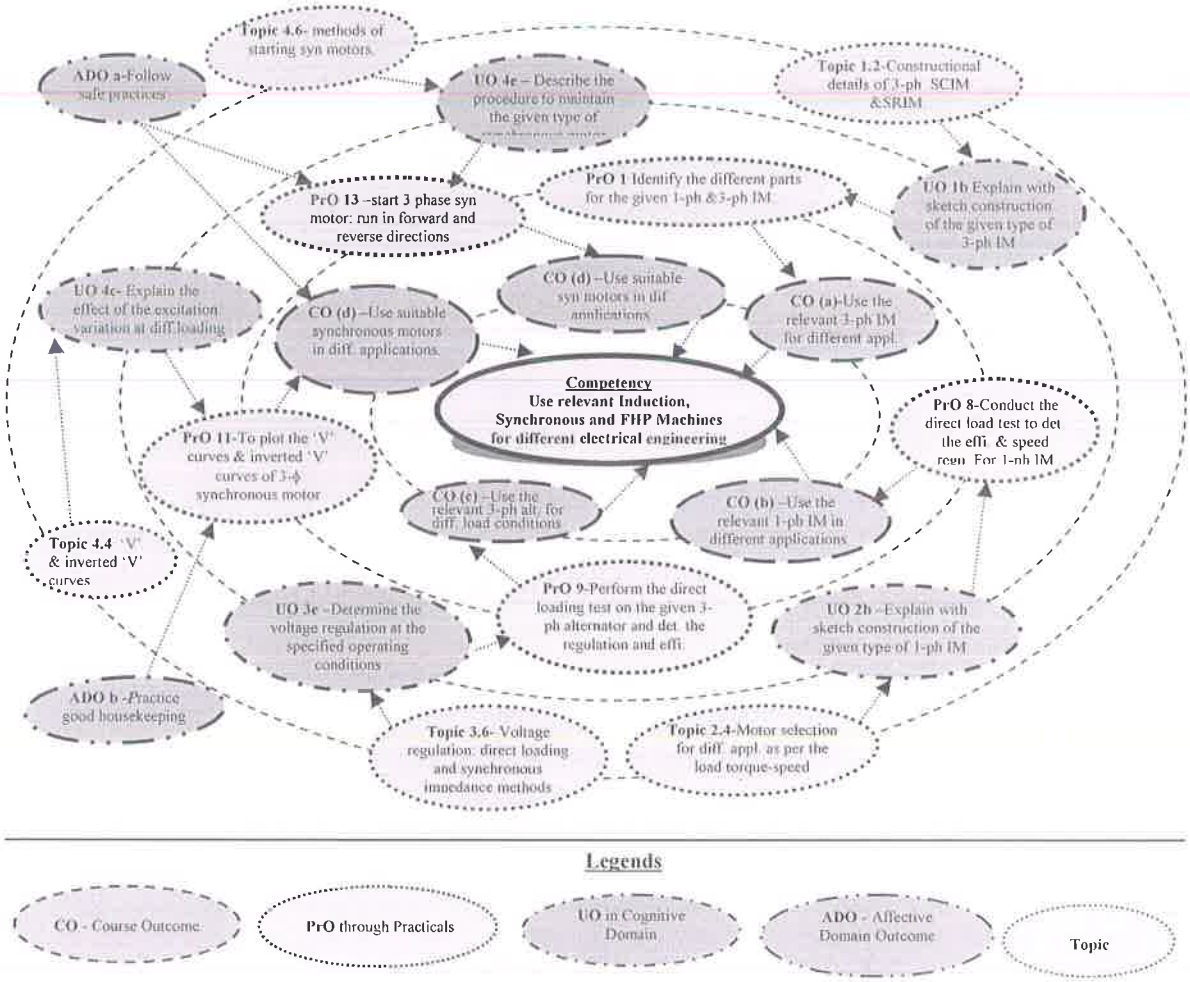


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Identify the different parts (along with function and materials) for the given single phase and three phase induction motor.	I/II	02*
2	Connect and run the three phase squirrel cage induction motors (in both directions) using the DOL, star-delta, auto-transformer starters (any two)	I	02*
3	Perform the direct load test on the three phase squirrel cage induction motor and plot the i) efficiency versus output, ii) power factor versus output, iii) power factor versus motor current and iv) torque – slip/speed characteristics.	I	02*
4	Conduct the No-load and Blocked-rotor tests on given 3-ϕ squirrel	I	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	cage induction motor and determine the equivalent circuit parameters.		
5	Conduct the No-load and Blocked-rotor tests on given 3-ϕ squirrel cage induction motor and plot the Circle diagram.	I	02*
6	Control the speed of the given three phase squirrel cage/slip ring induction motor using the applicable methods: i) auto-transformer, ii) VF.	I	02*
7	Control the speed of the given three phase slip ring induction motor using rotor resistance starter.	I	02*
8	Control the speed of the given three phase induction motor using pole changing methods	I	02#
9	Identify different windings & components of single phase capacitor start Induction Run motor & Connect to start & reverse the direction of rotation	II	02#
10	Conduct the direct load test to determine the efficiency and speed regulation for different loads on the given single phase induction motor; plot the efficiency and speed regulation curves with respect to the output power.	II	02*
11	Perform the direct loading test on the given three phase alternator and determine the regulation.	III	02*
12	Determine the regulation of the given three phase alternator from OC and SC tests (Synchronous impedance method)	III	02*
13	Start 3 phase synchronous motor & run synchronous motor in forward & reverse direction	IV	02*
14	Conduct the test on load or no load to plot the 'V' curves and inverted 'V' curves (at no-load) of 3-ϕ synchronous motor.	IV	02*
	Total		**28**

Minimum one to be performed.

Note

i. *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 10 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. *The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

S.No.	Performance Indicators	Weightage in %
a.	Preparation of experimental set up	20
b.	Setting and operation	20
c.	Safety measures	10
d.	Observations and Recording	10
e.	Interpretation of result and Conclusion	20
f.	Answer to sample questions	10
g.	Submission of report in time	10
Total		**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safety practices.
b. Practice good housekeeping.
c. Practice energy conservation.
d. Demonstrate working as a leader/a team member.
e. Follow ethical Practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organizing Level' in 2nd year
- 'Characterizing Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTSREQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Induction motors 3 hp/ 5hp, 415 V, 50 Hz, 1440 RPM squirrel cage type	1 to 6, 8
2	Induction motors 3 hp/ 5hp, 415 V, 50 Hz, 1440 RPM slip ring type.	1, 6, 7
3	Ammeters MI Type: AC/DC 0-5-10Amp	1 to 12, 14
4	Voltmeter MI Type: AC/DC, 0-150/300V, 0-250/500V	1 to 12, 14
5	Wattmeter: Three phase double element 5/10Amp, 250/500V or sr no 6	1 to 12, 14
6	Wattmeter: Single phase, single element 2.5/5Amp, 200/400V,	1 to 12, 14
7	Low power factor wattmeter : Single phase, 2.5/5Amp, 250/500V	4, 5
8	Auto transformer: 3-phase, 5kVA, 0 to 500V.	2, 4, 5, 6.
9	Load bank: Resistive, 3-phase, 5kW, 415V	11
10	Load bank: inductive, 3-phase, 2 to 5kVAR, 415V	11
11	Load bank: capacitive, 3-phase, 2 to 5kVAR, 415V	11
12	Star- delta, auto transformers starters	2 to 6.
13	Clip on meter (amp, volts) digital/analog	All
14	Digital multimeter4 ½ digit with standard make for measurements	All
15	Tachometers: contact and non-contact types: 100 to 10000 RPM	all
16	Brake load or other suitable means to load motors with suitable measurement facilities of powers (mechanical).	3, 8
17	3 phase alternator: 5kVA, 415 V, 50 Hz, 4 pole, 1500 RPM.	9, 10
18	3 phase synchronous motor: 3hp, 415 V, 50 Hz, 1500 RPM.	11

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit- I Three Phase Induction Motor	1a. Explain with sketch working of the given three phase induction motor. 1b. Explain with sketch construction of the given type of three phase induction motor. 1c. Derive the expressions for rotor induced emf and torque of three phase induction motor for different operating conditions. 1d. Explain with sketch the operation of the motor in the specified quadrant. 1e. Determine the specified performance parameters of the motor. 1f. Explain with sketch the operation of the relevant starter for the given motor. 1g. Explain the specified method of speed control. 1h. Suggest the relevant IM for the specified different given applications.	1.1 Working principle: production of rotating magnetic field, Synchronous speed, rotor speed and slip. 1.2 Constructional details of 3 phase induction motors: Squirrel cage induction motor and Slip ring induction motor. 1.3 Rotor quantities: frequency, induced emf, power factor at starting and running condition. 1.4 Characteristics of torque versus slip (speed), Torques: starting, full load and maximum with relations among them. 1.5 Induction motor as a generalized transformer with phasor diagram. 1.6 Four quadrant operation, Power flow diagram 1.7 Starters: need and types; stator resistance, auto transformer, star delta, rotor resistance and soft starters. 1.8 Speed control methods: stator voltage, pole changing, rotor resistance and VVVF. 1.9 Motor selection for different applications as per the load torque-speed requirements. 1.10 Maintenance of three phase induction motors
Unit– II Single phase induction motors	2a. Explain with sketch working of the given single phase induction motor. 2b. Explain with sketch construction of the given type of single phase induction motor. 2c. Suggest the relevant single phase motor for the specified different applications. 2d. Describe the procedure to maintain given type of single phase induction motor.	2.1 Double field revolving theory, principle of making these motors self start. 2.2 Construction and working: Resistance start induction run, capacitor start induction run, capacitor start capacitor run, shaded pole, repulsion type, series motor, universal motor, hysteresis motor. 2.3 Torque-speed characteristics for all of the above motors. 2.4 Motor selection for different applications as per the load torque-speed requirements. 2.5 Maintenance of single phase induction motors
Unit-III Three phase alternators	3a. Explain with sketch working of the given type of alternator 3b. Explain with sketch construction of the given type	3.1. Principle of working, moving and stationary armatures. 3.2. Constructional details: parts and their functions, rotor constructions.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	of alternator. 3c. Compare the rotor constructions of the given types of alternators. 3d. Determine the voltage regulation at the specified operating conditions. 3e. Describe the procedure to maintain the given type f three phase alternators.	Windings: Single and Double layer. 3.3. E.M.F. equation of Alternator with numerical by considering short pitch factor and distribution factor. 3.4. Alternator loading: Factors affecting the terminal voltage of alternator; Armature resistance and leakage reactance drops. 3.5. Armature reaction at various power factors and synchronous impedance. 3.6. Voltage regulation: direct loading and synchronous impedance methods. 3.7. Maintenance of alternators
Unit –IV Synchronous motors	4a. Explain with sketch working of the given type of synchronous motor. 4b. Explain with sketch construction of the given type synchronous motor. 4c. Explain the effect of the excitation variation for the given loading conditions.. 4d. Suggest suitable synchronous motors for given applications. 4e. Describe the procedure to maintain the given type of synchronous motor	4.1 Principle of working /operation, significance of load angle. 4.2 Torques: starting torque, running torque, pull in torque, pull out torque. 4.3 Synchronous motor on load with constant excitation (numerical), effect of excitation at constant load (numerical). 4.4 V-Curves and Inverted V-Curves. 4.5 Hunting and Phase swinging. 4.6 Methods of Starting of Synchronous Motor. 4.7 Losses in synchronous motors and efficiency (no numericals). 4.8 Applications areas.
Unit-V Fractional horse power motors (FHP)	5a. Explain the working principle of the given FHP motor. 5b. Explain construction of the given type of FHP. 5c. Suggest relevant FHP motor for the specified application. 5d. Describe the procedure to maintain the given type of FHP motor	5.1.Construction and working: Synchronous Reluctance Motor, Switched Reluctance Motor, BLDC , Permanent Magnet Synchronous Motors, stepper motors, AC and DC servomotors. 5.2.Torque speed characteristics of above motors. 5.3. Applications of above motors.

Note:To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'

9. SUGGESTED SPECIFICATION TABLE FORQUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Three phase induction motors	18	02	08	10	20
II	Single phase induction motors	12	04	04	06	14

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
III	Three phase alternators	14	02	06	08	16
IV	Synchronous motors	12	02	04	06	12
V	Fractional horse power motors (FHP)	08	02	02	04	08
Total		**64**	**12**	**24**	**34**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct any two of the following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Collect information/product brochures on three phase induction motors.
b) Collect information/product brochures on single phase induction motors.
c) Collect information/product brochures on stepper motors.
d) Collect information/product brochures on AC servomotors.
e) Collect information/product brochures on DC servomotors.
f) Collect information/product brochures on synchronous motors.
g) Collect information/product brochures on different types of alternators.
h) Collect information/product brochures on AC servomotors.
i) Collect information in brochures or other means for setting up VVVF drives.
j) Determine the full load torque form the name plate specifications of induction motors in the laboratory or other places.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c) About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d) With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e) Guide student(s) in undertaking micro-projects.
f) Flash/Animations to explain working of Electric Locomotive and Elevatos.
g) Pre-guided visits to, railway stations and Elevator manufacturing componay toobserve operation.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project is group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that she/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

a. **Induction motors:** Prepare report on market survey of various single and three phase induction motors(specification, manufacturer, cost, area of use)
b. **Synchronous motors:** Prepare report market survey of various synchronous motors(specification, manufacturer, cost, area of use)
c. **Alternators:** Prepare report market survey of various synchronous generators (specification, manufacturer, cost, area of use)
d. **FHP motors:** Prepare report on market survey of various special purpose FHP motors(specification, manufacturer, cost, area of use)

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	A text book of Electrical technology Vol II	Theraja B. L. Theraja A. K.	S. Chand and Co. New Delhi ISBN 10: 8121924375
2	Electrical Machines	Bhattacharya S. K.	Tata McGraw Hill, New Delhi ISBN 9780075415396
3	Electrical Machines	Kothari D. P. and Nagrath I. J.	McGraw Hill, New Delhi ISBN13: 978-9352606405
4	Basic Electrical Engineering	Mittle V. N.	McGraw Hill, New Delhi, 2014 ISBN 9780074516324
5	Special Purpose Electrical Machines	Sen S. K.	Khanna Publishers, New Delhi, ISBN- 9788174091529
6	Special Electrical Machines	Janardanan E. G	Prentice Hall India, New Delhi ISBN: 9788120348806
7	Electrical Technology	Hughes E.	ELBS
8	Electrical Technology	Cotton H.	ELBS

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a) www.nptel.iitm.ac.in
b) www.howstuffworks.com/
c) www.vlab.com
d) www.khanacademy.com
e) https://freevideolectures.com/course/2335/basic-electrical-technology/35
f) https://freevideolectures.com/course/2335/basic-electrical-technology/36

g) https://freevideolectures.com/course/2335/basic-electrical-technology/37
h) https://freevideolectures.com/course/2335/basic-electrical-technology/38
i) https://freevideolectures.com/course/2335/basic-electrical-technology/39
j) https://www.youtube.com/watch?v=fYV_siCu_RI
k) https://www.explainthatstuff.com/how-stepper-motors-work.html
l) https://www.edn.com/design/sensors/4406682/Brushless-DC-Motors---Part-I--Construction-and-Operating-Principles
m) https://www.youtube.com/watch?v=bCEiOnuODac


MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION

Program Name : Electrical Engineering Program Group

Program Code : EE/EP/EU

Semester : Fifth

Course Title : Switchgear and Protection

Course Code : 22524

1. RATIONALE

In spite of all care and precautions taken in the design, installation and operation of Power system and power equipment, abnormal conditions and faults do occur in the system. Some fault such as short circuits can prove highly damaging, not only to the components but also to the entire power system. However continuity of power supply is needed in day to day life.So study of switchgears and protection schemes is essential. It is expected that the understanding of operational principles, selection and testing aspects of switchgear and protection system must be known by students which ultimately help them to maintain the reliability of electric supply while performing their duties as a supervisor or a technician in substation, manufacturing industries and public service utilities.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Maintain switchgear and protection schemes used in electrical power systems.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a. Identify various types of faults in power system.
b. Select suitable switchgears for different applications.
c. Test the performance of different protective relays.
d. Maintain protection systems of alternators and transformers.
e. Maintain protection schemes for motors and transmission lines.
f. Maintain protection schemes for power system against over voltages.

4.TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory							Practical				
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
L	T	P			Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
4	-	2	6	3	70	28	30*	00	100	40	25#	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **ESE** -End Semester Examination; **PA** - Progressive Assessment*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

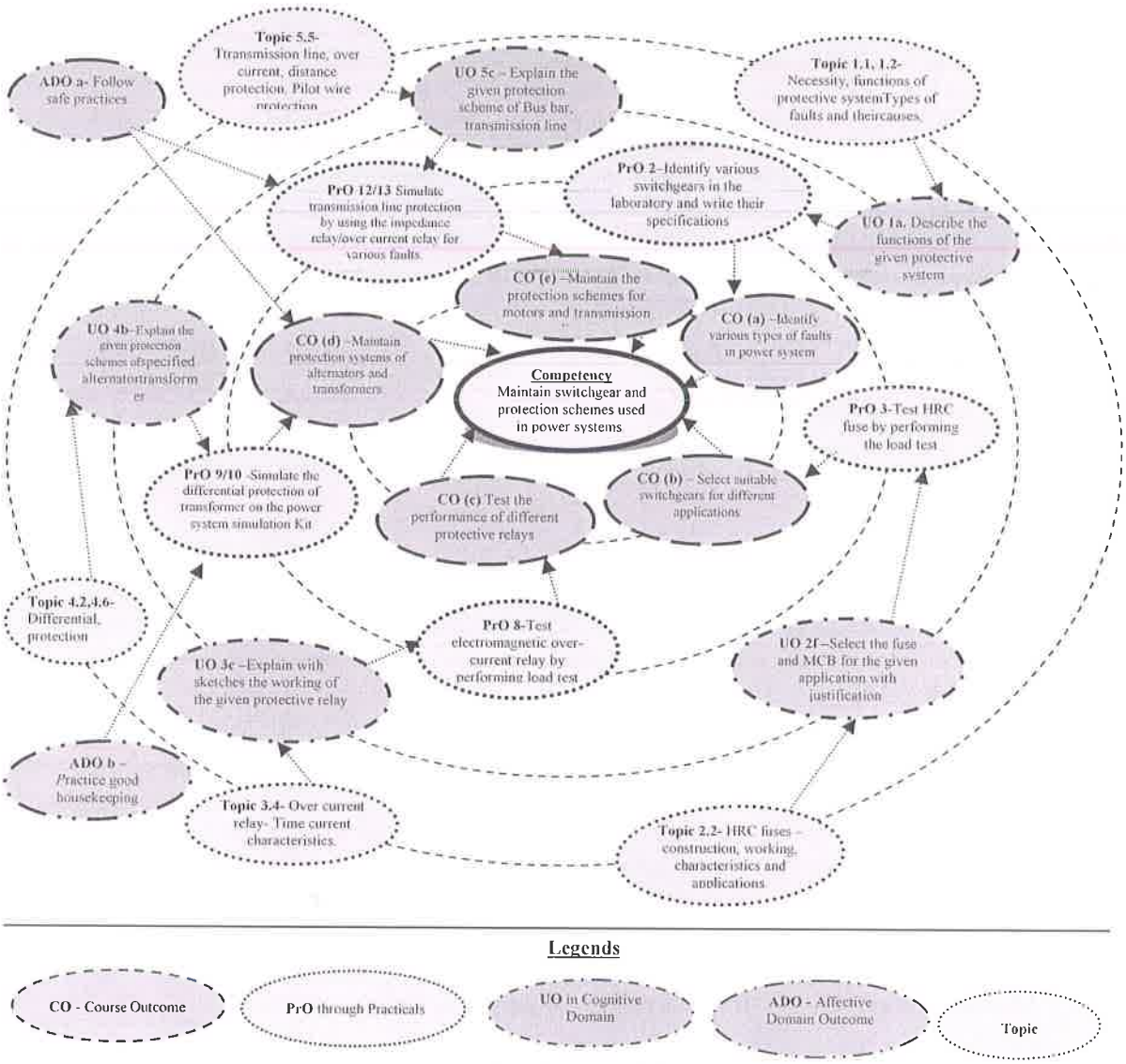


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Use switchgear testing kits.	I	02*
2	Identify various switchgears in the laboratory and write their specifications.	I	02*
3	Test HRC fuse by performing the load test.	II	02*
4	Test MCB by performing the load test	II	02*
5	Dismantle MCCB/ELCB and identify various parts.	II	02*
6	Video show on /Dismantle ACB/VCB and identify different parts.	II	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
7	Carry out plug and time setting (with PSM, TSM) of induction type electromagnetic relay.	III	02*
8	Test electromagnetic over-current relay by performing load test.	III	02*
9	Simulate differential protection scheme forO/	IV	02*
10	Simulate differential protection scheme for transformer on the power system simulation Kit. Part- II	IV	02
11	Test the working of the single phasing preventer using a three phase induction motor.	V	02*
12	Simulate transmission line protection by using the impedance relay/over current relay for various faults. (On transmission line protection simulation Kit). Part- I	V	02
13	Simulate transmission line protection by using the impedance relay/over current relay for various faults. (On transmission line protection simulation Kit). Part- II	V	02
14	Video show on/Dismantle Thyrite type arrester and identify different parts.	VI	02*
15	Video show on/Perform neutral earthing at different substations / locations. Part- I	VI	02*
16	Video show on/Perform neutral earthing at different substations / locations. Part- II	VI	02*
	Total		**32**

Note

i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S.No.	Performance Indicators	Weightage in %
a.	Preparation of experimental set up	20
b.	Setting, collection of data and operation	20
c.	Safety measures	10
d.	Observations and Recording	10
e.	Interpretation of result and Conclusion	20
f.	Answer to sample questions	10
g.	Submission of report in time	10
Total		**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safety practices.
b. Practice good housekeeping.
c. Practice energy conservation.
d. Demonstrate working as a leader/a team member.

e. Follow ethical Practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'CharacterisingLevel' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTSREQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Switchgear testing kit–(0-500V),(1-100A), variable AC and DC, with timer	1, 3,4
2	Cut sections and charts of MCB, MCCB, ELCB, HRC Fuse, ACB, Contactors and Induction type Over current/Earth fault, Microprocessor, Numerical relays.	2
3	HRC Fuses:5A, 10A, 16A, 32A, 100A.	3
4	MCB (SP/SPN/TP/TPN): 5A, 10A, 16A, 20A	4
5	MCCB: 32A, 63A.	5
6	ACB or VCB: 200A.	6
7	Over-current Induction type electromagnetic relay: 10A	7,8
8	Transformer protection simulation Kit.	9,10
9	Three phase induction motor with Single phasing preventer: 3HP.	11
10	Transmission line protection simulation Kit.	12,13
11	Thyrite type Lightning arrester.	14
12	Earth tester 500 V, hand driven or digital type.	15, 16

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– I Basics of protection	1a. Describe the functions of elements of the given protective system. 1b. Explain with sketches the given types of faults and abnormalities in a power system. 1c. Explain with sketches the concept of the Backup protection for the given protection zone. 1d. Calculate the short circuit	1.1 Necessity, functions of protective system. 1.2 Normal and abnormal conditions. 1.3 Types of faults and their causes. 1.4 Protection zones and backup protection 1.5 Short circuit fault calculations in lines fed by generators through transformers 1.6 Need of current limiting reactors and their arrangements.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	currents of symmetrical faults. 1e. Select suitable current limiting reactors for the given situation with justification.	
Unit– II Circuit Interrupti on Devices	2a. Explain with sketches the operation of given isolators. 2b. Explain with sketches the given terms related to the specified fuse (s). 2c. Explain with sketches arc formation, high resistance and zero current interruption in the given type of circuit breaker. 2d. Explain with sketches the operation of the given circuit breaker(s). 2e. Compare the given circuit interrupting devices on the specified parameters. 2f. Select the relevant fuse and MCB for the given application with justification. 2g. Select the relevant circuit breaker and MCCB for the given application with justification. 2h. Explain the Insulation coordination for the given installation/machine.	2.1 Isolators- Vertical break, Horizontal break and Pantograph type. 2.2 HRC fuses – Construction, working, characteristics and applications. 2.3 Arc formation process, methods of arc extinction (High resistance and Low resistance). 2.4 Arc voltage, Recovery voltage, Re-striking voltage, RRRV. 2.5 HT circuit breakers (Sulphur-hexa Fluoride (SF6), Vacuum circuit breaker) - Working, construction, specifications and applications. 2.6 L.T. circuit breaker(Air circuit breakers (ACB), Miniature circuit breakers (MCB), Moulded case circuit breakers (MCCB), MPCB , RCBO and Earth leakage circuit breaker(ELCB)) - Working and applications. 2.7 Selection of LT and HT circuit breakers (ratings). 2.8 Selection of MCCB for motors. 2.9 Gas insulated switchgear. 2.10 Insulation Coordination : Type1 & Type2 coordination 2.11 Introduction to ETAB
Unit-III Protective Relays	3a. Explain the given terms related to protective relays. 3b. Explain need of the given type of relay in power system. 3c. Explain with sketches the working of the given protective relay. 3d. Select relevant protective relay for required application with justification. 3e. Explain the steps for the specified settings of the given relay.	3.1 Fundamental quality requirements: Selectivity, Speed, Sensitivity, Reliability, Simplicity, Economy. 3.2 Basic relay terminology- Protective relay, Relay time, Pick up, Reset current, current setting, Plug setting multiplier, Time setting multiplier. 3.3 Protective relays: Electromagnetic disc relay operation, Thermal relay. Block diagram and working of Static relay, over voltage relay. 3.4 Over current relay-Time current characteristics. 3.5 Microprocessor based protection relays: Block diagram, workingand protection features. 3.6 Distance relaying- Principle

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		3.7 Directional relay: Need and operation with block diagram. 3.8 Operation of current and voltage differential relay.
Unit –IV Protection of Alternator and Transformer	4a. Describe the causes and remedies of the given faults in the specified machine. 4b. Explain with sketches the given protection schemes of the specified machine. 4c. Calculate CT ratio of the specified transformer protection scheme. 4d. Calculate percentage of winding protected for the specified alternator.	**Alternator Protection** 4.1 Faults 4.2 Differential protection : over current, earth fault, overheating and field failure protection. 4.3 Reverse power protection. **Transformer Protection** 4.4 Faults. 4.5 Differential, over current, earth fault, over heating protection. 4.6 Limitations of differential protection. 4.7 Buchholz relay: Construction, operation, merits and demerits. 4.8 Introduction to Microprocessor based transformer protection.
Unit-V Protection of Motors, Bus-bar And Transmission Line	5a. Describe the causes and remedies of the given faults in specified equipment. 5b. Explain with sketches the given protection scheme of the specified motor. 5c. Explain with sketches the given protection scheme of given component of the power system.	**Motor** 5.1 Faults. 5.2 Short circuit protection, Overload protection, Single phase preventer. **Bus bar and Transmission line** 5.3 Faults on Bus bar and Transmission Lines. 5.4 Bus bar protection: Differential and Fault bus protection. 5.5 Transmission line: Over current, Distance and Pilot wire protection. 5.6

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'

9. SUGGESTED SPECIFICATION TABLE FORQUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basics of Protection.	08	04	04	02	10
II	Circuit Interrupting Devices.	16	04	06	06	16
III	Protective Relays.	16	04	06	06	16
IV	Protection of Alternator and Transformer.	16	04	06	06	16
V	Protection of Motor, Busbar and Transmission Line.	08	02	04	06	12
Total		**64**	**18**	**26**	**26**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Collect specifications of different switchgear equipment used in electrical power system through market survey/visit and write a technical report.
b) Visit 400/220/132/66/33kV substation and take the help of sub-station in-charge to understand various switchgears, protective schemes and occurrences of faults.
c) Collect data of different protective schemes used for alternator, transformer, bus bar and transmission lines through internet/ industrial visit.
d) Write all the safety precautions which are to be taken while working with different switchgears and protective schemes.
e) Collect data of Lightning arresters used for substation through internet/ industrial visit.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c) About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d) With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e) Guide student(s) in undertaking micro-projects.
f) Correlate subtopics with power system protection and electrical equipments.
g) Use proper equivalent analogy to explain different concepts.
h) Use Flash/Animations to explain various Switchgears and protection schemes.
i) Use open source MATLAB models to explain different concepts of protective schemes.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to

maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects isgiven here. Similar micro-projects could be added by the concerned faculty:

a) **Installation and commissioning of MCB:**Calculate load current anddecide specifications of MCBsrequired for a load circuit of 5 kW or more and install it.
b) **Case study of past major grid power failure:**Prepare a report after surveying in the power failure or present the findings.
c) **Installation and commissioning of ELCB:** Calculate load current and decide specifications of ELCB required for a residential load circuit upto 5 kW and install it.
d) **Alternator/Transformer protection schemes:**Prepare power point presentation on Alternator/Transformer protection schemes used in generating station/substations.
e) **Motor protection schemes:** Prepare the detailed protection schemes for the 20HP motor.

13. SUGGESTED LEARNING RESOURCES:

S. No.	Title of Book	Author	Publication
1	Principles of Power System	Mehta V. K ; Rohit Mehta .	S.Chand and Co., New Delhi., 2016 ISBN: 978-81-2192-496-2.
2	Switchgear and Protection	Rao.Sunil S.	Khanna Publishers, New Delhi, 2015 ISBN: 978-81-7409-232-3.
3	Switchgear and Power System Protection	Singh, R. P.	PHI Learning, New Delhi,2015 ISBN: 978-81-203-3660-5.
4	Switchgear and Protection	Gupta. J. B.	S. K. Kataria and Sons, New Delhi, 2015ISBN: 978-93-5014-372-8.
5	Switchgear and Protection	Veerapan, N., Krishnamurty, S. R.	S .Chand and Co., New Delhi. 2014 ISBN: 978-81-2193-212-7.
6	Power System Protection and Switchgear	Ram, Badri Vishwakarma D. N.	McGraw-Hill, New Delhi. 2015 ISBN : 978-07-107774-X

14. SOFTWARE/LEARNING WEBSITES

a. www.cgglobal.com
b. www.youtube.com /switchgears
c. www.dreamtechpress.com /eBooks
d. www.nptelvideos.in/electrical engineering/ relays
e. www.electrical4u.com
f. www.en.wikipedia.org
g. www.abb.co.in/ProductGuide/
h. https://play.google.com/store/apps/



Program Name : **Electrical Engineering Program Group**

Program Code : **EE/EP/EU**

Semester : **Fifth**

Course Title : **Energy Conservation and Audit**

Course Code : **22525**

1. RATIONALE

The pressure of Technological development in all sectors on the Renewable energy sources has led to the growingthe cost of energy around the world. Efficient and judicious use of the available energy sources would lead to the easing of such pressures and drastic decrease in the operating costs of the organizations and industries. Thus it is necessary to save and conserve energy to the maximum possible extent. Also essential theoretical knowledge and practical skills about the concept of energy conservation is to be provided through different approaches, project management and economics accepts. The process of energy audit will help to identify the various possible avenues in which savings of energy can be effectively adopted. This course makes the diploma holder well acquainted in the techniques of energy conservation in the fields of engineering. It also introduces him to the energy audit procedures.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Undertake energy conservation and energy audit.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a. Interpret energy conservation policies in India.
b. Implement energy conservation techniques in electrical machines.
c. Apply energy conservation techniques in electrical installations.
d. Use Co-generation and relevant tariff for reducing losses in facilities.
e. Carryout energy audit for electrical system.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

Legends: ***L****-Lecture;* ***T*** *– Tutorial/Teacher Guided Theory Practice;* ***P*** *-Practical;* ***C*** *– Credit,* ***ESE*** *-End Semester Examination;* ***PA*** *- Progressive Assessment*

1. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

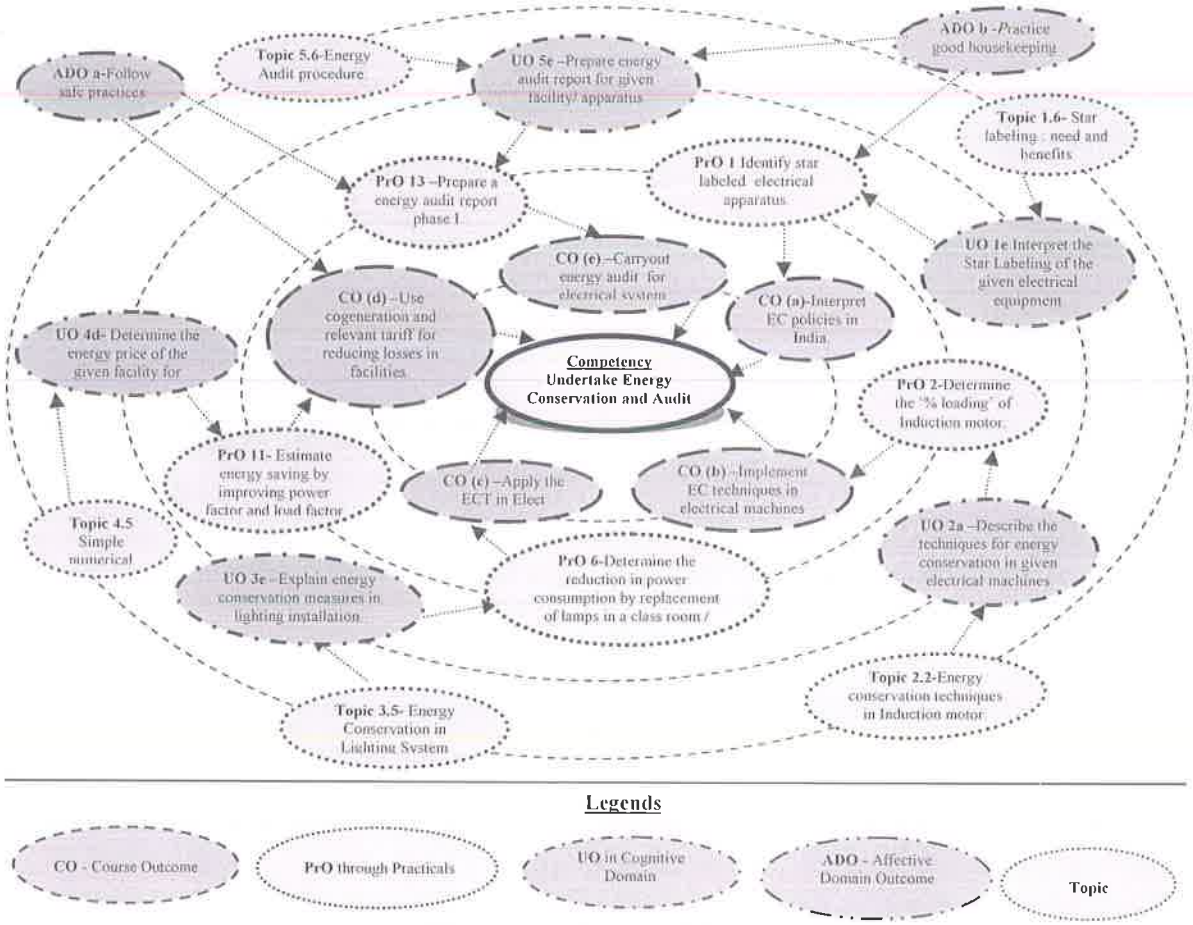


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs(i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Identify star labeled electrical apparatus andcompare the data for various star ratings.	I	02*
2	Determine the '% loading' along with the related efficiency for different loads of given Induction motor (30 to 110 percent in steps of 10%).	II	02*
3	Determine the reduction in power consumption in star mode operation of Induction motor compared to delta mode.	II	02*
4	Use APFC unit for improvement of p. f. of electrical load.	II	02
5	Compare power consumption of different types of TL with choke, electronic ballast and LED lamps by direct measurements.	III	02
6	Determine the reduction in power consumption by replacement of lamps in a class room / laboratory.	III	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
7	Determine the reduction in power consumption by replacement of Fans and regulators in a class room / laboratory.	III	02*
8	Collect electricity bill of an industrial consumer and suggest suitable tariff for energy conservation and its impact on energy bill.	IV	02
9	Collect electricity bill of a commercial consumer and suggest suitable tariff for conservation and reduction of its energy bill.	IV	02*
10	Collect electricity bill of a residential consumer and suggest suitable means for conservation and reduction of the energy bill.	IV	02*
11	Estimate energy saving by improving power factor and load factor for given cases.	IV	02
12	Prepare a sample energy audit questionnaire for thegiven industrial facility.	V	02*
13	Prepare an energy audit report (phase-I)	V	02*
14	Prepare an energy audit report (phase-II)	V	02*
15	Prepare an energy audit report (phase-III)	V	02*
	Total		**30**

Note

i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S.No.	Performance Indicators	Weightage in %
a.	Preparation of experimental set up	20
b.	Setting and operation	20
c.	Safety measures	10
d.	Observations and Recording	10
e.	Interpretation of result and Conclusion	20
f.	Answer to sample questions	10
g.	Submission of report in time	10
Total		**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safety practices.
b. Practice good housekeeping.
c. Practice energy conservation.
d. Work as a leader/a team member.
e. Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of

practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organizing Level' in 2nd year
- 'Characterizing Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	Pr O. No.
1	Induction motor (3phase /1 phase)	2,3
2	Ammeters MI Type: AC/ DC 0-5-10Amp	2,3
3	Voltmeter MI Type: AC/DC, 0-150/300V, 0-250/500V	2,3
4	Wattmeter: Three phase double element 5/10Amp, 250/500V	2,3
5	Wattmeter: Single phase, single element 2.5/5Amp, 200/400V,	5,6,7
6	Low power factor wattmeter : Single phase, 5/10Amp, 250/500V	4
7	Three phase Power factor meters: AC, 415V, 50 Hz , 5-10 Amp	1
8	Load bank: Resistive, 3-phase, 5kW, 415V	4
9	Automatic power factor controller (APFC)	4
10	Star- delta convertor	3
11	Lux meter	13,14
12	Clip on meter (amp, volts) digital/analog	5,13,14
13	FTL,CFL,LED of different ratings	5
14	Electric choke, Electronic ballast	5
15	Electric regulators ,Electronic regulators	7

8. UNDERPINNING THEORY COMPONENTS

The following topicsare to betaught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit-I Energy Conservation Basics	1a. Interpret the given energy conservation clause(s) 1b. Explain the specified BEE role(s) 1c. Explain the specified MEDA role(s) 1d. Interpret the Star Labeling of the given electrical equipment	1.1 Energy Scenario: Primary and Secondary Energy, Energy demand and supply, National scenario. 1.2 Energy conservation and Energy audit; concepts and difference 1.3 Energy Conservation Act 2001; relevant clauses of energy conservation 1.4 BEE and its Roles 1.5 MEDA and its Roles 1.6 Star Labeling: Need and its benefits.
Unit– II Energy Conservation in	2a. Describe the techniques forenergy conservation in the given electrical machine.	2.1 Need for energy conservation in induction motor and transformer. 2.2 Energy conservation techniques in induction motor by:

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Electrical Machines	2b. Explain with sketches the working principle of the given energy conservation equipment. 2c. Select relevant energy conservation equipment for given electrical machine with justification. 2d. Describe the technique(s) to improve the performance efficiency of the given type of electrical machine(s). 2e. Describe with sketches the construction and applications of the specified energy efficient transformer.	a) Improving Power quality. b) Motor survey c) Matching motor with loading. d) Minimizing the idle and redundant running of motor. e) Operating in star mode. f) Rewinding of motor. g) Replacement by energy efficient motor i) Periodic maintenance 2.3 Energy conservation techniques in Transformer. a) Loading sharing b) Parallel operation c) Isolating techniques d) Replacement by energy efficient transformers e) Periodic maintenance 2.4 Energy Conservation Equipment : Soft starters, Automatic star delta convertor, Variable Frequency Drives, Automatic p. f. controller (APFC) , Intelligent p. f. controller (IPFC), Active Harmonic filters (AHF). 2.5 Energy efficient motor; significant features, advantages, applications and limitations. 2.6 Energy efficient transformers, amorphous transformers; epoxy Resin cast transformer / Dry type of transformer.
Unit-III Energy conservation in Electrical Installation systems	3a. Interpret losses in the given Power system 3b. Explain the method to reduce the specifiedtechnical loss in the given electrical installation. 3c. Explain the method to reduce the specified commercial loss in the given electrical installation. 3d. Select the relevant energy conservation equipment for the given system with justification. 3e. Explain energy conservation measures for the specified lighting installation.	3.1 Aggregated Technical and commercial losses (ATC); Power system at state, regional, national and global level. 3.2 Technical losses; causes and measures to reduce by. a) Controlling I^2R losses. b) optimizing distribution voltage c) balancing phase currents d) compensating reactive power flow 3.3 Commercial losses: pilferage, causes and remedies 3.4 Energy conservation equipments: Maximum Demand Controller , kVAR Controller, Automatic Power Factor controller(APFC) 3.5 Energy Conservation in Lighting System a) Replacing Lamp sources. b) Using energy efficient luminaries. c) Using light controlled gears. d) Installation of separate transformer/ servo stabilizer for lighting.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		e) Periodic survey and adequate maintenance programs. 3.6 Energy Conservation techniques in fans, Electronic regulators.
Unit –IV Energy conservation through Cogeneration and Tariff	4a. Describe the method (s) to minimize losses in the given electrical system. 4b. Explain the method for optimum use of energy source in the given facility. 4c. Identify the cogeneration system for the given facility. 4d. Determine the energy price of the given facility for energy saving.	4.1 Co-generation and Tariff; concept, significance for energy conservation **4.2 Co-generation** a) Types of cogeneration on basis of sequence of energy use (Topping cycle, Bottoming cycle) b) Types of cogeneration basis of technology (Steam turbine cogeneration, Gas turbine cogeneration, Reciprocating engine cogeneration). c) Factors governing the selection of cogeneration system. d) Advantages of cogeneration. **4.3 Tariff** a) Types of tariff structure: LT and HT, Special tariffs; Time-off-day tariff, Peak-off-day tariff, Power factor tariff, Maximum Demand tariff, Load factor tariff and Availability Based Tariff (ABT). 4.4 Application of tariff system to reduce energy bill.
Unit-V Energy Audit of electrical systems	5a. Suggest relevant instrument (s) for the specified energy audit with justification. 5b. Develop questionnaire for the energy audit of the given facility. 5c. Develop the energy flow diagram of the given facility/ apparatus. 5d. Calculate the 'Simple Pay Back period' for the given situation. 5e. Prepare the energy audit report for the given facility/ apparatus	5.1 Energy audit (definition as per Energy Conservation act), Specific energy consumption. 5.2 Energy audit instruments and their use. 5.3 Questionnaire for energy audit projects. 5.4 Energy flow diagram (Sankey diagram) 5.5 Simple payback period, Energy Audit procedure (walk through audit and detailed audit). 5.6 Energy Audit report format.

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'*

9. SUGGESTED SPECIFICATION TABLE FORQUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Energy Conservation Basics	02	02	02	04	08
II	Energy Conservation in Electrical Machines	12	02	04	08	14
III	Energy conservation in Electrical Installation system	12	00	08	08	16
IV	Energy conservation through Cogeneration and Tariff	11	04	04	08	16
V	Energy Auditof electrical systems	11	04	04	08	16
Total		**48**	**12**	**22**	**36**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct any two of the following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Carry out internet survey (BEE/MEDAwebsite) to collect information related Energy conservation projects.
b) Collect the catalogues of star labeled equipments (min.2)
c) Write report on performance of motor after rewinding.
d) Collect videos to demonstrate working of Energy Conservation Equipments(any 2)
e) Prepare PPT presentation on energy efficient motors.
f) Prepare PPT presentation on energy efficient transformers.
g) Collect information about energy efficient luminaries.
h) Collect videos to demonstrate working of Energy Audit instruments.
i) Visit a facility adopting cogeneration systemand prepare a presentation.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c) About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d) With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.

e) Guide student(s) in undertaking micro-projects.
f) Use Flash/Animations to explain working of Energy Conservation techniques and equipment.
g) Pre-guided visits to malls, railway stations and areas adopting conservation strategies in which the students will casually observe during their visits.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project is group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that she/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects isgiven here. Similar micro-projects could be added by the concerned faculty:

a) **Energy efficient lamps:**Prepare comparative charts with ratings, cost and manufacturer details.
b) **Energy conservation campaign:** Prepare charts/slogans to create energy conservation awareness in polytechnic.
c) **Energy efficient electrical machines**: Prepare technical presentation on details of energy efficient transformers / motors.
d) **Energy conservation policies**: Prepare report on energy conservation policies of Govt. Maharashtra 2017.
e) **Energy Manager and Energy Auditor**: Identify from available resources their roles and responsibilities.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Guide Books no. 1 to 4 for National Certification Examination for Energy Managers and Energy Auditors	Bureau of Energy Efficiency (BEE)	Bureau of Energy Efficiency (A Statutory body under Ministry of Power, Government of India) (Fourth Edition 2015)
2	India - The Energy Sector	Henderson, P. D.	University Press, Delhi, 2016 ISBN: 978-0195606539
3	Energy Management Handbook	Turner, W. C.	Fairmount Press, 2012 ISBN 9781304520708
4	Energy Management and Conservation	Sharma, K. V., Venkataseshaiah; P.	I K International Publishing House Pvt. Ltd; 2011 ISBN 9789381141298
5	Principles of Power System	Mehta ,V. K.	S. Chand &Co.New Delhi, 2016, ISBN 9788121905947

S. No.	Title of Book	Author	Publication
6	Energy Management	Singh, Sanjeey; Rathire, Unmesh	S K Kataria&sons,New Delhi ISBN-13: 9789350141014.
7	Efficient Use and Management of Electricity in Industry	Desai, B. G.; Rana, J. S.; A. Dinesh, V.;Paraman, R.	Devki Energy Consultancy Pvt. Ltd.
8	Energy Engineering And Management	Chakrabarti, Amlan	e-books Kindle Edition
9	Energy Management	Murphy W.R.	Butterworth-Heinemann Publication
10	Art of reading Electricity bills	TalwareYogendra	DnyatavyaPrakashan

14. SOFTWARE/LEARNING WEBSITES

a) Website of bureau of energy and efficiency : www.bee-india.nic.in
b) Website of AkshayUrja News Bulletin : www.mnes.nic.in
c) Notes on energy management on : www.energymanagertraining.com
d) www.greenbusiness.com
e) www.worldenergy.org
f) Maharashtra Energy Development Agency (MEDA):www.mahaurja.com
g) Notes on energy management on: www.energymanagertraining.com
h) www.greenbusiness.com
i) www.worldenergy.org


MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION MUMBAI

Program Name : **Electrical Engineering Program Group**

Program Code : **EE/EP/EU**

Semester : **Fifth**

Course Title : **Elements of Industrial Automation (Elective)**

Course Code : **22526**

1. RATIONALE

This course aims to acquaint students with vital components of automation such as motor control circuits, typical input/output devices, Programmable Logic Controller (PLC), Distributed Control System (DCS), Supervisory Control and Data Acquisition (SCADA) and Human Machine Interface (HMI). This will facilitate students to develop understanding and skills related with operation and maintenance of basic building blocks of industrial automation, which will in turn enable them to effectively upkeep the automated systems in industry.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Maintain PLC related automation systems.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a. Maintain the relevant input/output components in industrial control circuits.
b. Wire PLCs for different applications.
c. Troubleshoot the PLC ladder programs for simple applications.
d. Test the PLC program in different applications.
e. Maintain the DCS and SCADA for different applications

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory							Practical				
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

***Legends:** **L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the

course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

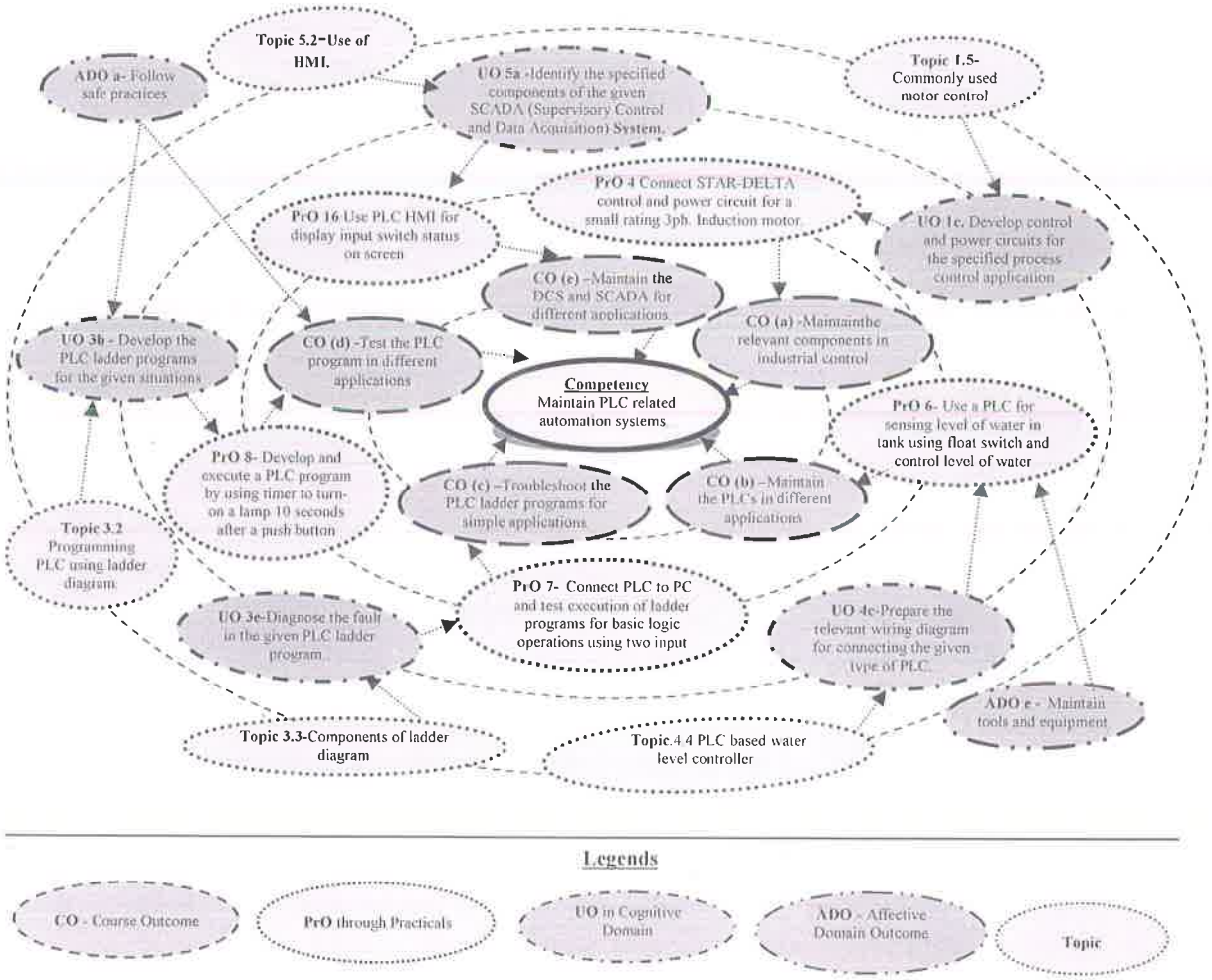


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Identify symbols in industrial control diagrams.	I	02*
2	Connect DOL starter control and power circuit for small rating 3ph Induction motor.	I	02*
3	Connect FOR-STOP-REV control and power circuit for a small rating 3ph Induction motor.	I	02*
4	Connect STAR-DELTA control and power circuit for a small rating 3ph. Induction motor.	I	02*
5	Simulate a simple seal-in circuit using PLC simulator.	III	02*
6	Connect PLC to PC and test execution of ladder programs for basic logic operations using two input switches and one output indicating lamp.	III	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
7	Execute a PLC program by using timer to turn-on a lamp 10 seconds after a push button press.	III	02*
8	Execute the PLC program by to count number of push button press events and display the same on screen.	III	02*
9	Connect PLC for STAR-DELTA staring of 3ph. Induction motor and test the ladder program for the same.	III	02
10	Connect PLC for FOR-STOP-REV control of 3ph. Induction motor and test the ladder program for the same.	III	02*
11	Use the PLC for running a stepper motor in clock-wise/anti-clock wise direction.	IV	02*
12	Use the PLC for sensing level of water in tank using float switch and control level of water using ON/OFF solenoid valve.	IV	02*
13	Use PLC for ON/OFF temperature control.	V	02
14	Use PLC for simulating traffic light control.	V	02
15	Use PLC HMI for display input switch status on screen.	V	02*
	Total		**30**

Note

i. *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. *The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

S.No.	Performance Indicators	Weightage in %
a.	Preparation of experimental set up	20
b.	Programming PLC and diagnose fault in the same.	30
c.	Observations and Recording	05
d.	Interpretation of result and Conclusion	05
e.	Answer to sample questions	20
f.	Submission of report in time	10
g.	Safety measures	10
Total		**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safety practices.
b. Practice good housekeeping.
c. Practice energy conservation.
d. Work as a leader/a team member.
e. Follow ethical Practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Control components: Push buttons (5 NOS), indicating lamps (5 NOS), float switch (2 NOs)	2 to 16
2	Three phase AC contactors (2 NOS)	2 to 16
3	Small rating (< 1HP) three phase Induction motor.	2 to 16
4	PLC with min 8 I/Os and HMI and its simulation/programming software.(1 No.)	2 to 16
5	Stepper motor drive module.	2 to 16
6	Traffic light simulation practical model.	2 to 16
7	Temperature control system.	2 to 16

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Industrial control circuits	1a. Identify a specified symbols along with their functions in the given industrial control diagram 1b. Explain with sketches the control and power circuit for the given motor control application. 1c. Develop control and power circuits for the specified process control application(s). 1d. Describe the method to troubleshoot the given industrial control circuit.	1.1 Need and benefit of automation, Different input devices such as push button, selector switch, limit switch, proximity switch and pressure switch. 1.2 Different output devices such as relay, contactor, solenoid valve, solid state relay (SSR) 1.3 Different symbols used in industrial control circuits. Concept of control and power circuit diagram. 1.4 Commonly used motor control circuits such as a) DOL starting b) Star-delta starter c) FWD-STOP-REV control and random reversing of induction motor.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		d) Soft Starters 1.6 Typical control and power circuit diagrams of hoist control, conveyer control, lifting magnet and Mill & Extruders.
Unit– II PLC Fundamentals	2a. Describe with sketches the function of a given part of PLC. 2b. Describe the function of the specified part of the given discrete IO module. 2c. Describe the function of the specified part of the given analog IO module. 2d. Describe the functions of the specified part of the given special IO modules. 2e. Compare the salient features of the given two PLCs using block diagrams.	2.1 Function of different parts of PLC such as CPU, memory, power supply and IO modules. 2.2 Digital IO module of PLC, Block diagram and specification 2.3 Analog IO module of PLC, Block diagram and specification 2.4 Special modules of PLC: Communication module PID controller module Stepper motor control module. 2.5 PLCs in market based on CPU type, no of IOs, speed and memory 2.6 Micro PLCs
Unit-III PLC Programming basics	3a. Identify the given parts of the ladder diagram along with the description their functions. 3b. Develop the PLC ladder programs for the given situations. 3c. Describe program scan process for the given type of PLC 3d. Modify the given relay instructions for proper implementation of the given ladder diagram. 3e. Describe the method to troubleshoot the given simple PLC ladder program.	3.1 Binary system, bit, byte, word, logic gates 3.2 Programming PLC using ladder diagram, Components of ladder diagram, Program scan process applied to single rung. 3.3 Ladder diagram for different logic gates. 3.4 Relay type instructions: IF-CLOSED, IF-OPEN Output Energize instructions. Internal relay instructions. 3.7 Timer/counter module: types of timers and counters
Unit –IV PLC Wiring diagrams and Ladder logic	4a. Develop ladder diagrams for the given situation(s). 4b. Select the relevant Input / Output devices required for the given application(s) with justification. 4c. Prepare the relevant wiring diagram for connecting the given type of PLC. 4d. Describe the method to troubleshoot the given PLC ladder	4.1 Seal in circuits using PLC 4.2 Ladder and wiring diagram of DOL starter with OLR 4.3 Latching Relay using PLC 4.4 PLC based water level controller. 4.5 Forward reverse control of 3-phase IM using PLC 4.6 Temperature control ON/OFF 4.7 Stepper motor control. 4.8 Bottle filling system.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	diagram and wiring diagram	4.9 Traffic light control
Unit-V SCADA and DCS	5a. Identify the specified components of the given SCADA System. 5b. Prepare a block diagram of the given architecture of SCADA. 5c. Identify the specified components in the given DCS diagram. 5d. Compare the salient features of given types of SCADA and DCS systems using block diagrams.	5.1 SCADA (Supervisory Control and Data Acquisition) overview. 5.2 Use of HMI. 5.3 SCADA architecture: Monolithic, distributed and networked. 5e. Concept of DCS (Distributed Control System)

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Industrial control circuits	08	02	06	08	16
II	PLC Fundamentals	10	02	04	08	14
III	PLC Programming basics	10	02	04	08	14
IV	PLC Wiring diagrams and Ladder logic	15	04	06	08	18
V	SCADA and DCS	05	02	02	04	08
Total		48	**12**	**22**	**36**	**70**

***Legends:** R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
***Note**: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Visit any manufacturing plant having PLC automation.
b) Visit any manufacturing plant with SCADA, HMI.
c) Make a survey of industrial control components based on their ratings.
d) Make a survey of commercially available PLCs.
e) Library / Internet survey of industrial automation circuits and systems.
f) Prepare power point presentation or animation on different automation circuits and their behavior.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c) About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d) With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e) Guide student(s) in undertaking micro-projects.
f) Correlate each topic and subtopics with requirement of automation in industrial environment.
g) Use proper equivalent analogy to explain different concepts.
h) Use PLC simulation software to exhibit mimic of an industrial problem.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a) PLC based induction motor control circuit.
b) PLC based servo motor control.
c) PLC based stepper motor control.
d) PLC based safety system.
e) PLC based closed loop temperature control system.
f) PLC based object counting system.
g) PLC based conveyer control system.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Handbook of Electrical Motor Control Systems	Eswar, U.S.	McGraw Hill Education, New Delhi, 2013, ISBN : 9780074604380
2	Control of Machines	Bhattacharya,	New Age International Publishers,

S. No.	Title of Book	Author	Publication
		S.K.; Singh, B.	New Delhi, 2006, ISBN: 978122418187
3	Programmable Logic Controllers – Principles and Applications	Webb, J.W; Reis,R.A.	PHI learning Pvt. Ltd., New Delhi, 2003; ISBN : 9780130416728
4	Programmable Logic Controllers	Hackworth, J.R.; Hackworth, F.	Pearson Education, New Delhi, 2015, ISBN : 9788177587715
5	Programmable Logic Controllers	Petruzella, F.D.	McGraw Hill Education(India) Edition, New York, 2016, ISBN: 9780073510880
6	Programmable Logic Controllers	Bolton, W.	Elsevier India Pvt, Ltd. New Delhi, 2016, ISBN: 9780128029299
7	Introduction to PLC	Dunning, G.	Cengage India (2009), ISBN: 9788131503027

14. SOFTWARE/LEARNING WEBSITES

a. http://electrical-engineering-portal.com/resources/plc-programming-training
b. PLC Basic Fundamentals and Wiring (Hindi): https://www.youtube.com/watch?v=g7ONCWmRy0w
c. Programmable Logic Controller Basics PLC Professor: https://www.youtube.com/watch?v=PLYosK87D8E
d. Basics of PLC ladder diagram: https://www.youtube.com/watch?v=Hci-eW5IihM
e. Controlling water level by using PLC: https://www.youtube.com/watch?v=1pRv-p_HbRk
f. Traffic signal control using PLC: https://www.youtube.com/watch?v=3WATUnwCwRA
g. Bottle Filling Process using PLC: https://www.youtube.com/watch?v=8UQOhGp8gqY

Program Name : Electrical Engineering Program Group

Program Code : EE/EP/EU

Semester : Fifth

Course Title : Power Electronic Applications (Elective)

Course Code : 22527

1.RATIONALE With rapid development in modern technology, power electronic devices and circuits are integral part of control system. As an electrical engineer it is necessary to exercise control on power given to the machine to control its speed, voltage and current to suit the requirement of various loads. It includes application of power devices such as converters, inverters, induction heating, dielectric heating, electric welding etc. This course aims to impart the knowledge and skills related to handling in terms of the use and maintenance of power electronic devices and circuits.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Maintain power electronic circuits used in industries.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a. Select power electronic devices for specific application(s).
b. Maintain functioning of the different types of chopper circuits.
c. Maintain functioning of the different types of inverters.
d. Maintain functioning of the different types of dual converters and cyclo-converters.
e. Use power electronic devices in various industrial applications.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory							Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

***Legends:** **L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **ESE** -End Semester Examination; **PA** - Progressive Assessment*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the

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course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

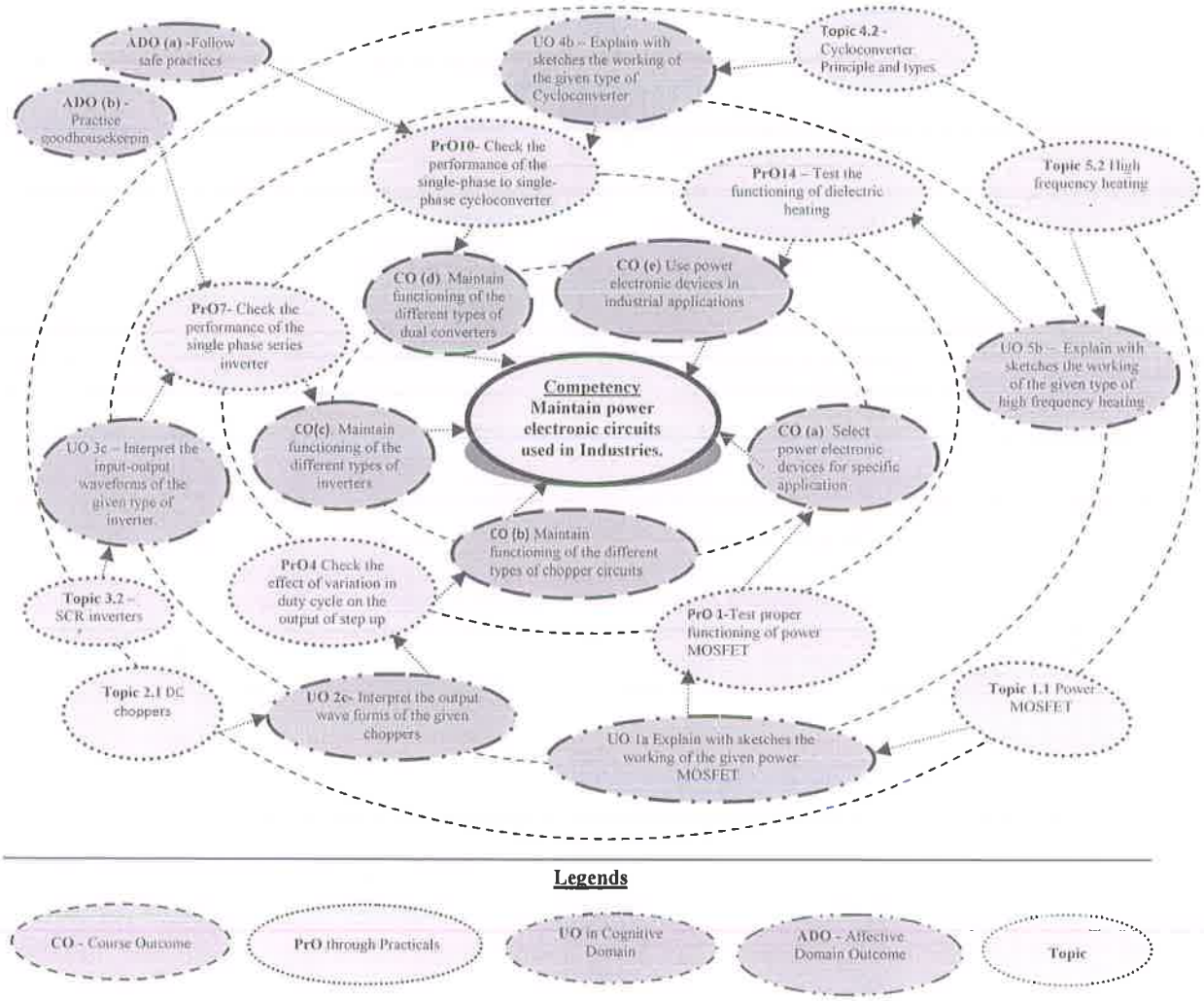


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Test proper functioning of power MOSFET.	I	02*
2	Test proper functioning of MCT.	I	02*
3	Test proper functioning of SIT.	I	02
4	Check the effect of variation in duty cycle on the output of step up chopper.	II	02*
5	Check the effect of variation in duty cycle on the output of step down chopper.	II	02*
6	Simulate the given chopper circuit in an open source software.	II	02*
7	Check the performance of the single phase series inverter.	III	02*
8	Perform the operation of single phase parallel inverter, observe the output voltage waveform and measure the load voltage.	III	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
9	Check the performance of the McMurray half bridge inverter.	III	02
10	Check the performance of the single-phase to single-phase cycloconverter.	IV	02*
11	Check the performance of the blocking mode dual converter.	IV	02
12	Simulate the given cycloconverter circuit in an open source software.	IV	02
13	Test the functioning of induction heating.	V	02*
14	Test the functioning of dielectric heating.	V	02*
15	Test the functioning of resistance welding.	V	02*
16	Test the functioning of ac relay type voltage stabilizer.	V	02*
	Total		**32**

Note:

i. *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12or more practical need to be performed, out16 of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. *The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

S. No.	Performance Indicators	Weightage in %
a.	Correctness of circuit diagrams	40
b.	Troubleshooting ability	20
c.	Quality of input and output displayed (observing , measuring, plotting and analysis of graph/characteristics/parameters)	20
d.	Answer to sample questions	10
e.	Submit report in time	10
Total		**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safe practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/a team member.
d. Maintain tools and equipment.
e. Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTSREQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Digital Multimeter:3½ digit, 0-800Volts,0-10A Micro-ammeters:0-100μA	All
2	Dual channel CRO: 25 MHz with isolation transformer OR Power scope , Attenuator probe for CRO	
3	DC Regulated Power Supply: 0-30 V,0-2 A,0-300 V,0- 10 A,	1 to 10
4	Single phase AC supply with 230 V , 10 A.	All
5	Experimental Thyristorised kits related to Choppers, Inverter, Dual converters, Cycloconverter, induction heating, dielectric heating and connecting cords.	All
6	Resistive load:(Lamp-100W,Heater coil- 500W), Resistive-Inductive load: (single phase fractional ¼ HP, 60W/75W Motor), as per requirement of the load.	4 to 12
7	Open Source Software free/License version	6,12

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Modern power devices	1a. Explain with sketches the working of the given power MOSFET&IGBT. 1b. Interpret the V-I characteristics of the given power electronic device. 1c. Describe the procedure to select suitable power electronic device for given situation with justification. 1d. Describe the procedure to trouble-shoot the given power electronic devices.	1.1 Power MOSFET& IGBT: construction, working, transfer characteristics, output characteristics, and application. 1.2 SCR construction, working, transfer characteristics, output characteristics, and application 1.3 SIT: construction, working, VI characteristics, and application. 1.4 MCT: construction, working, VI characteristics, and application. 1.5 FCT: construction, working, VI characteristics, and application.
Unit– II Chopper circuits	2a. Classify the type of choppers in the given chart. 2b. Compare with sketches the working of the given type of choppers. 2c. Interpret the output wave forms of the given choppers. 2d. Explain the effects of saturable core reactor in the given type of dual converter. 2e. Describe with sketches the	2.1 DC choppers: Types 2.2 Control strategies of chopper 2.3 Single quadrant, two quadrant, four quadrant chopper (circuit diagram, operation with waveforms) 2.4 Morgan chopper: circuit diagram, operation with waveforms. 2.5 Jones choppers: circuit diagram, operation with waveforms.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	procedure to troubleshoot the given chopper circuits.	
Unit– III Inverter circuits	3a. Explain with sketches the function of the given type of inverter. 3b. Calculate the output voltage and current for the given parameters of the inverter. 3c. Interpret the input-output waveforms of the given type of inverter. 3d. Describe with sketches the effects of the magnetically coupled inductor in the given McMurray-Bedford inverter with sketches. 3e. Describe with sketches the procedure to troubleshoot the given inverters.	3.1 Classification: Voltage-driven and current-driven inverter. 3.2 Transistor inverter, SCR inverters: Single-phase parallel inverter, single-phase series inverter, single phase bridge inverter description with circuits and waveforms. 3.3 Three-phase bridge inverter description with circuits and waveforms. 3.4 McMurray half bridge and full bridge inverters description with circuits and waveforms. 3.5 McMurray-Bedford inverter description with circuits and waveforms and applications.
Unit-IV Dual converters and Cycloconverters	4a. Explain with sketches the working of the given type of dual converters. 4b. Explain with sketches the working of the given type of Cyclo-converter. 4c. Select Dual converter and Cyclo-converter on the basis of applications with justification. 4d. Interpret the waveforms of the given type of Cyclo-converter.	4.1 Dual converters: Principle and types. 4.2 Circulatory current free mode, circulatory current mode dual converters. 4.3 Cyclo-converter: Principle and types. 4.4 Single phase to single phase and three phase Cyclo-converter: operation with circuit and waveforms.
Unit –V Industrial Applications of Power devices	5a. Explain with sketches the working of the given type of static circuit breaker. 5b. Explain with sketches the working of the given type of high frequency heating. 5c. Explain with sketches the working of the given type of AC voltage stabilizer. 5d. Describe speed control method for given servomotor. 5e. Simulation of chopper, Inverter and Cyclo-converter circuits.	5.1 Static circuit breaker(DC and AC). 5.2 High frequency heating: induction heating and dielectric heating control. 5.3 Electric welding control. 5.4 Battery charger control. 5.5 AC voltage stabilizer type: servo , solid state and relay. 5.6 Static VAR compensation system. 5.7 Closed loop speed control method for DC and AC servo motor. 5.8 Simulation: chopper, Inverter and Cyclo-converter circuits.

***Note**:To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'*

9. SUGGESTED SPECIFICATION TABLE FORQUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Modern power devices	06	02	02	04	08
II	Chopper circuits	10	02	06	08	16
III	Inverter circuits	10	02	06	08	16
IV	Dual converters and Cyclo converters	10	02	08	04	14
V	Industrial applications of power devices.	12	04	04	08	16
Total		**48**	**12**	**26**	**32**	**70**

***Legends:** R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
***Note**: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Visit the nearby power electronics based industry and observe the processes.
b. Take the market survey of various specifications of available power devices and submit the report.
c. Survey the market and submit the report of availablechoppers,inverters,dual converters and Cycloconverters.
d. Use internet to submit the report of various industrial control circuits.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning outcomes in this course:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the LOs/COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide to the student in undertaking micro-projects.
f. Demonstrate students thoroughly before they start doing the practice.

g. Encourage students to refer different websites to have deeper understanding of the subject.
h. Observe continuously and monitor the performance of students in Lab work and micro project related activities.
i. Use simulation software's for demonstrating the performance of different power devices.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. **Automatic street light :** Build and test the circuit of automatic street light.
b. **Choppers:** Build and test the Jones chopper circuit.
c. **Inverters :** Construct and test a circuit of thyristorised inverter and simulate using Scilab.
d. **Dual converters and Cyclo-converters:** Build and test the circuit of three phase to single phase Cyclo-converter.
e. **Speed control of AC/DC motor**: Build and test the speed control of DC motor using power electronic devices.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Modern Power Electronics	Sen P.C.	S. Chand & Company, New Delhi; 2013, ISBN: 978-8121924252.
2	Thyristors: Theory and Applications	Sugandhi R. K. and Sugandhi K. K.	New Age International Publishers, New Delhi, 2009, ISBN:978-0852268520.
3	Power Electronics and its Applications	Jain Alok	Penram International Publishing Mumbai, 2006; ISBN: 978-8187972228.
4	Power Electronics Circuits Devices and Applications	Rashid , Muhammad H.	Pearson Education India, Noida, 2014; ISBN: 978-0133125900.
5	Power Electronics	Singh, M. D. and Khanchandani, K.B.	McGraw Hill Publishing Co. Ltd, New Delhi, 2008 ISBN: 978-0070583894.
6	Power Electronics	Bimbhra P.S.	Khanna Publication

S. No.	Title of Book	Author	Publication
			New Delhi,2008 ISBN-13:978-8174092793

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.nptel.ac.in/courses/108101038
b. www.ee.iitb.ac.in/~apel/
c. www.tutorialspoint.com/power_electronics/
d. MATLAB: Software for Power Electronics Simulation
e. www.nptelvideos.in/2012/11/power-electronics.html
f. www.electrical4u.com/thyristor-triggering/
g. www.powerguru.org/power-electronics-videos/
h. www.youtube.com/watch?v=1Auay7ja2oY

Program Name : **Electrical Engineering Program Group**

Program Code : **EE/EP/EU**

Semester : **Fifth**

Course Title : **Wind Power Technologies (Elective)**

Course Code : **22528**

1. RATIONALE

Indian energy sector is undergoing a transition with wind power becoming a major energy source in the country with the establishment of large and small wind farms spread all across the country. Wind power plants have become a choice for generating clean and green electricity. Further, with a large number of large and small wind turbine manufacturers, there is a dearth of qualified and trained technologists who can manufacture and maintain the large and small wind turbines. This curriculum is designed in such a way that a technologist will be able to maintain the routine problems of related to large wind power plants and small wind turbines.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Maintain large wind power plants and small wind turbines.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following ***industry oriented*** COs associated with the above mentioned competency:

a. Identify the various types of wind power plants and their auxiliaries.
b. Maintain the normal working of large wind turbines.
c. Optimise the aerodynamic and electric control of large wind power plants.
d. Troubleshoot the common faults of large wind power plants.
e. Maintain the normal working of small wind turbines.
f. Troubleshoot small wind turbines.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
				Theory							Practical					
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
L	T	P			Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

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This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

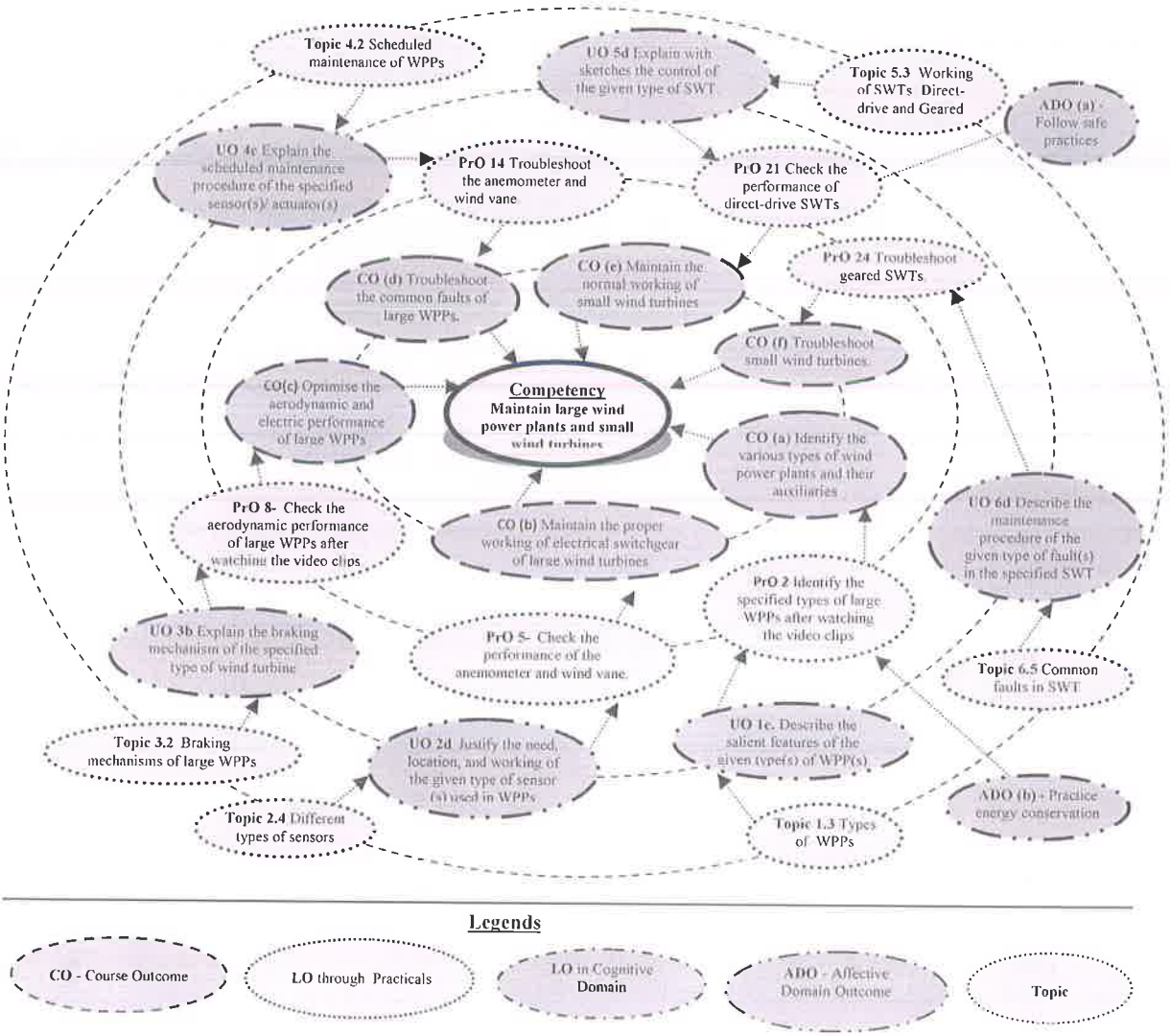


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Identify the specified items of a wind farm after watching the video clip.	I	02*
2	Identify the specified types of large WPPs after watching the video clips.	I	02
3	Identify the specified parts inside the nacelle of a large wind power plant after watching the video clips.	II	02*
4	Identify the specified parts of the electrical switchyard of a large wind power plant after watching the video clip.	II	02
5	Check the aerodynamic performance of large WPPs after watching	II	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	the video clips.		
6	Check the performance of the temperature and vibration sensor used in 125/150 kW WPPs.	III	02*
7	Check the performance of the SCIG	III	02*
8	Check the performance of the DFIG	III	02
9	Check the performance of the PMSG	III	02*
10	Check the performance of the hydraulic and electric pitch actuator and yaw actuator used in 125/150 kW WPPs.	IV	02*
11	Check the performance of the contactless RPM sensors used in WPPs	IV	02
12	Identify the specified parts which require routing maintenance, oiling and greasing, of the large wind power plants after watching the video clips.	IV	02*
13	Troubleshoot the anemometer and wind vane	IV	02*
14	Check the generator performance of SWTs.	V	02
15	Identify the parts of a direct-drive SWT	V	02*
16	Identify the parts of a geared SWT	V	02*
17	Dismantle a direct-drive SWT	VI	02*
18	Assemble a direct-drive SWT	VI	02
19	Dismantle a geared SWT	VI	02*
20	Assemble a geared SWT	VI	02
21	Check the performance of direct-drive SWT	V	02
22	Check the performance of geared SWT	V	02
23	Simulate faults in the small wind turbine trainer	V	02*
24	Troubleshoot direct-drive SWT	VI	02
25	Troubleshoot geared SWT	VI	02
26	Interpret the wiring of a SWT electric-electronic control panel	VI	02
	Total		**52**

Note

i. *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. *The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

S. No.	Performance Indicators	Weightage in %
1	Selection of suitable components, apparatus/instruments	20
2	Preparation of experimental setup	10
3	Setting and Operation	10
4	Safety measures	10
5	Observations and recordings	10
6	Interpretation of results and calculations	20
7	Answer to sample questions	10
8	Submission of report in time	10
	Total	**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/a team member.
d. Maintain tools and equipment.
e. Follow ethical Practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. S. No.
1	Video programmes of construction and working of large wind power plants.	1 to 4, 8
2	Second hand or new Nacelle of 150 kW to 500 kW wind turbine	3,12
3	Second hand or new 150 to 500 kW Wind turbine gear box	3,12
4	Second hand or new 150 to 500 kW Wind turbine electronic control panel	4
5	Thyristors used in 150 to 500 kW Wind turbine	4
6	Second hand or new 150 to 500 kW Wind turbine power electronic control panel	4
7	3-Cup type wind anemometer	13
8	Ultra sonic anemometer	13
9	Wind vane	13
10	Vibration sensor used in WPP	6
11	Temperature sensors of Gearbox, electric generator, ambient temperature used in WPP	6
12	RPM sensors of rotor and electric generator used in WPP	11
13	Hydraulic and electric pitch sensor and actuators used in WPP	10,12
14	3kW to 5 kW direct-drive small wind turbine with permanent magnet electric generator	14, 17, 18, 23
15	10 kW to 15 kW small wind turbine with gearbox and induction generator	16,19, 20, 24
16	10 kW to 15 kW small wind turbine electric-electronic control panel.	24 to 26
17	Small wind turbine trainer	23

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Wind Energy and Wind Power Plants	1a. Describe the India's wind power ranking in (name the year) compared to the world ranking, as well as the ranking between the states in India during the same year using pie chart sketches or bar charts. 1b. Explain the specified characteristics of the wind related to wind power generation 1c. Describe the salient features of the given type(s) of WPP(s). 1d. Explain the need for the specified component of the electric sub-station.	1.1 Wind power scenario in the world and India 1.2 **Characteristics of Wind Energy**: Wind movement, wind profile, roughness, effects of obstacles in wind path. 1.3 **Types of Wind Power Plants (WPPs)**: Small and large wind turbines; Horizontal and Vertical axis; Upwind and Downwind, One, Two and Three blades; constant and variable Speed; Geared, Direct-Drive and Semi-Geared (Hybrid) WPPs; WECS, WEGs, WTs, WPPs, 1.4 **WPP Tower Types**: Lattice; tubular: steel, concrete, hybrid, ladders, cables. 1.5 **WPP substation:** Switchgear, transformers, inside layouts of Electric electronic panels at block level.
Unit– II Construction and Working of Large Wind Power Plants	2a. Explain the given terms related to wind power. 2b. Describe the function(s) of the specified WPP component(s). 2c. Explain with sketches the specified principle of the rotation of the wind turbine rotor. 2d. Justify the need, location, and working of the given type of sensor (s) used in WPPs. 2e. Explain the need and working of the given type of actuator(s) used in WPPs.	2.1 **Wind Turbine Terminologies:** Cut-in, cut-out and survival wind speeds, Threshold wind speeds, rated power, nominal power, Wind Power Curve, 2.2 **Major parts and Functions of WPP:** Rotor blades, hub, nacelle, tower, electric sub-station, nacelle layouts of Geared, Direct-Drive and Semi-Geared WPPs, Main shaft, gearbox, electric generator, electronic control panels 2.3 **Rotation principles**: Drag and Lift principle, thrust and torque of wind turbine rotor. 2.4 **Different types of Sensors**: Anemometer, wind vane, rpm sensors of main shaft and generator, temperature sensors of nacelle, gearbox and generator; cable untwisting and vibration sensors 2.5 **Different types of Actuators**: Electric and hydraulic pitching and yawing mechanisms, cable untwisting and braking mechanisms
Unit– III Aerodynamic Control, Electric Generators and Grid Connection	3a. Distinguish the specified type of aerodynamic control also using the wind power curve. 3b. Explain with sketches the braking mechanism of the specified type of wind turbine. 3c. Explain with sketches the	3.1 Aerodynamic Control of WPPs: Stall, Pitch and Active Stall. 3.2 Braking mechanisms of large WPPs. 3.3 **Electric Generator Types**: Working of Squirrel-Cage rotor Induction Generator (SCIG), Wound-Rotor Induction Generator (WRIG), Doubly-Fed Induction Generator (DFIG), wound rotor and permanent magnet synchronous generators.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	working of the given type of electric generator used in large WPPs. 3d. Explain the impact of the specified problem when connecting the WPP to the grid.	3.4 Electric grid connection of WPPs: Local Impacts and system wide impact
Unit– IV Maintenance of Large Wind Power Plants	4a. Explain the procedure of preventive maintenance of the given WPP component. 4b. Describe the general maintenance issues of the specified type of WPP(s) 4c. Explain the scheduled maintenance procedure of the specified sensor(s)/ actuator(s). 4d. Explain the procedure of the unscheduled maintenance of the specified WPP component(s).	4.1 **General maintenance of WPPs:** preventive maintenance schedule of actuators such as yaw control, pitch control, braking mechanisms and sensors; oiling and greasing; electric and electronic equipment related; tower related; minor repairs, some tips, 4.2 **Scheduled Maintenance:** of Stall and Pitch and Active Pitch controlled WPPs 4.3 **Unscheduled maintenance**: operational factors, design faults, wear and tear of components, spurious trip, Major repairs. 4.4 Software related, warranty and insurance related issues
Unit– V Construction and Working Small Wind Turbines	5a. Distinguish the features of the given types of small wind turbines. 5b. Describe with sketches the functions of the given part(s) of the specified SWT. 5c. Explain with sketches the blade rotation of the given type of SWT. 5d. Explain with sketches the control of the given type of SWT. 5e. Describe with sketches the features towers of the given type(s) of SWT. 5f. Explain with sketches the working of the given type of electric generator used in SWT.	5.1 **Types and working of different type of small wind turbines (SWT):** Classification: Horizontal and Vertical axis, Upwind and Downwind, One, Two and Three blades; Constant and Variable Speed; Direct-Drive and Geared; braking of SWTs 5.2 **Parts of SWTs:** Rotor, generator, gearbox, tower, electric control panel, tale vane, anemometer, wind vane, temperature and rpm sensors. 5.3 **Working SWTs:** Direct-drive and Geared. 5.4 **Electrical generators in SWTs**: permanent magnet synchronous generators, induction generators 5.5 **SWT towers:** Lattice tubular type, hydraulic towers, ladders, cables.
Unit-VI Maintenance of Small Wind Turbines	6a. Describe the installation of the specified SWT. 6b. Identify the power electronic device(s) in the given SWT with justification	6.1 Small wind turbine assembly. 6.2 Installation of different types of small wind turbines (SWT): tubular and lattice types. 6.3 **SWT Routine maintenance:** Tips; Preventive maintenance schedule of braking mechanisms, sensors; oiling and

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	6c. Describe the function of the given type of power electronic converter in the specified type of SWT 6d. Describe the maintenance procedure of the given type of fault(s) in the specified SWT.	greasing related; electric and electronic equipment related; tower related; software related, minor repairs 6.4 Power electronic devices and converters in different types of SWTs: thyristors, power transistors 6.5 Common mechanical faults in SWTs 6.6 Common electrical faults in s SWTs

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Wind Energy and Wind Power Plants	04	02	02	04	08
II	Construction and Working of Large Wind Power Plants	08	02	04	06	12
III	Aerodynamic Control, Electric Generators and Grid Connection	10	02	06	08	16
IV	Maintenance of Large Wind Power Plants	08	02	04	06	12
V	Construction and Working Small Wind Turbines	10	02	04	08	14
VI	Maintenance of Small Wind Turbines	08	02	02	04	08
Total		**48**	**12**	**22**	**36**	**70**

***Legends:** R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
***Note**: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Prepare journal of practicals.
b. Undertake micro-projects.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.

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b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
a. Guide student(s) in undertaking micro-projects.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. Case study of any large wind power plant.
b. Study of gearboxes used in large WPPs.
c. Study of electric generators used in large WPPs
d. Study of towers used large WPPs
e. Study of electric switchyards used in large WPPs.
f. Comparative study of SWTs.
g. Comparative study of towers used in SWTs

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Wind Power Technology	Earnest, Joshua	PHI Learning, New Delhi, 2015, ISBN: 978-8120351660
2	Wind Turbines	Hau, Erich	Springer-Verlag, Berlin Heidelberg, Germany, 2013, ISBN: 978-3-642-27150-2
3	Wind Power Plants and Project Development	Earnest, Joshua	PHI Learning, New Delhi, 2015, ISBN: 978-8120351271
4	Wind Energy Basics	Gipe, Paul	Chelsea Green Publishing Co;2009, ISBN: 978-1603580304
5	Wind Electrical Systems	Bhadra, S.N., Kastha, D., Banerjee, S.	Oxford University Press, New Delhi 2013, ISBN: 9780195670936
6	Wind Energy	Siraj Ahmed	PHI Learning, New Delhi, 2015 ISBN: 978-8120351639

14. SOFTWARE/LEARNING WEBSITES

a. https://www.youtube.com/watch?v=FSB8_pb88P8
b. https://www.youtube.com/watch?v=P9SyZvHrJvc
c. https://www.youtube.com/watch?v=A-k2YGrpATo
d. https://www.youtube.com/watch?v=qSWm_nprfqE
e. https://www.youtube.com/watch?v=LNXTm7aHvWc
f. https://www.youtube.com/watch?v=x3AfhSHAcqg
g. https://www.youtube.com/watch?v=vN5Fdv_OKd0
h. https://www.youtube.com/watch?v=hXcgvKpDyzs
i. https://www.youtube.com/watch?v=c5sG1cMhSNw
j. https://www.youtube.com/watch?v=45Xh7FKS9nM (small wind turbine)
k. https://www.youtube.com/watch?v=j_fViOJbJLk (small wind turbine)
l. http://mnre.gov.in/file-manager/grid-wind/guideline-wind.pdf

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Program Name : Electrical Engineering Program Group

Program Code : EE/EP/EU

Semester : Fifth

Course Title : Power System Analysis (Elective)

Course Code : 22529

1. RATIONALE

The diploma engineers working in power sector, while undertaking major activities related to transmission and distribution systems they should be able to interpret significance of the activities assigned to them. For example, they should be aware of active and reactive power flow and methods to analyze performance of power system. They should also be able to represent power system components in circuit form and analysiswith the concept of 'Generalize Circuit'. They should adopt per-unit system calculations for power system analysis.Hence, this course is designed to enable diploma pass outs to handle different activities in power system sector with appropriate power flow perceptive. Thus this course is important for diploma electrical engineers who wish to work in power generation, transmission and distribution companies.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Maintain powersystem networks within power flow strategies.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a. Interpret circuits for various components ofthe power system.
b. Calculate line parameters for different types of transmission lines.
c. Use generalised circuit calculations for transmission line performance.
d. Estimate the power at sending and receiving ends of transmission line.
e. Ensureperformance of transmission lines by graphical analysis.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

***Legends:** L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P -Practical; C – Credit, ESE -End Semester Examination; PA - Progressive Assessment*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

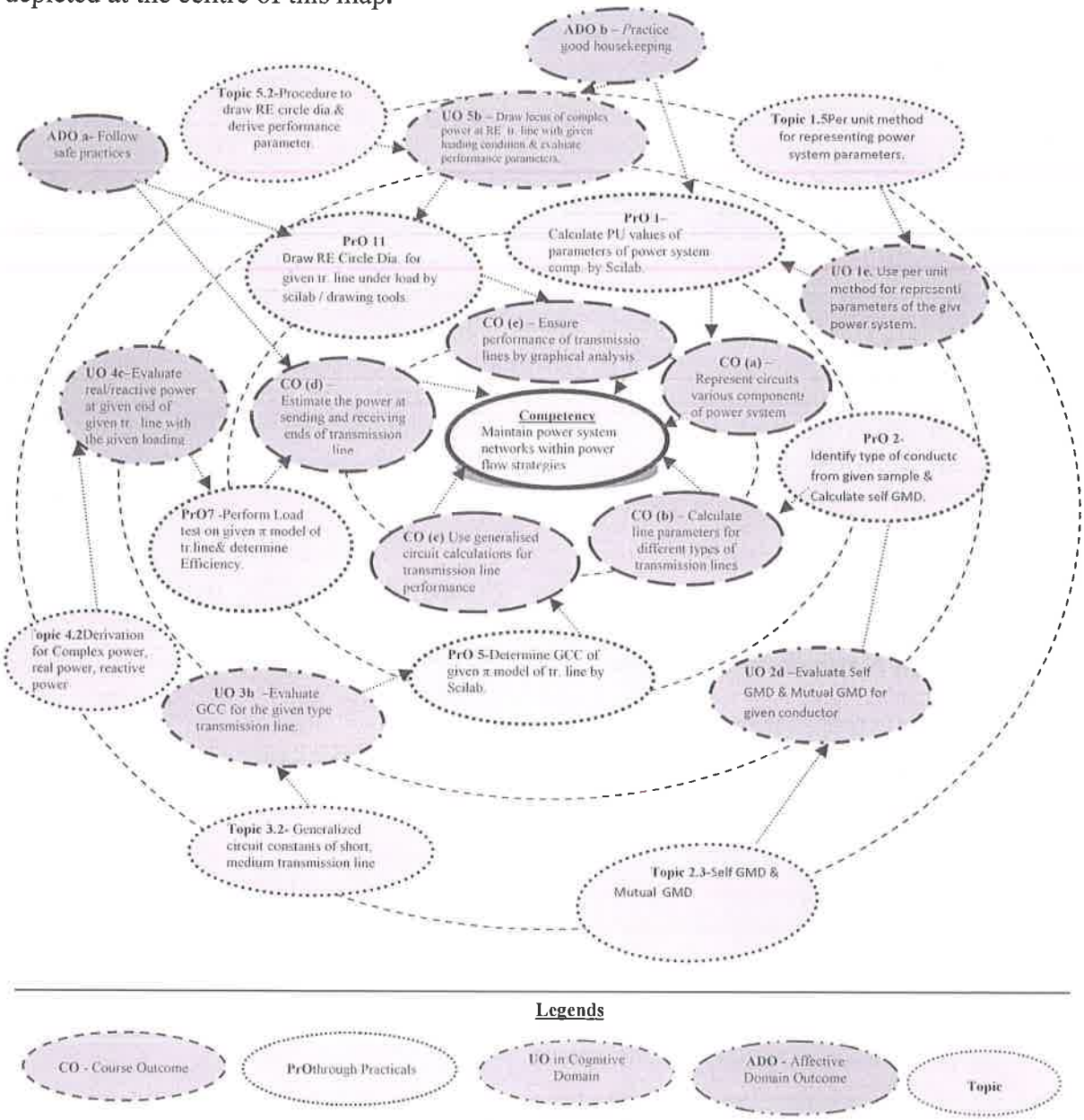


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Calculate per unit values of parameters of power system components for given power system by using Scilab.	I	02*
2	Identify type of conductor from given sample of line conductors and Calculate self GMD.	II	04*
3	Perform OC and SC Test and evaluate Generalized circuit constant	III	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	of given π model of transmission line.		
4	Perform OC and SC Test and evaluate Generalized circuit constant of given T model of transmission line.	III	02*
5	Determine Generalized circuit constant of given π model of transmission line by using Scilab.	III	02*
6	Determine Generalized circuit constant of given T model of transmission line by using Scilab	III	02
7	Perform Load test on given π model of transmission line and determine the Efficiency.	IV	02*
8	Perform Load test on given T model of transmission line and determine the efficiency.	IV	02
9	Evaluate Receiving end complex power by using Scilab for given transmission line under load condition	IV	02*
10	Evaluate Sending end complex power by using Scilab for given transmission line under given condition	IV	02*
11	Draw Receiving end Circle Diagram for given transmission line under load condition by using scilab / drawing tools.	V	02*
12	Draw Sending end Circle Diagram for given transmission line under given condition by using scilab / drawing tools.	V	02
13	Observe the effect of reactive power consumption by single phase split phase Induction motor connecting capacitor bank (REC).	V	02*
14	Observe the videos on reactive power compensation Equipmentsand prepare informative report.(part-1)	V	02
15	Observe the videos on reactive power compensation Equipments and prepare informative report. .(part-2)	V	02
	Total		**32**

Note

i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S.No.	Performance Indicators	Weightage in %
a.	Preparation of experimental set up	20
b.	Setting, collection of data and operation	20
c.	Safety measures	10
d.	Observations and Recording	10
e.	Interpretation of result and Conclusion	20
f.	Answer to sample questions	10
g.	Submission of report in time	10
Total		**100**

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The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safety practices.
b. Practice good housekeeping.
c. Practice energy conservation.
d. Demonstrate working as a leader/a team member.
e. Maintain tools and equipment.
f. Follow ethical Practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'CharacterisingLevel' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTSREQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Open source software Scilab 5.5.2 (any other suitable software)	1, 5,6, 9,10,11,12
2	Sample of transmission line conductors	2
3	Simulation π model of transmission line or trainer kit	3,7
4	Simulation T model of transmission line or trainer kit.	4,8
5	AC ammeter 2.5A, 5A	3,4,7,8,13
6	AC voltmeter 30V, 300V	3,4,7,8,13
7	Single Phase Wattmeter –Lpf 2.5A,300 V and unity pf 5A ,75/300V	3,4,7,8,13
8	Single Phase Auto transformer 0-250 V,10A	3,4
9	Lamp Bank 1KW, 230 V, 5A	7,8
10	Single phase split phase induction motor 1HP (Any other Suitable Motor)	13
11	Capacitor Bank	13
12	LCD projector, PC Arrangement with audio system.	14,2
13	Videos on reactive power compensation equipments.	14

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopicsshould betaught and assessed in order to develop UOs for achieving the COs to attain the identified competency.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– I Representation of power system.	1a. Explain the specified aspects of the given power system. 1b. Describe role of power system engineer for analysing the given power system. 1c. Draw the Equivalent circuit of the given power system components. 1d. Develop impedance diagram and reactance diagram from the given single line diagram of power system. 1e. Use per unit method for representing parameters of the given power system.	1.1 Aspects of power system analysis: 1.2 Role of power system engineer. 1.3 Equivalent Circuit representation of the System components-Alternator, Transformer, Load, Transmission line: Short, Medium and long. 1.4 Representation of power system by single line diagram, impedance diagram and reactance diagram. 1.5 Per unit method for representing power system parameters.
Unit– II Composition of Transmission Line	2a. Develop composition of the given transmission line 2b. Describe the impact of given parameter in transmission line performance. 2c. Calculate inductance of the given single phase line with given configuration. 2d. Evaluate Self GMD andMutual GMD for given conductor configuration. 2e. Develop the equation for inductance/capacitance of given transmission line 2f. Estimate the inductance/capacitance of three phase line for the given conductor arrangement.	2.1 Transmission line composition – resistance, inductance, capacitance and conductance and their significance. 2.2 Inductance-Single phase line composed of solid conductors and bundled conductors. 2.3 Self GMD and Mutual GMD 2.4 Inductance of three phase line (single circuit) composed of solid conductors with symmetrical and asymmetrical spacing. 2.5 Capacitance of single phase line composed of solid Conductors and Duplex bundled conductors. 2.6 Capacitance of three phase line (single circuit) with symmetrical and asymmetrical spacing. 2.7 Effect of earth field on transmission line capacitance.
Unit-III Generalized circuit representation	3a. Apply concept of generalized circuit for the given type transmission line. 3b. Evaluate the generalized circuit constants for the given type transmission line. 3c. Develop resultant generalized network of the given type combination of networks. 3d. Describe the benefits of generalised circuit representation of the given type of transmission line.	3.1 Generalized Circuit – Concept 3.2 Generalized circuit constants of short, mediumtransmission line. 3.3 Generalized circuit constants of two networks connected in series 3.4 Generalized circuit constants of two networks connected in parallel. 3.5 Advantages of Generalized circuit representation

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit –IV Power flow	4a. Describe the concept of complex power with reference to the given power system. 4b. Develop the expression for complex power at given end of given transmission line. 4c. Evaluate real/reactive power at given end of given transmission line forthe given loading condition. 4d. Develop the condition for maximum real power flow of given end of the given transmission line.	4.1 Complex Power ($S=V I^{*}$), Real Power and reactive Power. 4.2 Derivation for Complex power, real power, reactive power for receiving end of the tr. line using GCE. 4.3 Derivation for Complex power, real power, reactive power for sending end of the tr. line using GCE. 4.4 Condition for maximum powerat receiving end of transmission line. 4.5 Condition for maximum power at sending end of transmission line.
Unit-V Line performance by graphical analysis	5a. Describe the locus of complex power flowing through transmission line at both end 5b. Draw locus of complex power at receiving end transmission line with given loading conditionand evaluate performance parameters. 5c. Draw locus of complex power at Sending end transmission line with given condition and evaluate performance parameters. 5d. Identify the relevant reactive power compensating equipment for the given power system condition. 5e. Determine ratings of reactive power compensating equipment for given transmission line data.	5.1 Graphical method for Transmission line performance analysis- Receiving end circle diagramand Sending end circle diagram 5.2 Procedure to draw Receiving end circle diagram and derive performance parameter. 5.3 Procedure to draw Sending end circle diagram and derive performance parameter. 5.4 Reactive power compensation-Necessityand types ofequipments 5.5 Rating of equipment using receiving end circle diagram. 5.6 Advantages of graphical analysis

Note:To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'

9. SUGGESTED SPECIFICATION TABLE FORQUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Representation of power system	07	00	04	04	08
II	Composition of Transmission Line	16	04	06	06	16
III	Generalized circuit representation	09	04	06	08	18
IV	Power flow	07	02	06	08	16

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
V	Line performance by graphical analysis	09	02	04	06	12
Total		**48**	**12**	**26**	**32**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Collect specifications of different reactive power compensation equipment used in electrical power system through market survey/visit and write a technical report.
b. Visit 400/220/132/66/33kV substation and take the help of sub-station in-charge to understandvarious transmission line systems and write a technical report.
c. Collect data of different types of conductors used for different types of transmission lines through internet/ industrial visit.
d. Write all the safety precautionswhich are to be taken while working with distribution & transmission lines.
e. Collect information regarding maintenance of transmission lines. through internet/ industrial visit.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Correlate all units with subtopics of other units.
g. Use proper equivalent analogy to explain different concepts.
h. Use Flash/Animations to explain reactive power compensation concept.
i. Use open source Scilab software to explain different concepts of power flow.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are

group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects isgiven here. Similar micro-projects could be added by the concerned faculty:

a. **Reactive Power compensation scheme**: Collect the information and Prepare comparative chart.
b. **Case study on power flow:** Performance analysis by analytical and graphical method for given loading condition.
c. **Representation in Generalized circuit:**Represent the given transmission line in generalized circuit and evaluate constants.
d. **Information collection**: Collect information of existing EHV transmission line and prepare report.
e. **Development of circuit model of Transmission line:** Evaluate line parameters from given design of transmission line and represent circuit model.

13. SUGGESTED LEARNING RESOURCES:

S. No.	Title of Book	Author	Publication
1	Principles of Power System	Mehta V. K ; Mehta Rohit.	S.Chand and Co., New Delhi. ISBN: 978-81-2192-496-2.
2	Modern Power System Analysis	NagrathI. J. Kothari D. P.	McGraw HillEducation, New Delhi 2003.ISBN-0-07-049489-4
3	Elements of Power System Analysis e-book	Stevenson William	McGraw-Hill Book Company, New York, 2014(4th addition) ISBN 10: 0070612781 / ISBN 13: 9780070612785
4	Electrical Power System	WadhavaC. L.	New age international publishers ISBN: 13-978-1-4987-7757-5-(EPUB)
5	Power System Protection and Switchgear	Badri Ram Vishwakarma D. N.	McGraw-Hill, New Delhi. ISBN : 978-07-107774-X
6	Power system Analysis and Design	Gupta B.R.	S. Chand and Co. Ltd., New Delhi Edition: 6 Year: 2011 ISBN: 81-219-2238-0

14. SOFTWARE/LEARNING WEBSITES

a. Lecture series on power system https://nptel.ac.in
b. Lecture series on power system https://www.youtube.com/watch?v=fBmtdr_gRBk
c. https://circuitglobe.com/power-system.html
d. https://www.electrical4u.com/power-system

Program Name : Electrical Engineering Program Group

Program Code : EE/EP/EU

Semester : Fifth

Course Title : Illumination and Electrification of Buildings (Elective)

Course Code : 22530

1. RATIONALE

This course is intended to teach the students various aspects of Illumination scheme. Student will be in a position to apply principles and laws of Illumination and Illumination schemes. Students also have the knowledge of various types of lamps lighting accessories and control circuits. This will also enable them to use knowledge for preparing an Illumination scheme, requirement of the circuits, develop the skill of designing illumination scheme for specific applications. S/he will become aware of his role in adapting new changes in Illumination scheme necessitated due to technical innovations brought out by R and D in Illumination technology.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Design illumination schemes and associated electrification of buildings.**

3. COURSE OUTCOMES (COs)

The course content should be taught and learning imparted in such a manner that students are able to acquire required learning outcome in cognitive, psychomotor and affective domain to demonstrate following course outcomes:

a) Select the relevant Illumination levels for various applications
b) Select relevant lamps for various applications
c) Select the lighting accessories required for selected wiring scheme.
d) Design a control circuit for Illumination
e) Design Illumination schemes for various applications
f) Interpret the Illumination scheme for various purposes.

TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory							Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

***Legends:** **L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** - Credit;*
***ESE** - End Semester Examination; **PA** - Progressive Assessment*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

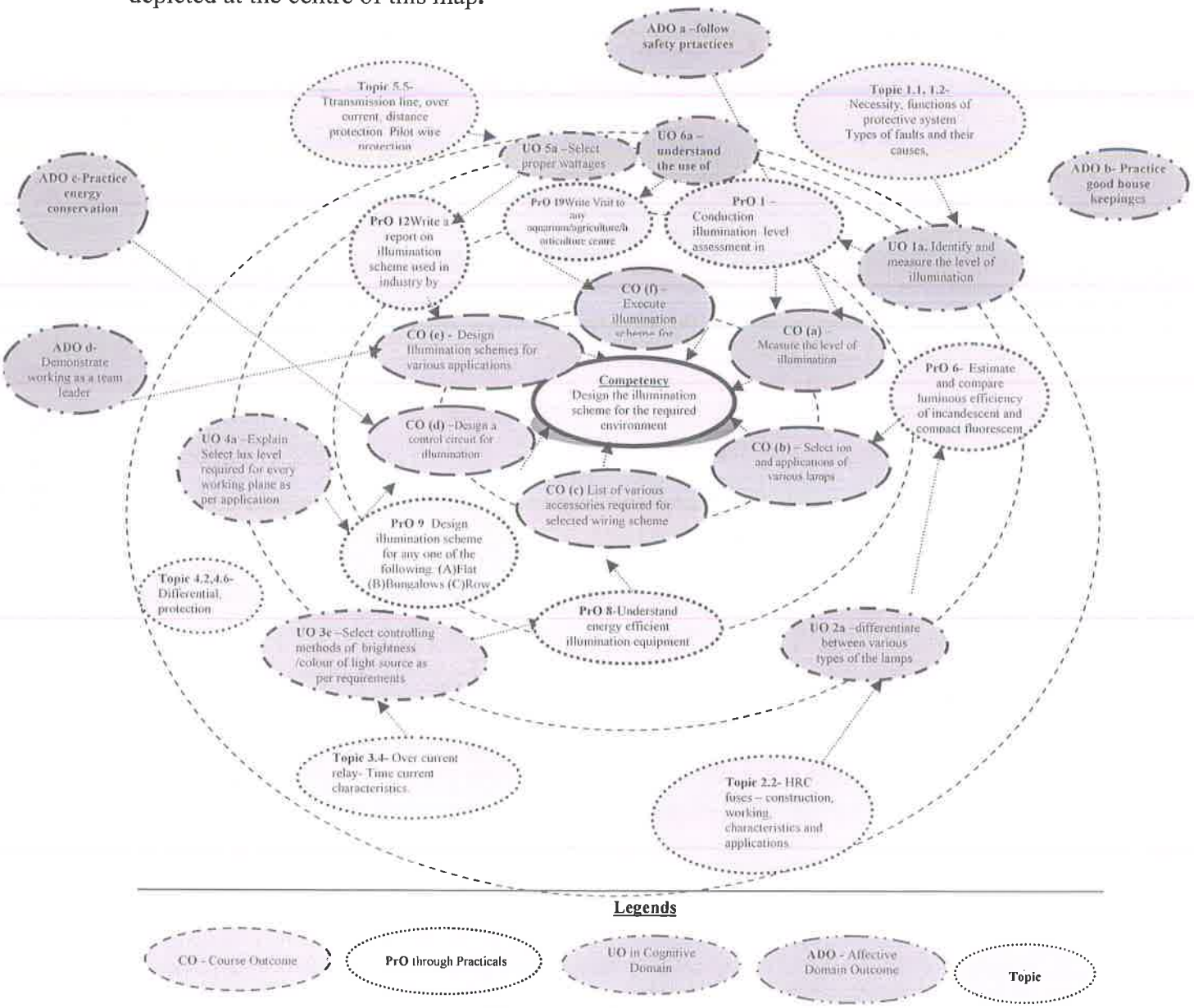


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Conduct illumination level assessment in workplace using lux meter.	I	02*
2	Fit the given lamp in the selected mounting	I	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
3	Interpret the polar curves of the given type of lamp and verify it using the lux meter	I	02
4	Measure the illumination output of different lamps (Incandescent , Fluorescent,CFL) and compare it with their wattage.	II	02*
5	Measure the illumination output of different lamps (LED,HPSV, HPMV) and compare it with their wattage.	II	02
6	Measure illumination level with and without reflectors used in the various Luminaries.	II	02
7	Estimate and compare luminous efficiency of incandescent and compact fluorescent lamp.	II	02*
8	Prepare light dimmer arrangement using the relevant dimmer type of transformer	III	02*
9	Identify the given types of dimmer transformer and their parts	III	02
10	Build an electronic dimmer – Part I	III	02
11	Build another type of electronic dimmer – Part II	III	02
12	Build a single lamp control by single switch	III	02
13	Build a single lamp control by two switches	III	02
14	Build a single lamp control circuit for two point method	III	02
15	Build a lamp control circuit for three point method	III	02
16	Build a lamp control circuit for four point method	III	02
	Total		**32**

Note

i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S.No.	Performance Indicators	Weightage in %
a.	Preparation of experimental set up	20
b.	Setting, collection of data and operation	20
c.	Safety measures	10
d.	Observations and Recording	10
e.	Interpretation of result and Conclusion	20
f.	Answer to sample questions	10
g.	Submission of report in time	10
Total		**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safety practices.
b. Practice good housekeeping.

c. Practice energy conservation.
d. Work as a leader/a team member.
e. Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Lux meter	1-4,6,9,12,16,18,19
2	Auto transformer	6,7
3	Control circuits for various Luminaries	7,8
4	Stroboscope	5
5	Wattmeter, voltmeter, ammeter, energy meter	8

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– I Fundamentals of illumination	1a Identify the illumination level required for the given situation with justification 1b Determine the wattage required for the given situation for the given data. 1c Interpret the polar curve of the given type of lamp. 1d Interpret with sketches the polar curve required for the given type of lamp. 1e Select the type and number of luminaires required for the given area in sq.m. with justification. 1f Prepare the lighting calculation of the given situation.	1.1 Basic illumination ,Terminology, Laws of illumination 1.2 Polar curves, polar curve: its meaning and applications for designing the lamp. 1.3 Concept of Photometry 1.4 Measurement of illumination 1.5 Lighting calculation methods a. Watt /m^2 method b. Lumens or light flux method c. Point to point method 1.6 Standards for illumination.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– II Types of lamps	2a Interpret with sketches the given type of lamp. 2b Explain the working of the given type of lamp 2c Select the relevant mounting arrangement for the given light source. 2d Compare the salient features of the given type of lamps.	2.1 Incandescent lamp 2.2 ARC lamps – AC and DC arc lamps 2.3 Fluorescent lamp 2.4 Types of other lamps: Mercury vapour lamp, HPMV lamp, Mercury iodide lamp, Sodium vapour lamp, LED, CFL, Halogen Lamps, Ultraviolet Lamps Neon Lamps. Neon Sign Tubes. Metal halides, Lasers 2.5 HID and Arc lamps 2.6 Selection Criteria for lamps
Unit-III Illumination Control and Control Circuits	3a. Select proper light source for given application. 3b. Select controlling methods of brightness/colour of light source for the given requirements. 3c. Explain with sketches the working of the given type of dimmer 3d. Design control circuit for Illumination 3e. Explain with sketches the given type of control circuit for lamps	3.1 Purpose of lighting control, and Dimmer, Resistance type Salt water Dimmer 3.1 Working principle and operation of Dimmer 3.2 Transformer and their types, Dimmer Transformer, Auto transformer dimmer, Two winding transformer dimmer 3.3 Electronic Dimmer: working principle and operation a) Thyrister operated dimmer b) Triac operated dimmer 3.4 Control of Enhance Lighting 3.5 Methods used for light control 3.6 Control circuits for lamps: single lamp controlled by single switch, two switches. 3.7 Single Lamp control by two point method, three point method and four point method 3.8 Control circuits for lamps (refer): ON/OFF control
Unit –IV Illumination for Interior Applications	4a. Select lux level required for given working plane as per application 4b. Calculate total lux level required for the given working plane 4c. Selection of proper light source with particular colour of light for the given situation 4d. Estimate the illumination scheme for the given type of residence.	4.1 Standard for various locations of Interior Illumination 4.2 Design considerations for Interior location of residences (1/2/3/4 BHK), Commercial, Industrial premises 4.3 Illumination scheme for different Interior locations of Residential, Commercial, industrial unit

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit-V Lighting for Outdoor and Special Applications	5a. Select proper wattage for the given number of light sources for the given outdoor purpose 5b. Locate specific mountings of lighting sources for outdoor applications in specific environment 5c. Select relevant lamps in order to save energy for the given situation with justification 5d. State the safety measure and precautions to be followed for the given special purpose lamp.	5.1 Factory Lighting 5.2 Street Lighting (Latest Technology), Flood Lighting 5.3 Railway Lighting 5.4 Lighting for advertisement /Hoardings/sports lighting, Agriculture and Horticulture lighting, Health Care Centers / Hospitals, Decorating Purposes, Stage Lighting, Aquariums and Shipyards 5.5 Special purpose lamps used in photography video films.

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fundamentals of illumination	05	00	02	04	06
II	Types of lamps	12	04	06	06	16
III	Illumination Control and Control Circuits	12	04	06	06	16
IV	Illumination for Interior Applications	09	02	06	06	14
V	Lighting for Outdoor and Special Applications	10	04	04	10	18
	Total	**48**	**14**	**24**	**32**	**70**

***Legends:** R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
***Note**: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Collect specifications of different illumination schemes used in various units and write a technical report.
b. Visit various units and take the help of unit in-charge to understand various illumination schemes.

c. Collect data of different illumination schemes used for residential, commercial industrial units and various places such as gardens, garages, substations etc.
d. Write all the safety precautions which are to be taken while working with different illumination schemes..
e. Collect data of Lightning schemes.
f. Study the IS codes implemented.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c) About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d) With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e) Guide student(s) in undertaking micro-projects.
f) Correlate subtopics with illumination schemes.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

a) Collect Techno-commercial information of different lamps available in market (i. e. Lamp manufacture, technical specification, cost etc.)
b) **Installation and commissioning of a lighting structure :** Calculate load current and illumination level for certain lighting scheme.
c) **Case study of past installed illumination scheme and try to draw the polar curve..**
d) **Installation and commissioning of LED fixture.** Calculate load current and illumination level for certain lighting scheme
e) **Installation and commissioning of LED fixture for the specific purpose such as illuminating a statue.:** Prepare power point presentation for comparing the incandescent lamp scheme replaced by the LED structure.

f) **Stroboscopic effect visualization / color rendering index of a lamp.**Prepare the detailed schemes for measuring CRI.

13. SUGGESTED LEARNING RESOURCES:

S. No.	Title of Book	Author	Publication
1	Applied Illumination Engineering	Lindsey, Jack L.	The Fairmont Press Inc.
2	Lighting Engineering: Applied Calculations	Simons, R. H., Bean,Robert	Architectural Press (ISBN 0750650516)
3	Handbook of Applied Photometry	Casimer M Decusatis	Springer (ISBN 1563964163)
4	Handbook of Industrial Lighting	Butterworths, Lyons Stanley,	Butterworths
5	Lighting Control Technology and Applications	Simpson Robert S	Focal Press
6	Energy Management in Illuminating Systems	Kao Chen	CRC Press

14. SOFTWARE/LEARNING WEBSITES

a) www.archlighting.com
b) www.youtube.com /illumination engineering
c) www.megaman.cc/resources/lighting-design/lighting software
d) www.nptelvideos.in/electrical engineering/ lamps
e) www.electrical4u.com
f) www.NPTEL.com

Maharashtra State Board of Technical Education, Mumbai

Teaching And Examination Scheme For Post S.S.C. Diploma Courses

Program Name : Diploma in Electrical Engineering / Diploma in Electrical Power System / Diploma in Electrical & Electronics (Power System)

Program Code : EE/EP/EU **With Effect From Academic Year: 2017 - 18**

Duration of Program : 6 Semesters **Duration : 16 Weeks**

Semester : Sixth **Scheme : I**

S. N.	Course Title	Course Abbrev iation	Course Code	Teaching Scheme			Credit (L+T+P)	Examination Scheme												Grand Total
								Theory							Practical					
								Exam Duration in Hrs.	ESE		PA		Total		ESE		PA		Total	
				L	T	P			Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
1	Maintenance of Electric Equipment	MEE	22625	3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
2	Utilization of Electrical Energy	UEE	22626	4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
3	Electrical Estimation and Contracting	EEC	22627	3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
4	Emerging Trends in Electrical Engineering	ETE	22628	3	-	-	3	90 Min	70*#	28	30*	00	100	40	--	--	--	--	--	--	100
	Elective – II (Select Any One)																				
5	Industrial Drives and Control (EE/EU)	IDC	22629	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
	Power System Operation and Control (EP)	PSO	22632	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
	Electric Substation Practices (EE/EP/EU)	ESP	22633	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
6	Capstone Project - Execution and Report writing	CPE	22060	-	-	4	4	--	--	--	--	--	--	--	50#	20	50~	20	100	40	100
			Total	**16**	**-**	**12**	**28**	--	**350**	--	**150**	--	**500**	--	**150**	--	**150**	--	**300**	--	**800**

Student Contact Hours Per Week: **28 Hrs.** Medium of Instruction: **English**

Theory and practical periods of 60 minutes each. Total Marks : **800**

Abbreviations: ESE- End Semester Exam, PA- Progressive Assessment, L - Lectures, T - Tutorial, P - Practical

@ Internal Assessment, # External Assessment, *# On Line Examination, ^ Computer Based Assessment

* Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain LOs required for the attainment of the COs.

~ For the courses having ONLY Practical Examination, the PA marks Practical Part - with 60% weightage and Micro-Project Part with 40% weightage

- **If Candidate not securing minimum marks for passing in the "PA" part of practical of any course of any semester then the candidate shall be declared as "Detained" for that semester.**

MSBTE – Final Copy Dt. 24.09.2019

Program Name : **All Branches of Diploma in Engineering and Technology.**

Program Code : **CE/CR/CS/CH/CM/CO/IF/CW/DE/EJ/EN/EQ/ET/EX/IE/ MU/EE/EP/EU/IS/IC/AE/FG/ME/PG/PT/DC/TX/TC**

Semester : **Sixth**

Course Title : **Capstone Project – Execution & Report Writing**

Course Code : **22060**

1. RATIONALE

This course on 'Capstone Project–Execution and Report Writing' is the continuation of the previous semester course on 'Capstone Project–Planning'. So, in this semester, the students are to implement the detailed Capstone Project Plan, which they have prepared in the preceding semester. Therefore, to successfully complete this Capstone Project by the end of this semester, it is necessary to incorporate the suggestions of the guide/examiners of the preceding semester. Hence, it is of utmost importance for the student to again re-capitulate and comprehend the importance, concept and need of the 'Capstone Projects' which are well explained in the 'Capstone Project–Planning' course in the previous semester.

Often, the jobs in the industry, which the diploma holders will come across when they join it and will be in the form of small or large projects. Such projects are generally an integration of the various types of skills which cut across the three major domains of learning i.e. cognitive, psychomotor and affective domain which must have acquired during their journey from first semester to the last semester. Hence, it is essential that students are also given an opportunity to do large projects which require more time compared to the micro-projects in order to develop and integrate the highly essential industry oriented competencies and associated skills in the students. Therefore, in this semester the 'Capstone Project – Execution and Report Writing' will continue to integrate some more additional competencies along with those in the previous semester and hence build up greater confidence to face such situations in the world of work.

2. COMPETENCY

The course should be taught and implemented with the aim to develop the required course outcomes (COs) so that students will acquire following competency needed by the industry:

- **Implement the Capstone Project Plan to solve the identified problem/task faced by industry/user related to the concerned occupation by integrating the various types of skills acquired during the programme.**

3. COURSE OUTCOMES (COs)

Depending upon the nature of the projects undertaken, the following could be some of the major course outcomes that could be attained, although, in case of some projects few of the following course outcomes may not be applicable.

a) Implement the planned activity individually and/or as team.
b) Select, collect and use required information/knowledge to solve the identified problem.
c) Take appropriate decisions based on collected and analysed information.
d) Ensure quality in product.
e) Incorporate energy and environment conservation principles.
f) Consider the ethical issues related to the project (if there are any).
g) Assess the impact of the project on society (if there is any).
h) Communicate effectively and confidently as a member and leader of team.

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i) Prepare project report after performing due plagiarism check using appropriate tools.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory							Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
-	-	4	4	--	--	--	--	--	--	--	50#	20	50~	20	100	40

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment

5. Course details

As the implementation of the Capstone project progresses and which has to be submitted at the end of project work, one of the outputs of this course is a detailed ***Project Report*** that is continuously prepared by the student. There will also be regular progressive assessment by the teacher as per the criteria no 7 on the basis of rubrics mentioned in **Appendix –C** and in the formats as shown in **Appendix-B** and also for the end-of-semester examination.

5.1 Guidelines for Capstone Project–Execution and Report Writing

a) The students would like to revise the 'Capstone Project – Plan' based on the feedback received in the fifth semester examination.

b) This revised 'Capstone Project – Plan' would be again approved by the project guide. As soon as the revised plan is approved by the teacher, the student will begin to work according to it and would also continue to maintain a dated ***'Project Diary'*** for the whole semester. This is a sort of a 'weekly diary' indicating all the activities conducted by the student every week in the semester to complete the project. This 'Project Diary' should be got signed by the teacher at regular intervals for progressive assessment. If this is maintained sincerely and truthfully by the student, it will be very helpful in compiling the ***Final Project Report*** at the end of the semester by him/her.

6. Project report

During the final Semester, the student will prepare a 'Project Report' in continuation with the activities conducted in fifth semester under Project Planning having following sub-titles:

Suggested contents of the Project report

- Title page (with name of team members and mentor teacher)
- Certificate (in the Format given in this document as annexure A)
- Acknowledgements (this may need revision at the end of the final semester)
- Abstract (in one paragraph not more than 150 words)
- Content Page

Chapters

1. Chapter–1 Introduction (background of the Industry or User based Problem/Task)
2. Chapter–2 Literature Survey (to finalise and define the Problem Statement)
3. Chapter–3 Scope of the project
4. Chapter–4 Methodology
5. Chapter-5 Details of designs, working and processes

6. Chapter-6 Results and Applications
7. Chapter-7 Conclusions And future scope
8. Appendix (if any)
9. References and Bibliography

Note:

i. The report should contain as many diagrams, figures and charts etc as relevant for the project.
ii. Originality of the report (written in own words) would be given more importance rather than quality of printing and use of glossy paper or multi-colour printing

7. ASSESSMENT OF PROJECT WORK

Project work has two components, first is Progressive Assessment (PA), while another is End Semester Examination (ESE).

7. 1. Progressive Assessment (PA) Guidelines and Criteria

Project guide is supposed to carry out this assessment. It is a continuous process, during which for developing desired qualities in the students, faculty should orally give **informal feedback** to students about their performance and interpersonal behaviour while guiding them on their project work every week. Following criteria should be considered while assessing students informally or formally during different stages of the project work.

The following factors need consideration for both Capstone Project-Planning and Capstone Project-Execution and Report Writing.

a) Students should be assessed during the project work so that students can also get feedback for further improvement.
b) It should be kept in mind that project work is mainly experiential learning and it is not the research work, so emphasis should be on work based learning or learning from experience and development of attitudes and skills as mentioned in course outcomes. So focus of assessment should also be on learning from the process of completing project work rather than on novelty or innovation in the project work.
c) For progressive assessment at the end, students should be asked to give the power point presentation before group of teachers and junior students (so that junior students may also get awareness about the major project work they have to carry out in future)
d) The students would be awarded marks for their efforts (In some cases it may happen that due to some reasons such as unavailability of some material or component or some other resources, students may not be able to complete the project, but they have tried their best, in such cases students would be given appropriate marks if they have done enough efforts.)
e) The students would not be awarded marks if they have completed the project by getting done the work from market or some professionals (taking some help and guidance is different as compared to getting the work or maximum part of the work completed from others on payment basis).
f) Originality of the report (written in own words) would be given more importance.
g) The Project Guide will assure the quality of project done by his group.

Criteria of Marks for PA for Capstone Project -Execution and Report Writing.

S. No.	Criteria	Marks
1	**Project Proposal /Identification**	10
2	**Punctuality and overall contribution**	
3	**Project Diary**	
4	**Execution of Plan during sixth semester**	20
5	**Project Report including documentation**	15
6	**Presentation**	05
	Total	**50**

7.2 END SEMESTER EXAMINATION (ESE)

Evaluation shall be carried out according to following criteria. For each project, students from the concerned group should be asked to make presentation of their project , in front of the external and internal examiners which should be followed by question answer session to ascertain the contribution made by each student.

Criteria of Marks for ESE for Capstone Project -Execution and Report Writing

S. No.	Criteria	Marks
1	Project Proposal	05
2	Punctuality and overall contribution	
3	Project diary	
4	Execution of Plan during sixth semester	10
5	Project Report including documentation	10
6	Presentation	10
7	Question and Answer	15
	Total	**50**

8. SPECIAL TEACHING STRETAGIES (If any)

a) Teacher's should not spoon feed the students and let them try on their own at different stages of the project work and even first let them strive hard and only when efforts of students have failed, then teacher should guide them. Guidance should be in initially in the form of clues or hints rather than complete explanation, detailed explanation should be given only when students are not able to work based on clues/hints. The role of teacher should be limited to guide and facilitator

b) Teachers should help students in selecting a topic which is relevant and challenging (but within capacity) for students according to their abilities.

c) ***Teachers should come out of the mindset that there should be compulsorily some innovation and novelty in the project work. Because as discussed earlier, project is mainly opportunity for work based or experiential learning, the aim of which is to develop higher order cognitive skills and attitudes. Project at diploma level is not research or innovation.*** The main thing teachers have to ensure is that students choose a task or problem for their project work which is challenging but according to their capability i.e. a task which they can complete on their own without getting it done from market.

d) Teachers should ensure that students prepare the project plan in as much detail as possible, since this way only they would learn the importance of planning and how to do the detail planning. Teachers should allow students to proceed ahead only when they have detailed plan with them.

e) Teachers should motivate students to maintain project document project diary and project report. They should explain benefits of these activities to students and also train them in these activities, because most of them may be doing this first time.

f) Project Guide should ensure that students submit chapter of report one by one to him/her as per schedule and should check the content of the chapters. The Project guide should monitor that schedule is maintained and report writing is not left till last few weeks. It should not be a problem since first three chapters of the report should have been written in fifth semester itself.

g) Teachers should also encourage students to openly discuss their weaknesses and shortcomings .Teachers should develop confidence in students that admitting mistakes and weaknesses helps in improving them.

h) Teachers should continuously discuss with students about working of group and progress in the project and from this discussion should identify their personal qualities (both strengths and weaknesses) and suggest to them ways for improving those qualities.

i) Internal as well as external examiners should reward students for original work and efforts of students even if they are not fully successful or not able to complete the project in comparison to those students who have taken paid help from others to complete their project.

Appendix–A

CERTIFICATE

This is to certify that Mr./Ms.....

from .....Institute having Enrolment No: .....

has completed project of final year having title .....,.... during the academic year20__-20__. The project completed by individually/ in a group consisting of..... persons under the guidance of the Faculty Guide.

.....

.....

Name & Signature of Guide: .....

Telephone:.....



Appendix–B

PROGRESSIVE ASSESSMENT (PA) OF CAPSTONE PROJECT – EXECUTION AND REPORT WRITING

Evaluation Sheet for Internal Assessment

Name of Student: .....
Name of Programme..... **Semester: Sixth**
Course Title: Capstone Project : Execution and Report Writing **Code:22060.**
Title of the Capstone Project: .....
.....

A. **POs addressed by the Capstone Project** (Mention only those predominant POs)

a) .....
b) .....
c) .....
d) .....

B. **COs addressed by the Capstone Project** (Mention only those predominant POs)

a) .....
b) .....
c) .....
d) .....

C. **OTHER LEARNING OUTCOMES ACHIEVED THROUGH THIS PROJECT**

1. **Unit Outcomes (Cognitive Domain)**
   a) .....
   b) .....
   c) .....
   d) .....

2. **Practical Outcomes (in Psychomotor Domain)**
   a) .....
   b) .....
   c) .....
   d) .....

3. **Affective Domain Outcomes**
   a) .....
   b) .....
   c) .....
   d) .....

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PROGRESSIVE ASSESSMENT (PA) Sheet		
S. No.	**Criteria**	**Marks**
1	Project Proposal /Identification	10
2	Punctuality and overall contribution	
3	Project Diary	
4	Execution of Plan during sixth semester	20
5	Project Report including documentation	15
6	Presentation	05
Total		**50**

Appendix–B

Suggested Rubric for Capstone Project – Execution and Report Writing

S. No.	Characteristic to be assessed	Poor	Average	Good	Excellent
1	**Problem/Task Identification (Project Title)**	Relate to very few POs Scope of Problem not clear at all	i. Related to some POs ii. Scope of Problem/Task vague	i. Take care of at-least Three POs ii. Scope of Problem/task not very specific	• Take care of more than three POs ii. Scope of problem/task very clear
2	**Literature Survey /Industrial Survey**	Not more than ten sources (primary and secondary), very old reference	At-least 10 relevant sources, at least 5 latest	At –least 15 relevant sources, most latest	About 20 relevant sources, most latest
3	**Project proposal**	Methods are not appropriate, All steps not mentioned, Design of prototype not started (if applicable).	Appropriate plan but not in much detail. Plan B for critical activities not mentioned. Time line is not developed. Design of Prototype is not complete. (if applicable)	Appropriate and detailed plan with Plan B for critical activities mentioned, but clarity is not there in methods, time line is given but not appropriate. Design of prototype is not detailed (if applicable)	Appropriate and detailed plan with Plan B for critical activities mentioned, clarity in methods with time line, Detailed design of prototype (if applicable)
4	**Project Diary**	Entries for most weeks are missing. There is no proper sequence and details are not correct.	Entries for some weeks are missing, details are not appropriate, not signed regularly by the guide.	Entries were made every week but are not in detail. Signed and approved by guide every week	Entries were made every week in detail, signed and approved by guide every week
5	**Final Report Preparation**	Very short, poor quality sketches, Details about methods, material, precaution and conclusions	Detailed, correct and clear description of methods, materials, precautions and	Conclusions. Sufficient Graphic Description.	Very detailed, correct, clear description of methods, materials, precautions and conclusions. Enough tables,

S. No.	Characteristic to be assessed	Poor	Average	Good	Excellent
		omitted, some details are wrong			charts and sketches
6	**Presentation**	Major information is not included, information is not well organized .	Includes major information but not well organized and not presented well	Includes major information and well organized but not presented well	Well organized, includes major information ,well presented
7	**Defense**	Could not reply to considerable number of question.	Replied to considerable number of questions but not very properly	Replied properly to considerable number of question.	Replied to most of the questions properly

Appendix C

Suggestive Project Diary format

Week no:
Activities planned:
Activities Executed:
Reason for delay if any
Corrective measures adopted
Remark and Signature of the Guide

Program Name : **Electrical Engineering Program Group**

Program Code : **EE/EP/EU**

Semester : **Sixth**

Course Title : **Maintenance of Electrical Equipment**

Course Code : **22625**

1. RATIONALE

The electrical engineering technologist is required to carry out the maintenance of the electrical machines and equipment, which includes installation and testing. S/he is thus expected to use the relevant skill-sets while working in the industry, commercial establishments, and public utility departments such as PWD, irrigation, electricity supply agencies, water supply and sewage board. This course arms the student with the skills to inspect various types of installations and test electrical machines as per prevailing standards. S/he will also be able to carry out different types of maintenances of electrical equipment. S/he will follow the relevant safety practices during such activities.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Maintain different types of electrical equipment following safe practices.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following ***industry oriented*** COs associated with the above mentioned competency:

a) Follow safe practices to prevent accidents while using electrical equipment.
b) Prepare maintenance schedules for electrical equipment.
c) Maintain rotating electrical machines.
d) Maintain single phase and three phase transformers.
e) Maintain insulation systems of electrical equipment.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

Legends: ***L****-Lecture;* ***T*** *– Tutorial/Teacher Guided Theory Practice;* ***P*** *-Practical;* ***C*** *– Credit,* ***ESE*** *-End Semester Examination;* ***PA*** *- Progressive Assessment*

5. COURSE MAP (with sample COs, PrOs,UOs,ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

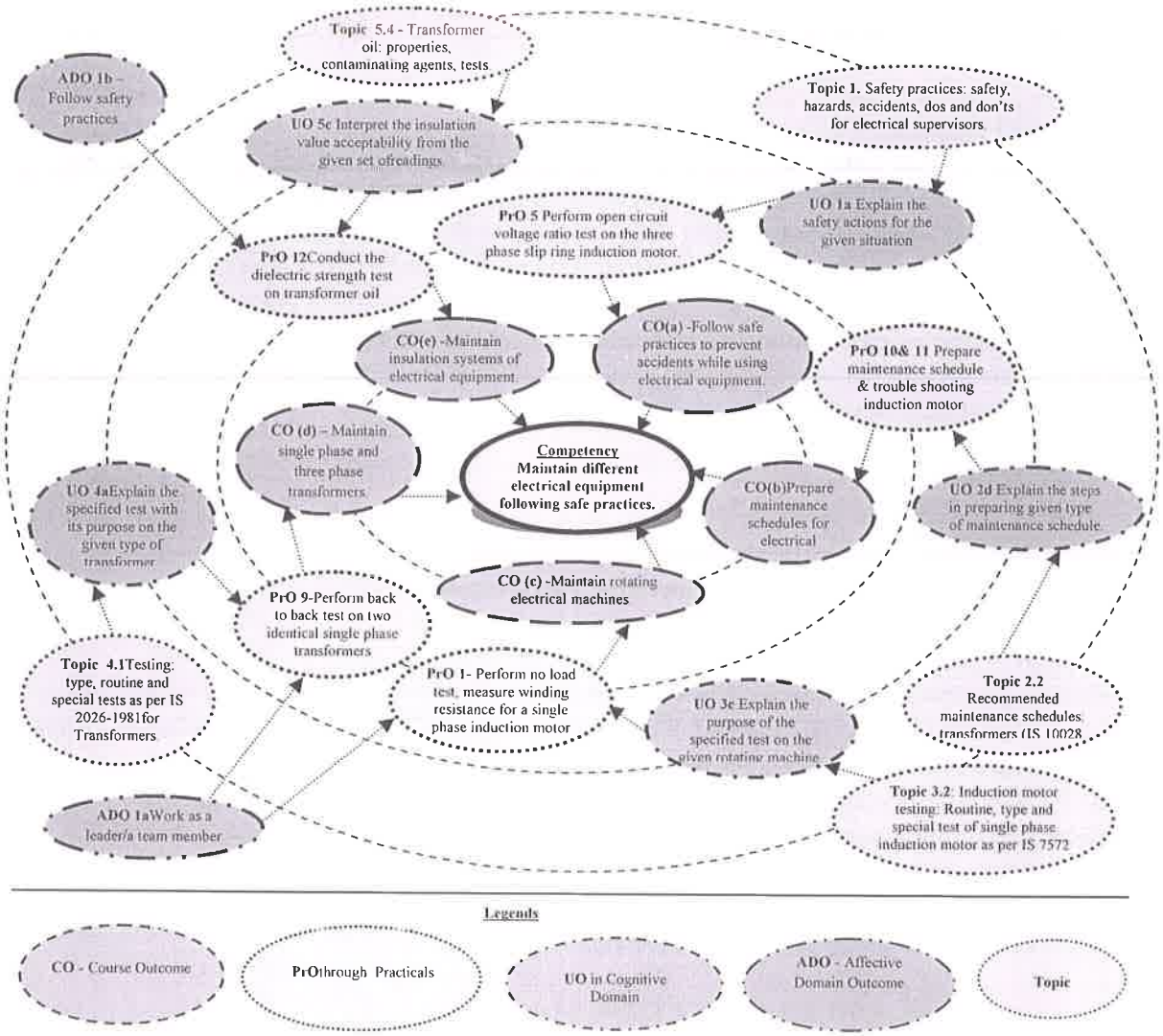


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Perform the no load test, measure winding resistance for a single phase induction motor and determine its performance. (as per relevant IS)	III	02*
2	Perform no load and blocked rotor test on three phase induction motor to determine the equivalent circuit. (as per relevant IS)	III	02*
3	For the motor tested in practical at S. no. 2 plot the circle diagram and judge its performance. (as per relevant IS)	III	02*
4	Perform the brake load test on the three phase Induction motor	III	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	to plot the following operating characteristics, [(1) torque versus speed, (2) current drawn versus output and (3) power factor versus output] (as per relevant IS)		
5	Perform open circuit voltage ratio test on the three phase slip ring induction motor. (as per relevant IS)	III	02*
6	Perform the phasing out and polarity tests on the three phase transformer. (as per relevant IS)	IV	02*
7	Perform the open circuit and short circuit tests on the single phase transformer and determine its performance (regulation and efficiency). (as per relevant IS)	IV	02#
8	Perform the open circuit and short circuit tests on the three phase transformer and determine its performance (regulation and efficiency). (as per relevant IS)	IV	02#
9	Perform back to back test on two identical single phase transformers and determine their efficiencies and regulations.	IV	02*
10	Prepare the maintenance schedule for trouble shooting chart for the single phase induction motor. (as per relevant IS)	II/III	02^
11	Prepare the maintenance schedule for trouble shooting chart for the three phase induction motor. (as per relevant IS)	II/III	02^
12	Prepare maintenance schedule for trouble shooting chart for 3ph Transformers. (as per relevant IS)	II/IV	02*
13	Conduct the dielectric strength test on transformer oil (sample 1). (as per relevant IS)	V	02 &
14	Conduct the dielectric strength test on transformer oil (sample 2). (as per relevant IS)	V	02 &
15	HV test on three phase induction motor (as per relevant IS)	III/V	02%
16	HV test on single phase induction motor. (as per relevant IS)	III/V	02%
	Total		**32**

Legend: #: any one to be performed; &: any one to be performed, %: any one to be performed, ^: any one to be performed,

Note

i. *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practicals need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. *The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and Recording	10
5	Interpretation of result and conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10

S. No.	Performance Indicators	Weightage in %
	Total	100

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a) Follow safety practices.
b) Practice good housekeeping.
c) Practice energy conservation.
d) Work as a leader/a team member.
e) Follow ethical Practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organisation Level' in 2nd year
- 'Characterisation Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by administrators.

S. No.	Equipment Name with Broad Specifications	PrO.No.
1	230 V, 50 Hz, single phase capacitor start cage type induction motor (suitable available HP)	1
2	3-phase 5 HP, 400 V, 50 Hz, 1500 RPM squirrel cage induction motor with brake load arrangement as required.	2, 3, 4
3	400V/230V, 50 Hz, 3-phase transformer with all phase winding terminals brought out for connections (suitable output in range of 2 kVA to 4 kVA)	8
4	3-phase 400V, 50 Hz, 1500 RPM slip ring induction motor about 5 HP.	5
5	At least two identical 230 V/115 V or 400 V/ 230 V 50 Hz, 1 or 2 kVA single phase transformers.	6, 7, 9
6	Dielectric oil testing kit (with input at 230 V)	12, 13
7	HV test kits for motors up-to 400 V.	14, 15, 16
8	AC Ammeter range (0-2.5-5-10A), Portable analog MI type as per relevant BIS standard	1, 2, 4, 5, 7, 8, 9
9	AC Voltmeter Range (0-75/150/300V, 0 - 300V /600 V), Portable analog MI type as per relevant BIS standard.	1, 2, 4, 5, 7, 8, 9
10	Tachometers 0-5000 RPM minimum	1, 2, 4
11	Single phase auto transformer 0-270 V, 15 A, input single phase, 230 V.	1, 6, 7, 9
12	Three phase auto transformer 0-450 V, 15 A, input 3 phase, 400 V.	2, 4, 5, 8
13	A. C Watt meters: 0-300/600 V, 5/10 A or 10/20 A as needed.	1,2,4,7, 8, 9
14	LPF Wattmeter, 0-300/600 V, 1A to 2A.	1, 2, 7, 8, 9

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8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Safety and prevention of accidents	1a. Explain the safety actions for the given situation. 1b. Explain the hazards involved for the given situation and action. 1c. Explain the responsibilities of the supervisor in the given hazardous or accident situation. 1d. Explain the level of accountability of the supervisor in the given hazardous or accident situation 1e. Explain the monitoring actions to be taken by the supervisor while working in the given hazardous or accident situation 1f. State the principal characteristics and related precautions for safety of equipment earthed by the specified class.	1.1 Safety practices: safety, hazards, accidents, dos and don'ts for electrical supervisors. 1.2 Electric shock: factors influencing severity of shock, rescuing persons, procedures for artificial respiration. 1.3 Precautions against electric fires, use of fire extinguishers, actions in case of such fires, types and operation of fire extinguishers. 1.4 Earthing of electrical equipment {refer IS code IS 3043-1987):Objectives, classification of electrical equipment with regard to protection against electric shock: class 0 to III.
Unit – II Maintenance schedules	2a. Explain the need for maintenance for the given type of electrical equipment. 2b. Explain the relevant type of maintenances required for the given type of electrical equipment. 2c. Explain the advantages of the given type of maintenance. 2d. Explain the steps in preparing given type of maintenance schedule.	2.1 Maintenance: routine, breakdown, preventive and predictive maintenance, factors affecting preventive maintenance schedules. 2.2 Recommended maintenance schedules: transformers (IS 10028, part III – 1981);single phase and three phase induction motors (IS 900 – 1992); three phase alternators and synchronous motors.
Unit- III Testing and Maintenance of rotating machines	3a. Explain the objectives of testing the given type of electrical machine. 3b. Explain the need for the given type of test/s on the specified machine. 3c. Explain the purpose of the specified test on the given type of rotating machine. 3d. Explain the steps in preparing trouble shooting chart for the given type of rotating machine. 3e. Explain the steps in preparing foundation for the given type of rotating machine. 3f. Explain with sketch the foundation for the given type of rotating machine.	3.1 Testing: Need and standards, tolerance, types: routine, type, special and supplementary tests, Methods of testing: direct, indirect and regenerative with advantages and applications. 3.2 Induction motor testing: Routine, type and special test of single phase induction motor as per IS 7572 – 1974 (re-affirmed in 2002) and three phase induction motor as per IS4029 -2010. 3.3 Alternator and synchronous motor testing: Routine, type and special test of three phase alternator and synchronous motor as per IS 7132 1973 (reaffirmed in 2002).

	3g. Suggest the tools for the given operation under maintenance of the rotating machine.	3.4 Trouble shooting chart for single phase and three induction motor (IS 900 – 1992). 3.5 Foundations: Requirements and factors affecting rotating machine foundation. 3.6 Tools/instruments: Bearing puller, filler gauge, dial indicator, spirit level, megger, earth tester, growler, test lamps, multimeter, spanner sets, and screwdrivers.
Unit– IV Testing and trouble shooting of Transformers	4a. Explain the specified test with its purpose on the given type of transformer. 4b. Explain the causes of failure of the specified type of transformer from the given symptoms. 4c. Explain the steps in preparing trouble shooting chart for the given type of transformer. 4d. Explain the remedies for the specified fault in the given transformer. 4e. Suggest the foundation with sketch for the given type of transformer.	4.1 Testing: type, routine and special tests as per IS 2026-1981 for Distribution and Power transformers. 4.2 Causes of failure: internal and external, types of faults: mechanical. electrical and magnetic 4.3 Trouble-shooting and remedies: trouble shooting charts for single phase and three phase transformers, 4.4 Foundations: requirements for static machine foundations, factors governing them.
Unit– V Maintenance of Electrical Machine Insulation	5a. Suggest the insulation material for the given application. 5b. Explain with sketch the procedure to measure the insulation resistance of the given type of machine. 5c. Interpret the insulation value acceptability from the given set of readings. 5d. Explain the reasons for weakening of given type of insulation. 5e. Explain with sketch the procedure to strengthen the given insulation. 5f. Describe the procedure to maintain the insulation of the specified electrical machine in healthy condition. 5g. Prepare the sample history for the specified electrical machine.	5.1 Classification of insulating materials as per IS 8504- 1994, 5.2 Factors affecting life of insulating materials. 5.3 Measurement of insulation resistance and interpretation of condition of insulation. 5.4 Transformer oil: properties, contaminating agents, tests. 5.5 Strengthening insulations: weakening agents, cleaning, drying, re-varnishing, baking, impregnation, filtration. 5.6 Measures to be taken to maintain the insulation resistance of electrical machines to healthy levels. 5.7 History sheets of transformers and induction motors: [Part A: machine specifications with component specifications (installation information, bearings, oil type, core weight etc. as applicable). Part B: date wise: observations of parameters such as voltage,

		current, temperature etc., symptoms, works carried out under maintenance)

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Safety and prevention of accidents	06	02	04	04	10
II	Maintenance schedules	10	02	02	06	10
III	Testing and maintenance of rotating machines	12	04	06	10	20
IV	Testing and trouble shooting of Transformers	12	04	06	10	20
V	Maintenance of electrical machine insulation.	08	02	02	06	10
Total		**48**	**14**	**20**	**36**	**70**

***Legends:** R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
***Note**: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare report for step by step procedure to be followed for artificial respiration to be given to shock affected person.
b) Carry out preventive maintenance on any one machine in lab and prepare report on it.
c) Prepare power point presentation on testing of Induction motor as per IS.
d) Prepare power point presentation related to foundation of transformers.
e) Collect sample of various class of insulating materials and prepare a chart of it.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c) About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).

d) With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e) Use Flash/Animations to explain various theorems in circuit analysis
f) Guide student(s) in undertaking micro-projects.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

Suggestive lists of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a) Collect information on safety signs used for electrically hazardous areas.
b) Prepare a case study report on faulty electrical machine in institute campus through inspection, conduction of tests, troubleshoot and remedial actions needed.
c) Visit electrical machine manufacturing unit and collect data of various tests conducted on it.
d) Prepare a report on diagnosis of transformer oil sample by conducting various tests on it.
e) Collect information of specifications, uses, cost of various tools and equipment needed for maintenance of different electrical machines.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Electrical Machines	Bhattacharya,S. K.	McGraw Hill Education. New Delhi, ISBN : 9789332902855
2	Electrical Technology Vol-II (AC and DC machines)	Theraja, B.L.	S.Chand and Co.Ltd., New Delhi ISBN : 9788121924375
3	Electrical Machines Theory and Practice	Bandyopadhyay, M. N.	PHI Learning Pvt. Ltd., New Delhi, ISBN :9788120329973 Vi
4	IS codes for transformers	IS 2026 (part 1-2011, part 2-2010), IS 10028 (part III) -1981.	
5	IS codes for induction motors	IS 325-1996, IS 4029-2010, IS 900-1992.	
6	Guide for testing of single phase and universal motors	IS 7572 – 1974 (reaffirmed 2002)	

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION MUMBAI

a) https://www.youtube.com/watch?v=w4jHpHoYZhk
b) https://www.youtube.com/results?search_query=artificial+respiration+methods
c) https://www.youtube.com/results?search_query=dielectric+tests+of+transformer
d) https://www.youtube.com/results?search_query=maintenance+charts+for+transformer
e) https://www.youtube.com/watch?v=ntOc4h792UE
f) https://www.youtube.com/watch?v=uMxK6djp_rI
g) https://www.youtube.com/results?search_query=transformer+oil+filtration+procedure
h) www.nptel.ac.in
i) www.wikipedia.com
j) www.electricaltechnology.org
k) www.howstuffworks.com
l) www.electrical4u.com

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION MUMBAI

Program Name : **Electrical Engineering Program Group**

Program Code : **EE/EP/EU**

Semester : **Sixth**

Course Title : **Utilization of Electrical Energy**

Course Code : **22626**

1. RATIONALE

Electricity is used in every walk of life whether it is home, office, industry or farm. It is being used for lighting, heating, cooking, air conditioning, operating machines/computers, welding, traction, irrigation. Due to power crisis, economical utilization of electrical energy and energy conservation is an essential aspect. Every diploma electrical engineer therefore should know to operate and maintain main electrical utilities for their efficient operations. Essential theoretical and practical knowledge will be achieved by this course.Keeping the above objectives in view, besides giving him basic knowledge in the topics concerned, attempts have been made to ensure that the knowledge acquired is applied in various fields as per his job requirements.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Maintain different types of electrical utilities and systems.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Maintain the functioning of different types of lamps and fittings.
b) Maintain different electric heating and welding equipment.
c) Maintain different electric drives and elevators.
d) Use different electric traction systems.
e) Use equipment for economic operation.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **ESE** -End Semester Examination; **PA** - Progressive Assessment*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the

course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

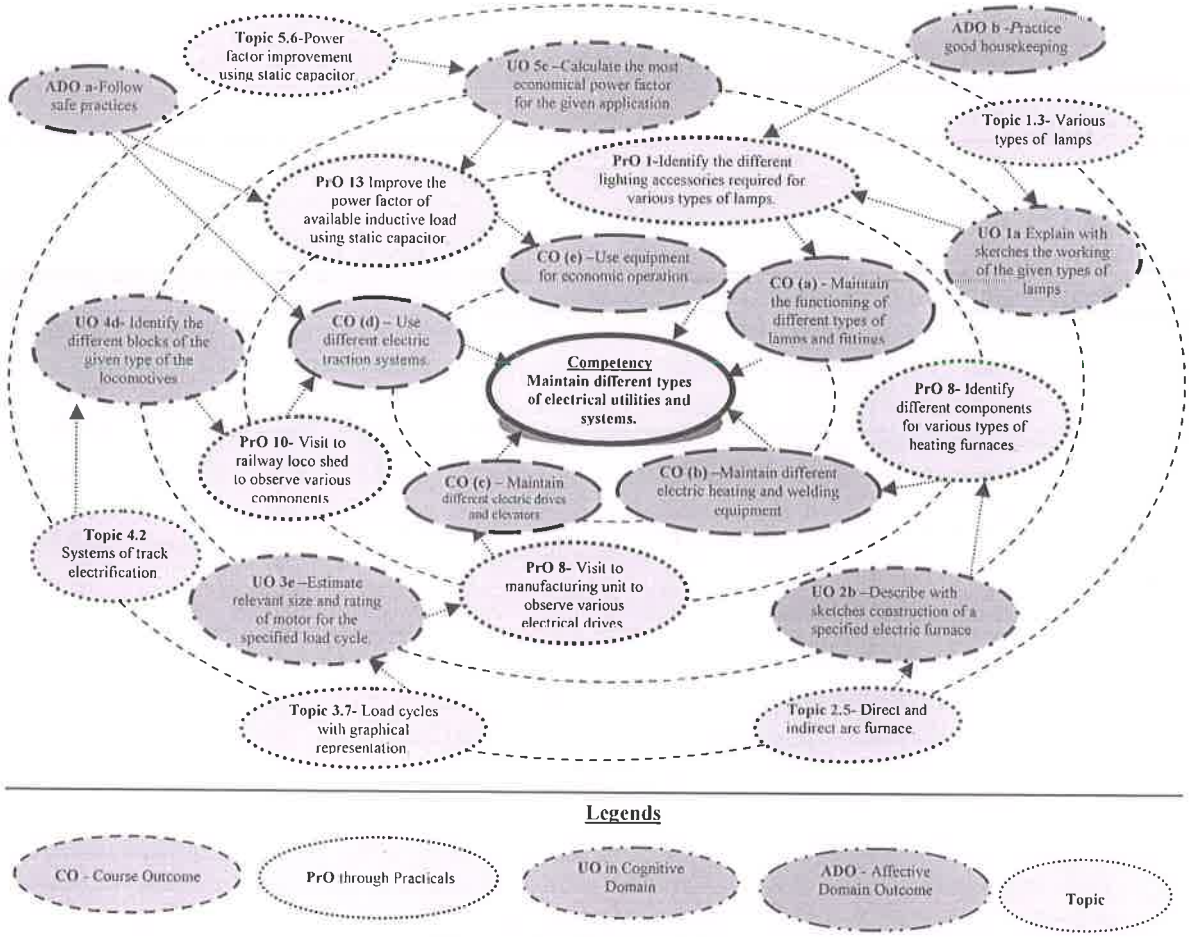


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs(i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

S.No	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Identify the different lighting accessories required for various types of lamps.	I	02*
2	Identify the different lighting accessories required for various types of lamp fittings.	I	02
3	Measure illumination at different places in college using luxmeter.	I	02*
4	Identify the different components required for various types heating furnaces	II	02*
5	Observe construction and working of various heating furnaces by watching video programmes.	II	02
6	Identify the different accessories and safety devices required for various types of welding system.	II	02
7	Prepare a report of specification of various electrical welding machines available in college workshop	II	02*
8	Visit a small manufacturing unit to observe various electrical drives and prepare a technical report.	III	02*

S.No	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
9	Prepare a comparative chart of two different manufacturing company in India for any two Lift/Elevator with technical data.	III	02
10	Visit a railway loco shed to observe various components and working of electric locomotive and prepare a technical report.	IV	02
11	Prepare a report /chart on various types of traction systems.	IV	02*
12	Prepare a report/chart on speed time curves.	IV	02
13	Improve the power factor of available inductive load using static capacitor.	V	02*
14	Prepare a report based on comparative study of various tariff structure of Maharashtra.	V	02
15	Prepare Energy Bill based on energy consumption of residence/ Institute	V	02*
16	Prepare a technical report after visiting an industry, various power factor improvement devices used. (otherwise from internet)	V	02
	Total		**32**

Note

i. *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practical's marked as '*' are compulsory and any 04 of remaining so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. *The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

S.No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and Recording	10
5	Interpretation of result and Conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
Total		**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a) Follow safety practices.
b) Practice good housekeeping.
c) Practice energy conservation.
d) Work as a leader/a team member.
e) Follow ethical Practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organisation Level' in 2nd year
- 'Characterisation Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTSREQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	FTL,CFL,LED of different suitable ratings,	01
2	Electric choke, Electronic ballast of different suitable ratings,	02
3	Digital Lux meter (UptoLUX-100K)	03
4	Heating furnace / Oven of suitable ratings	04,05
5	Video programme / internet information on various types of heating furnaces	05
6	Electrical welding machine of suitable rating.	06
7	Video programme / internet information on various types of welding systems	06,07
8	Industry visit / internet information for various types industrial drive	08
9	Video programme / internet information on various types of Elevators	09
10	Loco shed/ Track Electrification system visit for observing components /equipment related to traction	10,11
11	Ammeters MI Type: AC/DC 0-5-10Amp	13
12	Voltmeter MI Type: AC/DC, 0-150/300V, 0-250/500V	13
13	Wattmeter: Three phase double element 5/10Amp, 250/500V	13
14	Wattmeter: Single phase, single element 2.5/5Amp, 200/400V,	13
15	Dimmer: 1-phase,1kVA,230V	13
16	Dimmer: 3-phase, 5kVA	13
17	Three phase Power factor meters: AC, 415V, 50 Hz , 5-10 Amp	13
18	Load bank: Resistive, 3-phase, 5kW, 415V	13
19	Automatic power factor controller (APFC)	13
20	Video programme /internet information Tariffs electricity calculation	13
21	Clip on meter (amp, volts) digital/analog	13

8. UNDERPINNING THEORY COMPONENTS

The following topicsare to betaught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit-I Illumination.	1a. Explain with sketches the working of the given types of lamp (s) 1b. Describe with sketches the construction of the given type of lamp fitting. 1c. Explain with sketches the specified lighting scheme for the given application. 1d. Select the relevant lamp for the specified application with justification.	1.1 Definitions of various illumination terminology- Luminous flux, solid angle, luminous intensity, lux, candlepower, MHCP, MSCP, MHSCP, illumination, lamp efficiency, depreciation factor, maintenance factor, coefficient of utilization, space to height ratio, reflection factor, waste light factor, glare, shadow. 1.2 Laws of illumination: Inverse squares and Lambert's Cosine law. 1.3 Various types of lamps: Low pressure mercury vapour lamps(fluorescent

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	1e. Design simple lighting scheme for the given data. 1f. Describe the procedure to maintain the given type of lamp and fitting.	tube),Compact fluorescent Lamps (C.F.L.), High pressure mercury vapour lamps, Sodium vapour lamps, Metal halide lamps, LED lamps. 1.4 Various lighting schemes: features and application. 1.5 Domestic and industrial lamp fittings. 1.6 Electronic ballast.
Unit– II Electric Heating and welding systems.	2a. Explain with sketches and broad specifications working principle of the specified electrical heating system. 2b. Describewithsketches construction of the specified electric furnace. 2c. Recommend therelevantheatingsystem for the given application with justification. 2d. Design the heating element of the given type of furnace forthe specified data. 2e. Select the relevant welding system for aspecifiedapplication with justification. 2f. Describe the procedure to maintain the given type of heating and welding system.	2.1 Concept of electrical heating, classification of electric heating, modes of heat transfer. 2.2 Direct andindirect resistance heating: workingprincipleandconstruction and applications. 2.3 Requirements of resistance heating element material, methods of temperature control, design of heating element. 2.4 Arc Heating: Working principle,properties of material used for electrode, advantages of graphite electrode over carbon electrode. 2.5 Direct arc furnace and indirect arc furnace:construction and operation, specifications,applications. 2.6 Induction heating: Working principle, applications. 2.7 Direct core type furnace:Constructionand working of horizontal and vertical type. 2.8 Coreless type inductionfurnace: Construction, working and applications. 2.9 Dielectric heating: workingprinciple, and applications. 2.10 Eddy current heating: working principle and applications. 2.11 Types of welding systems:plastic and fusion, classifications of electrical welding system. 2.12 Quality of a good weld, welding defects. 2.13 Resistance welding:spot,seam,butt, projection welding and their working principles and applications. 2.14 Arc welding: working principle, characteristics of arc, factors on which arc length, methods of arc stabilization,types of electrodes, advantages of coated electrode. 2.15 Metal and carbon arc applications. 2.16 Supply requirements;AC welding machines-welding transformer, safety precautions.
Unit-III Electric Drives and	3a. Differentiate the salient features between the given types of electric drives.	3.1 Electric drives: concept,factors governing selection of electric drives (motor).

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Elevators.	3b. Recommend relevant motor for the given application with justification. 3c. Select the relevant enclosure of motor for the given atmospheric condition with justification. 3d. Select the power transmission drive of the electric motor for the given application with justification. 3e. Estimate relevant size and rating of electric motor for the specified load cycles. 3f. Explain with sketches relevant braking system for the given electric motor. 3g. Select relevant elevator machine and electric motor for the specified application with justification. 3h. Describe the procedure to maintain the given electric drive and elevator.	3.2 Types of electrical drives: Individual and group drive, applications. 3.3 Mechanical features of drives: Purpose, types and application of various types of enclosures. 3.4 Transmission of mechanical power: Direct and indirect drive(Belt, Rope, Chain, Gear),Vertical drives and its applications. 3.5 Bearing: Types and applications. 3.6 Size and rating of motor, Definition of standard rating as per IS. 3.7 Load cycles: Concept with graphical representation. 3.8 Load Equalization: Meaning, methods and condition of load equalization. 3.9 Braking : Definition of braking, requirements of ideal braking system, 3.10 Types of electrical braking systems: Plugging, rheostatic (Dynamic) and regenerative braking for D.C. series motor and three phase Induction motor. 3.11 Elevators: Function, application, Types, its motors and safety. 3.12 Factors on which shape and size of car depends. 3.13 Bombay Lift Act 1939. (Latest Amendment).
Unit –IV Electric Traction	4a. Recommend relevant traction system for the given application with justification. 4b. Select the relevant track electrification system for the specified traction services with justification. 4c. Differentiate the salient features between the given types of track electrification system. 4d. Draw the speed-time curvefor the specified electric traction application. 4e. Differentiate between the given types traction services based on the given criteria. 4f. Determine average and schedule speed for the giventraction services. 4g. Describe the procedure to	4.1 Requirements of an ideal traction system, different types of traction system used in India: Electric and diesel electric 4.2 Systems of track electrification: D.C., single phase 25kV A.C., composite system 4.3 Traction mechanics : Block diagram of A.C. electric locomotive and function of each part. 4.4 Traction motors: Desirable characteristics, D.C. series motor, single phase A.C. series motor, chopper controlled motors 4.5 Definition of average and schedule speed, factors affecting schedule speed. 4.6 Speed-time curve: Trapezoidal and quadrilateral speed time curve and its applications. 4.7 Current collecting system: Over head wire and conductor rail system, current

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	maintain the given electric traction system.	collector - pantograph types. 4.8 Traction services: Urban, suburban, main line services. Metro rail and monorail: main features that different them, types of electric motors used, current collectors, speed time characteristics
Unit-V Tariff and Power Factor Improve ment	5a. Select the relevant tariff for the given applications with justification. 5b. Explain with the sketches the relevant method for power factor improvementforthe given load. 5c. Calculate the most economicalpower factor forthegiven application(s). 5d. Describe the procedure to maintain the specifiedpower factor of the system.	5.1 Tariff: Desirable characteristics, types(Flat rate, block rate, KVA maximum demand andTime of Day tariff). 5.2 Power factor: Disadvantage of low power factor, advantages ofimprovedp.f., causes of low p.f.,avoidance of low p.f. without using p.f.improvementdevices. 5.3 Power factor improvement using; static capacitor, most economical power factor,location of power factorimprovement devices from consumer and electrical supply company point of view.

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'ApplicationLevel'and above of Bloom's 'Cognitive Domain Taxonomy'

9. SUGGESTED SPECIFICATION TABLE FORQUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Illumination	08	02	02	04	08
II	Electric Heating and Welding System	18	04	06	08	18
III	Electric Drives and Elevator	16	02	08	08	18
IV	Electric Traction	16	04	06	08	18
V	Tariff and Power factor improvement	06	02	02	04	08
Total		64	**14**	**24**	**32**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct any two of the following activities in group

and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare a survey report after collecting technical information of various lamps available in the local market(otherwise from internet).
b) Prepare a report on different luminaries available in the market and collect the technical data
c) Preparing reports based on tutorial practices.
d) Assignments for solving numerical.
e) Identify different types of illumination schemes in the Institute.
f) Note the ratings of various types of welding machines in the Institute workshop.
g) Prepare chart of various electrical equipment used for heating.
h) Seminar on elevators.
i) Seminar on latest electric traction in India.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c) About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d) With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e) Guide student(s) in undertaking micro-projects.
f) Flash/Animations to explain working of Electric Locomotive and Elevators.
g) Pre-guided visits to, railway stations and elevator manufacturing companytoobserve operation.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project isgroup-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that she/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects isgiven here. Similar micro-projects could be added by the concerned faculty:

a) **Illumination:** Design suitable lighting scheme for a laboratory or class room.
b) Prepare report on market survey of various types of lamps(specification, manufacturer, application and cost) and do its comparative analysis.
c) **Electric heating:** Prepare power point presentation related to heating furnaces.

d) **Electric welding:** Prepare power point presentation related to welding equipments and accessories.
e) **Electric Drives**: Prepare report on market survey of various drives (specification, manufacturer, application and cost).
f) **Elevators**: Prepare report on market survey of various Lift and Elevator (specification, manufacturer, application and cost) and collect Lift and Elevator Act.
g) **Electric Traction**: Prepare power point presentation related to Electric traction systems in India and its comparative analysis.
h) Prepare a chart of Electric Locomotive and show the various components.
i) **Tariff**: Calculation of electricity bill for their own residence/ Institute.
j) **Power factor Improvement**: Prepare the report on the power factor improvement process in the nearby substation/Institute/Small scale industry.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Art and Science of Utilization of Electrical Energy	Partab, H.	Dhanpat Rai &Sons, New Delhi, 2017, ISBN:9788177001440.
2	Utilization of Electric Power and Electric Traction.	Gupta,J. B.	S. K. Kataria& Sons, New Delhi, 2016, ISBN: 978-9350142585
3	Utilization of Electric Power and Electric Traction	Garg,G. C.	Khanna Publishers, New Delhi, 2016, ISBN-8174091645.
4	Electric Traction	Upadhyay, J. Mahendra,S. N.	Allied Publisher Ltd., New Delhi, Latest edition ISBN-8177640054|9788177640052
5	Fundamentals of Electrical Drives	Dubey,G. K.	Narosa Publishing House. New Delhi, Latest edition ISBN-8173190410, 9788173190414.
6	Principles of Power system	Mehta,V.K.	S.Chand, New Delhi, Latest edition ISBN-9788121924962.
7	Generation and Utilization of Electrical Energy	Sivanagaraju, S. Balasubba Reddy M., SrilathaB.	PearsonEducation, New Delhi, 2016 ISBN-9789332515673
8	Modern Electric Traction	Partab, H.	Dhanpat Rai & Sons , New Delhi, 2016, ISBN: 1234567147206

14. SOFTWARE/LEARNING WEBSITES

a) www.nptel.iitm.ac.in
b) www.howstuffworks.com
c) www.khanacademy.com
d) https://www.youtube.com/watch?v=CoHVA7nr82A
e) https://www.youtube.com/watch?v=7GLiBwgVBLQ
f) https://www.youtube.com/watch?v=fakGLu03jYg
g) https://www.youtube.com/watch?v=fQrZMMWo1mA
h) https://www.youtube.com/watch?v=BDMFsYnTdVI
i) https://www.youtube.com/watch?v=49rH3buD0bc
j) https://www.youtube.com/watch?v=82EFMvYcbN4
k) https://www.youtube.com/watch?v=AAyLKnz4UJY

l) https://www.youtube.com/watch?v=EN2ee15BIyg
m) https://www.youtube.com/watch?v=XdrVwsQIgao
n) https://www.youtube.com/watch?v=F1MM2gjCv7I

IS, BIS and International Codes:

o) IS 1860-1980 code of practice for installation, Operation and maintenance of electric Passenger and goods lifts.
p) IS 3534-1976 Outline Dimensions of Electric Lifts.

Program Name : **Electrical Engineering Program Group**

Program Code : **EE/EP/EU**

Semester : **Sixth**

Course Title : **Electrical Estimating and Contracting**

Course Code : **22627**

1. RATIONALE

The wiring installations are important aspects of any electrical installations. This course will empower the students with the necessary principles of planning, electrical bylaws, supply system and method of installations. This course will also help the students to work as contractors, an entrepreneur and execute different electrical installations work.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Plan electrical installations with their cost estimates.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following ***industry oriented*** COs associated with the above mentioned competency:

a. Interpret various electrical diagrams.
b. Prepare estimate of domestic and commercial electrical installations.
c. Prepare estimate of industrial electrical installations.
d. Prepare estimate of overhead and underground distribution lines.
e. Prepare estimate of public lighting installations.
f. Prepare quotation, tender and other related documents.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

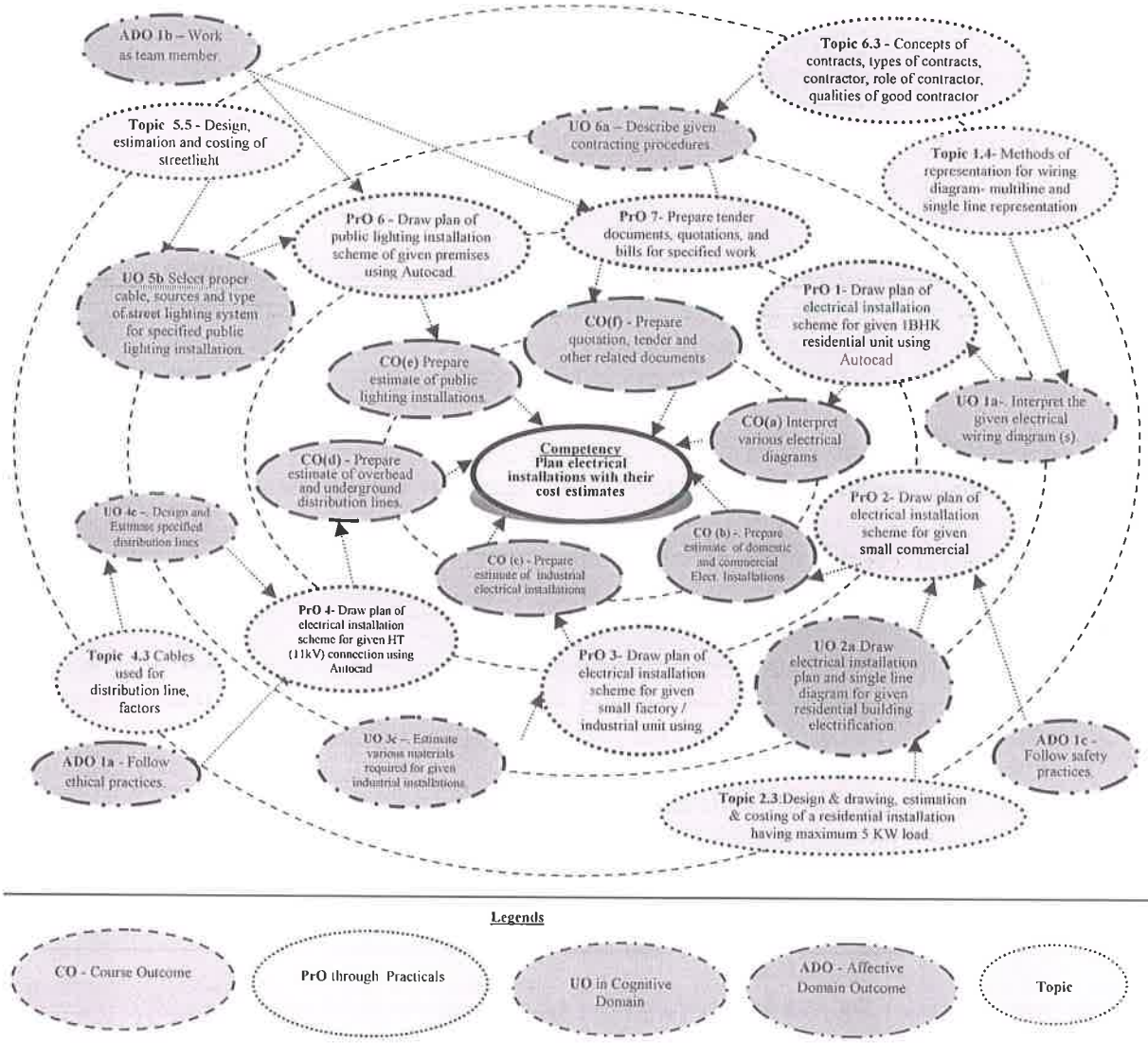


Figure 1 - Course Map

6. SUGGESTED PRACTICALS / EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Draw plan of electrical installation scheme for 1BHK residential unit using Auto-cad and prepare list of materials required.	II	
	1a. Draw the symbols of installation components on the plan showing their location.	II	01#
	1b. Draw the installation wiring route diagram for the plan.	II	01*
	1c. Draw single line wiring diagram of residential installation	II	01#
	1d. Prepare list of materials required.	II	01*

2	Draw plan of electrical installation scheme for small commercial unit using Auto-cad. Also, determine rating of main and sub-distribution board.	II	
	2a. Draw the symbols of installation components on the plan showing their location.	II	01*
	2b. Draw the installation wiring route diagram for the plan	II	01#
	2c. Draw single line wiring diagram of commercial installation.	II	01*
	2d. Determine rating of main and sub distribution board.	II	01*
	# any one * Compulsory		
3	Draw plan of electrical installation scheme for small factory / industrial unit using Auto-cad and type and rating of starter, protective relay.	III	
	3a. Draw the symbols of installation components, starter and motor on the plan showing their location.	III	02*
	3b. Draw the installation wiring route diagram for the plan.	III	01*
	3c. Draw single line wiring diagram of industrial installation.	III	01*
	3d. Determine type and rating of starter, protective relay.		01*
4	Draw plan by using Auto-cad and Estimate the size/ rating of electrical installation system for HT (11kV) scheme.	IV	-
	4a. Draw the symbols of installation components along with equipments (i.e. Transformer, CT, PT and ACB) on the plan showing their location.	IV	02*
	4b. Draw the installation wiring route diagram for the plan.	IV	01*
	4c. Draw single line wiring diagram of HT (11kV) installation.	IV	02*
	4d. Estimate the size/ rating of electrical installation system for HT (11kV) scheme.	IV	02*
5	Draw plan of electrical service installation scheme for LT (415V) line connection using Auto-cad. Prepare the list material required.	IV	
	5a. Draw single line wiring diagram of Overhead service connection.	IV	02*

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	5b. List the components required for Overhead service connection.	IV	01*
	5c. Draw single line wiring diagram of Underground service connection.	IV	02#
	5d. List the components required for Underground service connection.	IV	01#
	# any one * Compulsory		
6	Design public lighting installation scheme and Draw plan for the designed lighting scheme using Auto-cad.	V	-
	6a. Draw plan showing location of street lamp post and stay wire.	V	02*
	6b. Draw connection wiring diagram of street lamp post installation.	V	02*
7	Prepare tender documents, quotations, and bills for specified work.	VI	02*
		Total	32

Note

i. *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. *The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

S. No.	Performance Indicators	Weightage in %
1	Drawing using AutoCAD	40
2	Understanding line diagram	25
5	Answer to sample questions	25
6	Submission of report in time	10
Total		**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a) Follow safety practices.
b) Practice good housekeeping.
c) Practice energy conservation.
d) Work as a leader/a team member.
e) Follow ethical Practices.

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The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organisation Level' in 2nd year
- 'Characterisation Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by administrators.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	NIL	-

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Electrical Wiring Diagram/ (s)	1a. Draw the diagram/(s) of specified electrical installation. 1b. Convert the given wiring diagram into single line diagram. 1c. Explain the specified method of representation of wiring diagram. 1d. Convert the specified single line diagram into the wiring diagram. 1e. Describe the requirements of NEC 2011 related to the given electrical installation.	1.1 Electrical symbols used in electrical diagrams as per Indian standard, multiline and single line representation of conductors. 1.2 Electrical diagrams, their Classification. Definition of wiring and circuit (Schematic) diagram according to IS: 2042(Part-I)-1962. 1.3 Methods of representation for the wiring diagram- multiline and single line representation, conversion of multiline representation into single line and vice versa 1.4 Fundamental principles for electrical installations, Safety in electrical work, permit to electrical work, safety instruction and safety practices 1.5 Scope and features of National Electrical Code 2011 (NEC 2011), Types of electrical installation- Non industrial and industrial, Standard value of voltages and their limits,
Unit – II Domestic and commercial Installations	2a. Draw electrical installation plan and single line diagram for the given residential building electrification. 2b. Draw electrical installation plan and	2.1 Domestic Dwellings/Residential Buildings, its classification, Necessity and reading of Civil Engineering building drawing. Interpretation of electrical installation plan and electrical diagrams. 2.2 General requirements and inspection of electrical installation according to IS: 732-

	single line diagram for the given commercial building electrification. 2c. Estimate materials required for the given domestic and commercial installations. 2d. Estimate materials required for the specified residential service connection.	1982. 2.3 Design and drawing, estimation and costing of a residential installation having maximum 5 KW load. 2.4 Design consideration of electrical installation in commercial buildings. Design electrical installation scheme of commercial complex such as drawing halls, and auditorium. 2.5 Residential building Service Connection- types Underground and overhead. Calculation of Material required for service connection.
Unit- III Industrial Installations	3a. Compare the installations on the given points. 3b. Draw an installation plan, wiring diagrams and single line diagrams for the given industrial installations. 3c. Design the given industrial installation. 3d. Estimate various materials required for the given industrial installations.	3.1 Classification of industrial buildings, Classification based on power consumption, Difference between non-industrial and industrial load, General characteristics of industrial building, selection of wiring system 3.2 Drawing of wiring diagram and single line diagram for single phase and three phase motors. 3.3 Design consideration in industrial installations. 3.4 Design electrical installation scheme and preparation of small industrial unit having total aggregate three -phase load of 30 KW, agricultural pump and flourmill. 3.5 Erection, Inspection and testing of installation as per part 1 section 13 of NEC 2011.
Unit– IV Distribution Lines	4a. Draw the diagram for the given three phase three wire and three phase four wire system by using different types of insulators. 4b. Draw the given pole structures. 4c. Design the specified distribution lines. 4d. Prepare the estimate for the specified distribution lines.	4.1 Introduction to overhead and underground distribution line. 4.2 Materials used for distribution line HT (11KV) and LT (415 V) 4.3 Cables used for distribution line, factors determining selection of LT/ HT power cables, and cable termination methods. 4.4 Design, estimation and costing of HT (11KV), LT (415 V) overhead line and underground cabling.
Unit– V Public Lighting Installation	5a. Draw the installation plan, single line diagram and the other related drawings of specified public lighting installation. 5b. Select the suitable cable, sources and type of street lighting system for specified public lighting	5.1 Classification of outdoor installations, streetlight/ public lighting installation 5.2 Terminology used according to NEC 2011 – Terms related to highway, lighting installation, photometric terms, luminaries etc. Aim of public lighting installation, classification of roads, standard layout of roads. 5.3 Street light pole structures. Selection of equipments, sources used in street light installations. 5.4 Cables, recommended types and sizes of cable.

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	installation with justification. 5c. Prepare the list of the given materials required for the given public lighting installations. 5d. Design the specified public lighting installations. 5e. Prepare an estimate for the specified public lighting installation.	On off Control of equipments of street light installation. 5.5 Design, estimation and costing of streetlight.
Unit– VI Contracting	6a. Describe purposes of the given types of estimates and contracts. 6b. Decide the type of estimate for the given work. 6c. Describe the given contracting procedures. 6d. Prepare tender documents, quotations, and bills for the specified work. 6e. Compare tenders and quotations on the given criteria. 6f. Explain the specified actions for e-tendering.	6.1 Purpose of estimating and costing, Qualities of good estimator, essential elements of estimating and costing. 6.2 Meaning and purpose of- Rough estimate, detailed estimate, supplementary estimate, annual maintenance estimate and revised estimate, Factors to be considered while preparation of detailed estimate and economical execution of work. 6.3 Concepts of contracts, types of contracts, contractor, role of contractor, qualities of good contractor 6.4 Type of tender, tender notice, preparation of tender document, and method of opening of tender;e-tendering. 6.5 Quotation, quotation format, comparison between tender and quotation. Comparative statement, format of comparative statement. Order format, placing of purchasing order 6.6 Principles of execution of works, planning, organizing and completion of work, Billing of work.

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Electrical Wiring Diagram/ (s)	04	02	00	04	06
II	Domestic and commercial Installations	14	02	08	08	18
III	Industrial Installations	10	02	04	08	14
IV	Distribution Lines	08	02	04	08	14
V	Public Lighting Installations	08	02	02	08	12

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
VI	Contracting	04	02	00	04	06
Total		**48**	**12**	**18**	**40**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare abstract of Indian standards related to industrial and non-industrial installations.
b) Use E- tab for small assignments.
c) Summarize given section of National Electrical Code (NEC), 2011 required for electrical installation.
d) Prepare report on market survey of various electrical accessories, wires and cables (specification, manufacturer, quality, cost)
e) Collect any one electrical drawing of existing electrical installation and prepare estimate for the same.
f) Collect information of tender published in newspaper or of e-tender related to industrial or non-industrial electrical installation and fill necessary documents.
g) Prepare power point presentation for acquiring electrical installation work.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c) About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d) With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e) Use Flash/Animations to explain various theorems in circuit analysis
f) Guide student(s) in undertaking micro-projects.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually***

undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

a. **Electrical Diagrams**: Prepare a report on existing electrical drawing.
b. **Domestic and commercial Installations**: Collect civil engineering drawing and prepare estimation for the same.
c. **Industrial Installations**: Collect industrial installation plan and prepare estimation for the same using softwares as E-tab etc.
d. **Distribution Lines**: Collect existing installation plan of distribution lines and prepare estimation for the same.
e. **Public Lighting Installations**: Collect existing installation plan of street lighting scheme and prepare estimation for the same.
f. **Contracting:** Collect any tender document related to electrical installation and fill all related documents.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Electrical Wiring Estimating and Costing	Uppal, S.L. C.G. Garg	Khanna Publisher New Delhi, ISBN 9788174092403
2	Electrical Design Estimating and Costing	Raina, K.B. Dr. Bhattacharya, S.K.	New Age International Publisher, First, Reprint 2010, ISBN: 978-81-224-0363-3
3	Electrical Estimating and Costing	Singh,Surjit Ravi Deep Singh,	Dhanpat Rai and Sons, 2014 New Delhi, ISBN:1234567150995
4	Electrical Estimating and Costing	Allagappan, N. S.Ekambarram,	Tata Mc-Graw Hill Publishing Co. Ltd, First Edition, 2000, ISBN:9780074624784
5	A Course in Electrical Installation Estimating and Costing	J.B. Gupta	S.K. Kataria and Sons; New Delhi Reprint Edition, 2013, ISBN: 13: 978-9350142790
6	SP-30:2011, National Electrical Code, 2011	-	Bureau of Indian Standard.
7	IS: 732-1989, Code of Practice for Electrical Wiring Installation	-	Bureau of Indian Standard.
8	Handbook of e-tab		

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a) https://ask-the-electrician.com/wiringdiagrams.html

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b) https://www.btechguru.com/courses--nptel--electrical-engineering-video-lecture--ee.ht...
c) https://www.electricaltechnology.org/2013/09/electrical-wiring.htm
d) https://www.howstuffworks.com/search.php?terms=electrical%20installatio
e) https://www.electrical4u.com/electrical-engineering-articles/utilities/
f) http://www.neca-neis.org/the-standards
g) http://www.metlabs.com/product-safety/2011-national-electrical-code-nec-updates-standard-for-the-safe-installation-of-electri

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Program Name : **Electrical Engineering Program Group**

Program Code : **EE/EP/EU**

Semester : **Sixth**

Course Title : **Emerging Trends in Electrical Engineering**

Course Code : **22628**

1. RATIONALE

Every technological area is developing at an exponential rate. New applications are coming up and it's mandatory for all technologists to be well versed in these areas to survive and provide satisfactory and quality services to the society in respect of such technologies. This course aims to prepare the diploma graduates to be conversant with such emerging trends for staying in the race. The main areas in which such developments are in, encompasssmart systems, intelligent motor controls, tariff and digitization beyond automation. The course gives a decent introduction of these areas and helps the students to be in a state of preparedness.

2. COMPETENCY

Aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Use the trending practices in electrical engineering fields.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Suggest the relevant IoT technologies for electrical systems.
b) Suggest the relevant components for implementing a smart grid.
c) Suggest different electrical systems for a smart city.
d) Suggest the relevant MCC or IMCC for the given application/s.
e) Propose the relevant improved tariff and metering for the specified type of consumer.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												Grand Total
				Theory Marks						Practical Marks						
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total		
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	
3	-	-	3	90 Min	70*#	28	30*	00	100	40	-	-	-	-	-	-	100

(#): Online examination of 90 minutes duration.0*
(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests (of MCQ type) to be conducted during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

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Legends: ***L****-Lecture;* ***T*** *– Tutorial/Teacher Guided Theory Practice;* ***P*** *-Practical;* ***C*** *– Credit,* ***ESE*** *–End Semester Examination;* ***PA*** *- Progressive Assessment#-External Assessment*

5. COURSE MAP (with sample COs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

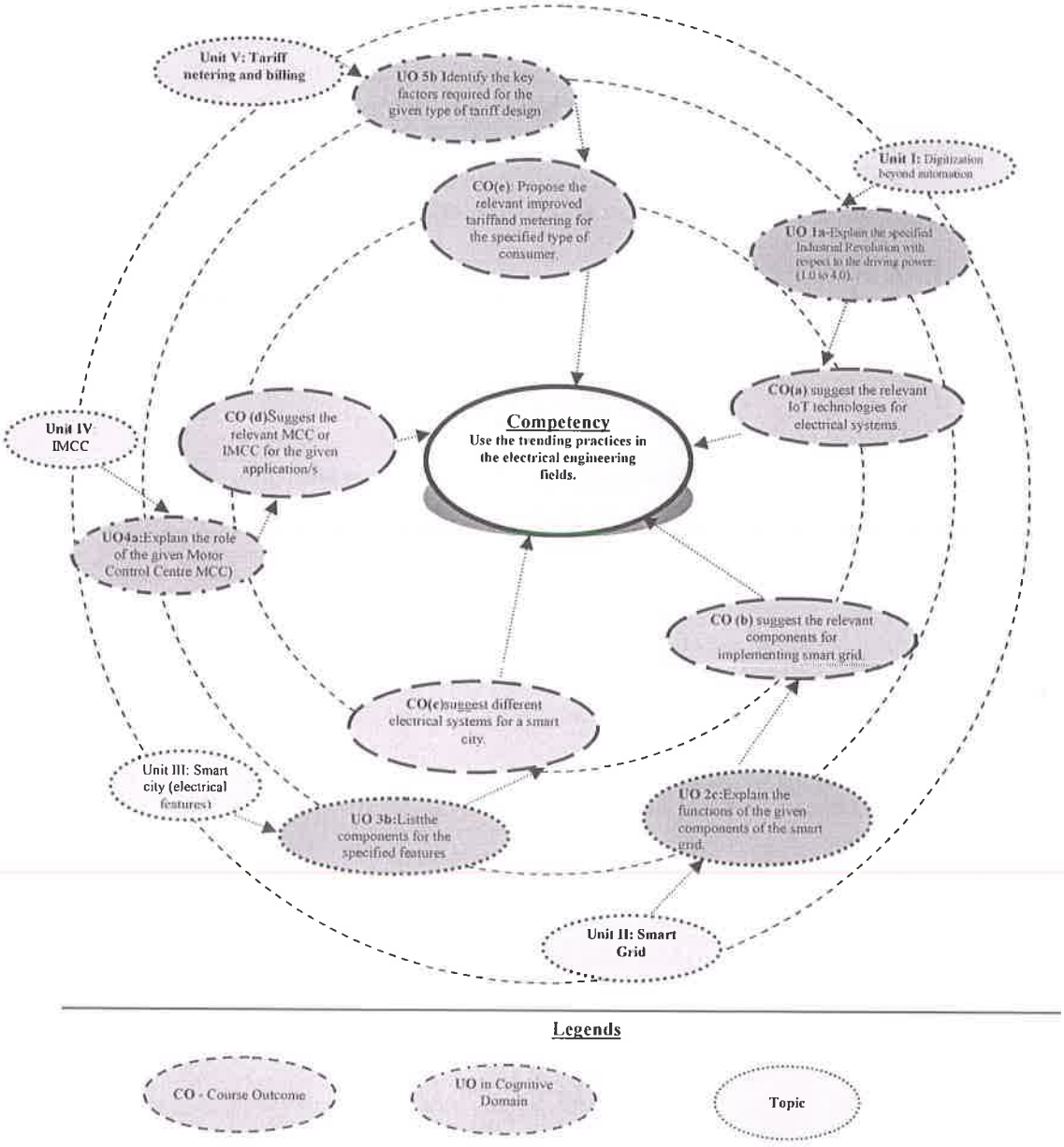


Figure 1 - Course Map

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6. SUGGESTED PRACTICALS/ EXERCISES: Not Applicable

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED: Not Applicable

8. UNDER-PINNING THEORY COMPONENTS

The following topicsare to betaught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Digitization beyond automation	**1a.** Explain the specified Industrial Revolution with respect to the driving power. (1.0 to 4.0). **1b.** Compare the specified Industrial revolutions with reference to the given points. **1c.** Explain the importance of the Industrial Revolution 4.0 with respect to the specified component/s. **1d.** Explain the principle of IoT used in the given application. **1e.** Explain the IoT used in the given electrical application. **1f.** Explain the IoT approach used in the given application for the power distribution system.	**1.1 Industrial Revolutions:** Versions 1.0, 2.0, 3.0 and 4.0; the driving energies/powers for these revolutions. **1.2 Components of Industrial Revolution 4.0**: CPS (Cyber Physical Systems), IoT (Internet of Things), Cloud Computing and Cloud Manufacturing. **1.3 IoT principle and features.** **1.4 IoT application areas in electrical systems**: building automation SCADA, Smart metering, Illumination systems (public lighting). **1.5 IoT initiatives in power distribution systems:** Mobile Apps, Geo coordinates of the network as well as consumer premises, Various digital service platforms for consumers.
Unit- II Smart Grid	**2a.** Explain the need for the given smart grid. **2b.** Draw a labeled layout for the specified smart grid. **2c.** Explain the functions of the given components of the smart grid. **2d.** Identify the barriers for the given smart grid. **2e.** Identify the advantages for the given smart grid. **2f.** List the smart grid projects in the Indian grid. **2g.** Explain the need for the given micro grid.	**2.1 Smart Grid**: Need and evolution, layout and its components,Advantages and barriers, Smart Grid Projects in India. **2.2 Micro-Grid & Distributed Energy Resources**:Needand formation of micro grid, Distributed Generation Systems and Distributed Generation Technologies. **2.3 Smart Substation**:Need, Layout and Components,Typical Specifications of existing substations.

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Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	2h. Explain the general layout of the micro grid. **2i.** Explain the working of the given micro grid. **2j.** Explain the significance of the Distributed Generation Systems in the given power scenario. **2k.** Explain the given Distributed Generation Technology. **2l.** Explain the functions of the given components of the smart substation. **2m.** Compare the smart substation and conventional substation for the given criteria.	
Unit– III Smart City (Electrical Features)	**3a.** Explain the relevant features of the specified smart city. **3b.** List the components for the specified features. **3c.** Explain the importance of e-vehicles in the given scenario (environment and energy). **3d.** Explain the working of the given type of e-car. **3e.** Explain with sketch (block schematic) the working of the given type charging station. **3f.** Identify the features of the given fuel cell used in e-cars. **3g.** Identify the barriers for the adoption of e-cars in the specified scenario. **3h.** Identify the components required for the specified features in the given smart home. **3i.** Identify the illumination and its control components /devices for a specified room of a given smart home. **3j.** Explain with schematic sketch the working principle of the given appliance in a	**3.1 Smart City:**Features, components, Objectives and challenges of smart Cities in India. **3.2 E-car:**Role of Electric Vehicles in energy transition, basics of electric car, types of electric cars, working principle, charging stations. Fuel cell for e-cars, types, features, limitations. **3.3 SmartHome:**Features and Components.Illumination and smart appliance control principles (block diagram/s).

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Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	smart home.	
Unit– IV Intelligent Motor Control Centers	**4a.** Explain the role of the given Motor Control Centre MCC). **4b.** List the devices and components used in (with functions) the given MCC. **4c.** Explain the roles of the components of the given motor control centre (MCC). **4d.** Explain the need for the given type of MCC. **4e.** Explain the roles and functions of the devices /components of the specified IMCC. **4f.** Prepare the outline with components of the IMCC suitable for a given application. **4g.** List the advantages of given type of MCC. **4h.** List the disadvantages of given type of MCC. **4i.** List the advantages of given type of IMCC. **4j.** Suggest an IMCC for a given set of applications.	**4.1 General/traditional (conventional) Motor control center:** Role in Motor protection and motor management. Typical block diagram and general architecture or arrangement. Components: symbols and functions. Traditional MCCs: advantages and disadvantages. **4.2 Intelligent or Smart MCCs:** Need and the requirements that lead to have IMCCs. Role as compared to traditional MCCs. Functional Block diagram/s with general arrangements. **4.3 Devices and Components typical to IMCCs**: Intelligent relays, fuses, control devices, effective security and dedicated software. **4.4 Basic components of intelligent systems**: Control by microprocessor/microcontroller-based systems; networking/technology replaces hard wiring and enhanced diagnostic/protective functionality. **4.5 Selection of MCC**: intelligent and conventional types for typical applications.
Unit– V Tariff, Metering and Billing	**5.a** Describe terms related to tariff economics. **5.b** Identify the key factors required for the given type of tariff design. **5.c** Identify the components for the given type of consumer's electricity bill. **5.d** Compare Average Billing Rate (ABR), Aggregate Revenue Requirement (ARR). **5.e** Explain the suitability of ABT for the given type of	**5.1Tariff:**Power Purchase, Power Purchase Agreements (PPA), Power purchase cost. **5.1.1Tariff Design**:Key factors for Tariff Design, Major Components of an Electricity Bill, various slabs in billing, electricity duty, tax on electricity and Cross subsidy. **5.1.2Special tariffs**: Average Billing Rate (ABR), Aggregate Revenue Requirement (ARR), Availability based Tariff (ABT), Time of Day Tariff (ToD),Recent ToD structure

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	consumer. **5.f** Suggest with justification the applicable type of tariff for the given type of consumer in the present-day scenario. **5.g** Explain the working principal of kVAh meter. **5.h** Determine the electricity bill for the given type of consumer by kVAh billing methodology. **5.i** Differentiate between Net metering and Gross metering. **5.j** List out the relevant MERC rules for Net-metering billing. **5.k** Explain with schematic diagram the use of Net-metering principle for integration of micro-generators with grid system. **5.l** Explain with schematic diagram MRI/AMR reading techniques for the given consumer.	**5.1.3kVAhtariff:**kVAhbilling method for HT and LT Consumers, kVAh Metering methodology, kVAh based Billing calculation, **5.2 Metering and Bill Management:** Working of Net metering and Gross metering, MERC rules for Net-metering bill (Regulations 2015), Application of Net Metering for integration of micro-generators with grid system. Recent Meter Reading techniques-MRI/AMR reading.

***Note**:To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Digitization Beyond Automation	08	04	02	02	08
II	Smart Grid	08	06	04	02	12
III	Smart City (Electrical Features)	08	08	06	02	16
IV	Intelligent Motor Control Centers	12	04	06	08	18
V	Tariff, Metering and Billing	12	04	08	04	16
	Total	**48**	**26**	**26**	**18**	**70**

***Legends:** R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
***Note**: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual*

distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages (one activity by each group), also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Perform general survey regarding the recent electrical technologies.
b. Prepare a power point presentation on IoT applications.
c. Perform Group discussion on new electricity tariff approaches.
d. Prepare a visit report on IMCC.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Show video demonstration on safety precautions.
g. Demonstrate the actions and care to be taken.
h. Arrange a visit to.
i. Arrange expert lecture of industry person.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the year. In the first two years, the micro-project are group-based. However, in the third year, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs as applicable. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

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A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

a. Prepare a report on existing automation in an industry and suggest improvements.
b. Prepare a reporton Smart Grid.
c. Prepare a report on any four Electrical Applications in Smart cities.
d. Present a power point presentation on various IMCCs.
e. Prepare a report on the procedure of meter reading by MRI and AMR techniques.
f. Conduct a survey and prepare a report on the IMCCs in one industry.
g. Prepare a report on mobile apps used for energy billing procedures.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Fundamentals of Smart Grid Technology	Bharat Modi, AnuPrakash, Yogesh Kumar	S.K. Kataria& Sons; 2015 EditionISBN-10: 9350144859, 13: 978-9350144855
2	Smart Grid: Technology and Applications	JanakaEkanayake, Kithsiri Liyanage et al,	Wiley, 2015 Edition ISBN-10: 9788126557356, 13: 978-8126557356
3	Sustainable Smart Cities in India: Challenges and Future Perspectives	Sharma, Poonam, Rajput, Swati	Springer, ISBN 978-3-319-47145-7
4	Control of Electrical Machines	S K Bhattacharya	New Age International ISBN 8122409970, 9788122409970
5	Handbook of Electrical Motor Control Systems	U. S. Eshwar	Tata McGraw-Hill Education ISBN 0074601113, 9780074601112
6	Applied Intelligent Control of Induction motor Drives	Keli Shi and Tze Fun Chan	Wiley ISBN 10:0470825561, 13:978-0470825563
7	Art of Reading Electricity Bill	Mr. YogendraTalware	Strom EnergiePvt. Ltd. Pune. (stromenergie.pune@gmail.com)

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. http://www.slideshare.net.in (search with relevant key words)
b. www.youtube.com (search with relevant key words)
c. https://en.m.wikipedia.org/wiki/Technological_revolution#Potential_future_technological_revolutions (general introduction to the new industrial revolution)
d. https://www.plm.automation.siemens.com/global/en/our-story/glossary/industry-4-0/29278 (Industrial revolution 4.0)

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e. https://www.industry.siemens.com/topics/global/en/digital-enterprisesuite/Documents/PDF/PLMportal_Industrie-40-Internet-revolutionizes-the-economy.pdf (Industrial revolution 4.0)
f. https://www.trendmicro.com/vinfo/us/security/definition/industrial-internet-of-things-iiot (Internet of things)
g. https://www.leverege.com/blogpost/difference-between-iot-and-iiot
h. https://www.computradetech.com/blog/iot-vs-iiot/
i. https://www.quora.com/Who-coined-the-term-internet-of-things
j. https://iot-analytics.com/the-leading-industry-4-0-companies-2019/
k. http://www.mercindia.org.in/pdf/Order%2058%2042/Order-195%20of%202017-12092018.pdf (MERC order on metering)

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION MUMBAI

Program Name : **Electrical Engineering Program Group**

Program Code : **EE/EP/EU**

Semester : **Sixth**

Course Title : **Industrial Drives and Control (Elective-II)**

Course Code : **22629**

1. RATIONALE

The electrical engineering applications in many industries use small and large AC and DC motors in some crucial application systems. Further electrical speed control in almost all industrial applications are incomplete without the use of the specific electric drive. This course will empower the students with the necessary skills to identify operate and maintain the AC and DC drives.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Maintain different types of electric drives.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following ***industry oriented*** COs associated with the above mentioned competency:

a) Identify the relevant electric drive for the required speed torque characteristics.
b) Maintain the functioning of DC Drives using converters.
c) Maintain the functioning of DC Drives using choppers.
d) Maintain the functioning ofAC Drives.
e) Use microcontroller-based systems for motor control.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
				Theory							Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **ESE** -End Semester Examination; **PA** - Progressive Assessment*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

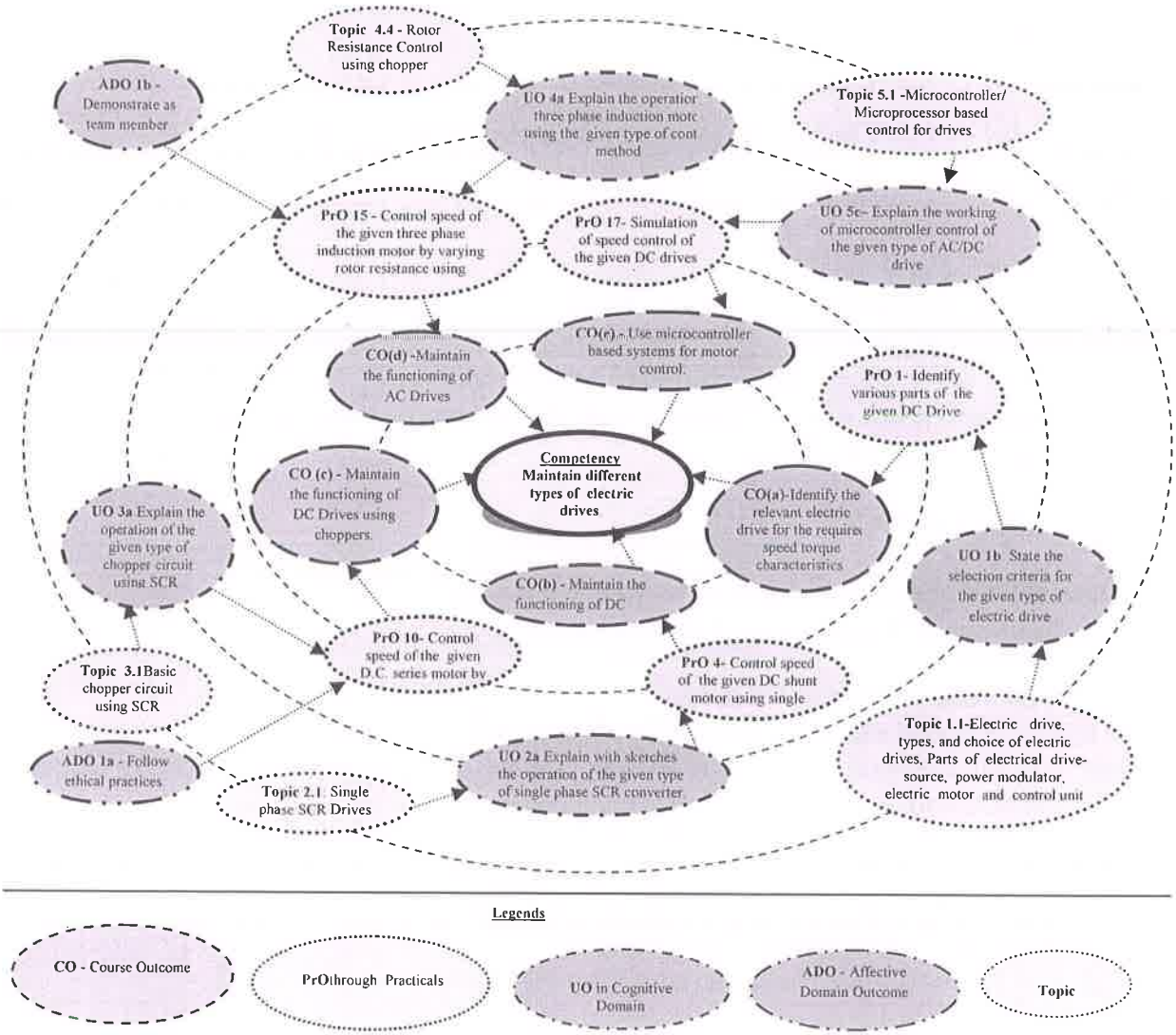


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Identify various parts of the given DC Drive.	I	02*
2	Identify various parts of the given AC Drive.	I	02*
3	Test the given DC motor to interpret the speed torque characteristics	I	02
4	Control speed of the given DC shunt motor using single phase half wave converter	II	02*
5	Control the speed of the given DC shunt motor using single phase full wave converter	II	02*
6	Control the speed of the given separately excited DC motor by changing the firing angle of SCR using single phase semi converter.	II	02
7	Control speed of the given separately excited DC motor by changing the firing angle of SCR using single phase full converter.	II	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
8	Check high power SCR/power devices with heat sink arrangement.	II	02*
9	Measure the output voltage of the given chopper for resistive load by varying the frequency and /or duty cycle of chopper.	III	02*
10	Control speed of the given D.C. series motor by varying armature voltage using step down chopper.	III	02*
11	Control the speed of the given D.C. separately excited motor by varying armature voltage using step down chopper.	III	02
12	Control the speed of the given three phase squirrel cage induction motor by varying stator voltage using thyristor circuit.	IV	02
13	Control the speed of the given three phase induction motor by using constant V/f method and plot the graph between speed and frequency.	IV	02*
14	Control the speed of the given three phase induction motor by varying frequency and plot the graph between speed and frequency	IV	02*
15	Control the speed of the given three phase induction motor by sensorless vector control.	IV	02
16	Control the speed of the given three phase induction motor by varying rotor resistance using chopper.	IV	02*
17	Simulation of speed control of the given synchronous motor drives using microcontroller in SCILAB simulation software.	V	02
18	Simulation of speed control of the given DC drives using microcontroller in SCILAB simulation software.	V	02*
	Total		**36**

Note

i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '' are compulsory and any 04 from remaining so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S.No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and Recording	10
5	Interpretation of result and conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
	Total	**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a) Follow safety practices.
b) Practice good housekeeping.
c) Practice energy conservation.

d) Work as a leader/a team member.
e) Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organisation Level' in 2nd year
- 'Characterisation Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by administrators.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Digital storage oscilloscope: Dual trace 50Mhz	3 to 6, 8 to 14
2	Ammeters DC, 0-5/10Amp,0-1.5 Amp,0-2.5Amp,0-0.5/1Amp	3 to 6, 8 to 14
3	Voltmeter DC, 0-150/300V, 0-250/500V,0-75/150V	3 to 14
4	Dimmer: 1-phase,1kVA,230V	1 to 6, 8 to 10
5	Dimmer: 3-phase, 5kVA,440V	11 to 17
6	Resistive load bank upto 10kW	8
7	Digital tachometer 4000 R.P.M.for speed measurement.	3 to 6, 8 to 16
8	DC Series motor 1 to 3 HP	1,9,18
9	DC Shunt motor 1 to 3 HP	1,3,4,18
10	Separately excited DC motor 1 to 3 HP	5,6,10
11	Three phase induction motor 1HPto 3 HP or Fractional horse power motor	12,13,14,15,16
12	Synchronous motor 1 to 3HP	17
13	Simulation soft ware such as SCILAB or similar	17, 18

8. UNDERPINNING THEORY COMPONENTS

The following topicsare to betaught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Basics of Electric Drives	1a. Describe the block diagram of the given type of electric drive 1b. State the selection criteria for the given type of electric drive 1c. Determine the power rating for the given load curve by equivalent current, torque and power methods. 1d. Select the relevant motor on the basis of given duty cycles with justification. 1e. Describe with sketches the	1.1 Electric drive, types and choice of electric drives, Parts of electrical drive-source, power modulator, electric motor and control unit 1.2 Motor duty class, classification– continuous, short time, intermittent period. 1.3 Motor power rating for continuous, short time and intermittent duty, equivalent torque current, and power methods for fluctuating

	characteristics of the given type of motor(s). 1f. Describe the procedure to maintain the given type of electric motor.	and intermittent loads.(Simple numerical) 1.4 Speed-torque characteristics of DC motors 1.5 Speed-torque characteristics of three phase induction motor
Unit – II DC Drive using converters	2a. Explain with sketches the operation of the given type of single phase SCR converter. 2b. Explain with sketches the operation of the given type of three phase SCR converter. 2c. Give the effect of power factor variation in the given type of SCR motor drive. 2d. Describe the procedure to maintain the given type of DC drive using converter	2.1 Single phase SCR Drives a) Half wave converter b) Full wave converter c) Semi converter d) Dual converter 2.1 Three Phase SCR Drives a) Half wave converter b) Full wave converter c) Semi converter d) Dual converter 2.2 Power factor in SCR motor drives 2.3 Reversible SCR Drives.
Unit- III DC Drive using choppers.	3a. Explain with sketches the operation of the given type of chopper circuit using SCR. 3b. Explain with sketches the operation of the given type of single quadrant chopper drive with quadrant diagram 3c. Explain with sketches the operation of the given type of two quadrant chopper drive with quadrant diagram 3d. Explain with sketches the operation of chopper controlled DC Drive in Solar and battery powered vehicles 3e. Describe the procedure to maintain the given type of DC drive using chopper	3.1 Basic chopper circuit using SCR 3.2 Classification based on output voltage and quadrant of operation 3.3 Chopper Controlled DC Drives a) Class A Chopper Drive b) Class B Chopper Drive c) Class C Chopper Drive d) Class D Chopper Drive e) Class E Chopper Drive 3.3 Application of chopper control drive in Solar and battery powered vehicles.
Unit– IV AC Drives	4a. Explain with sketches the operation of three phase induction motor using the given type of control method 4b. Explain with sketches the operation of three phase induction motor using the given type ofslip power recovery system 4c. Describe with sketches the working of the given type of solar powered pump drives. 4d. Describe the procedure to maintain the giventype of AC	4.1 Stator voltage control method using thyristor circuit. 4.2 Variable frequency control method using square wave inverter 4.3 Constant V/F control method 4.4 Rotor resistance control using chopper 4.5 Slip power recovery system 4.6 Solar powered pump drives 4.7 Drives required at each stage for following applications: Textile mills, Steel rolling mills, Paper mills, Sugar mills

	drive.	
Unit-V Advanced techniques of motor control	5a. Explain with sketches the working of PLL control for the given type of DC motor 5b. Explain with sketches the working of microprocessor control of the given type of AC/DC drive 5c. Explain with sketches the working of microcontroller control of the given type of electricdrive. 5d. Describe the procedure to maintain the given type of electric drive using microcontroller.	5.1 Microcontroller/ Microprocessor based control for drives. 5.2 Phase locked loop control of DC motor. 5.3 AC/DC drive using microprocessor control 5.4 AC/DC drive using microcontroller control. 5.5 Synchronous motor drives. 5.6 Ratings and specifications of stepper motor. 5.7 Stepper motor drives employing microcontroller (No programming)

Note:To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basics of Electric Drives	4	2	4	4	10
II	DC Drive using converters	12	4	4	8	16
III	DC Drive using choppers	12	4	4	8	16
IV	AC Drives	12	4	4	8	16
V	Advanced techniques of Motor Control	8	--	4	8	12
Total		**48**	**14**	**20**	**36**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Visit any one textile mill to know the types of drives used in each stage of operation.
b) Visit any one sugar mill to know the types of drives used in each stage of operation.
c) Visit any one paper mill to know the types of drives used in each stage of operation
d) Read the safety precautions of various electric motors used in different drives
e) Find troubleshooting techniques and steps to troubleshoot DC drives

f) Make comparative table for various drives based on its application and maximum power ratings.
g) Check the performance of at least two different types of drives using simulation software like Scilab.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment ofthe various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c) About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d) With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e) Use Flash/Animations to explain various theorems in circuit analysis
f) Guide student(s) in undertaking micro-projects.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed six.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a) **AC motor power rating for given application**: Determine the power rating of fractional h.p. ac motor requiredfor the given desert cooler to lift the water up to 1.5 meter. Assume efficiency between 50 to 75% of rated load.
b) **Brush less DC motor**: Design and assemble 24 Volt, 500 W BLDC motor for robotic applications.
c) **Reversible SCR drive** : Design reversible SCR drive using four quadrant chopper or using L293D and L298 dual H-bridge motor driver ICs for controlling the rotation of the motor in both clockwise and anticlockwise direction.
[Rcf.- http://playwithrobots.com/dc-motor-driver circuits/]
d) **PWM inverter**: Design PWM inverter using 8051 micro controller for speed control of the given AC motor.
e) **Battery operated vehicles**: Design a battery operated bicycle of rating 24V/36V/48V, 250W/500/W/1000W using brushless DC motor.A battery electric vehicle (BEV) is a type of electric vehicle (EV) that uses chemical energy stored in rechargeable battery packs. BEVs use electric motors and motor controllers instead of internal combustion engines (ICEs) for propulsion. They derive all power from battery packs

and thus have no internal combustion engine, fuel cell, or fuel tank. BEVs include motorcycles, bicycles, scooters, skateboards, rail cars, watercraft, forklifts, buses, trucks and cars.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Fundamentals of Electrical Engineering	Saxena, S.B lal; Dasgupta, K.	Cambridge university press pvt. Ltd., New Delhi, 2016, ISBN: 9781107464353
2	A Text Book of Electrical Technology Vol-II	Theraja, B. L.; Theraja, A. K.	S. Chand and Co. Ramnagar, New Delhi, 2012; ISBN :9788121924405
3	Basic Electrical Engineering	Mittle, V.N. ; Mittle, Arvind	McGraw Hill Education, Noida, 2005ISBN: 978-00-705-9357-2
4	Power Electronics	P.C.Sen	Mcgraw-Hill Publishing CompanyLimited, New Delhi.
5	Fundamentals of Electrical Drives,	Dubey,Gopal K.	Narosa Publishing House,New Delhi, 2016, Second Edition
6	Electrical Drives Concepts and Applications	Subrahmanyam, Vedam	Mcgraw-Hill Publishing New Delhi, 2016
7	Power Electronic Systems Theory and Design	Agrawal,Jai P.	Pearson Education ,Inc. New Delhi, 2016
8	Electrical Machines	Deshpande,M.V.	PHI Learning, New Delhi, 2016
9	A first course on Electrical Drives	Pillai,S.K.	Wiley Eastern Ltd. New Delhi, 2016 ISBN 81-224-0166-X

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a) www.cesim.com/simulations
b) www.scilab.org/scilab
c) www.ni.com/multisim
d) www.youtube.com /electric circuits/AC-DC DRIVES
e) www.dreamtechpress.com /ebooks/AC-DC DRIVES
f) www.nptelvideos.in/electrical engineering/ AC-DC DRIVES
g) www.learnerstv.com/free-engineering/AC-DC DRIVES
h) www.orcad.com/resources/orcad-downloads
i) www.electricaltechnology.org
j) www.electrical4u.com

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Program Name : **Electrical Engineering Program Group**

Program Code : **EE/EP/EU**

Semester : **Sixth**

Course Title : **Power System Operation and Control (Elective-II)**

Course Code : **22632**

1. RATIONALE

The diploma engineers working in power sector, while undertaking major activities related to transmission and distribution systems they should be able to interpret significance of the activities assigned to them. For example, they should be aware of active and reactive power control strategies/mechanisms, and methods to ensure power system stability. They should also be aware of load flow studies and load dispatch. Hence, this course is designed to develop awareness about these concepts in diploma pass outs so that they may ensure power system stability. Thus this course is important for diploma electrical engineers who wish to work in power generation, transmission and distribution companies.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Maintain the power system network for stability and load dispatch.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Interpret real and reactive power flow in power system network.
b) Interpret the functioning of Automatic Generation control.
c) Interpret development of Load flow studies.
d) Apply different techniques to maintain stability of power system.
e) Interpret factors involved in Load dispatch.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory							Practical				
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
L	T	P			Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the

course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

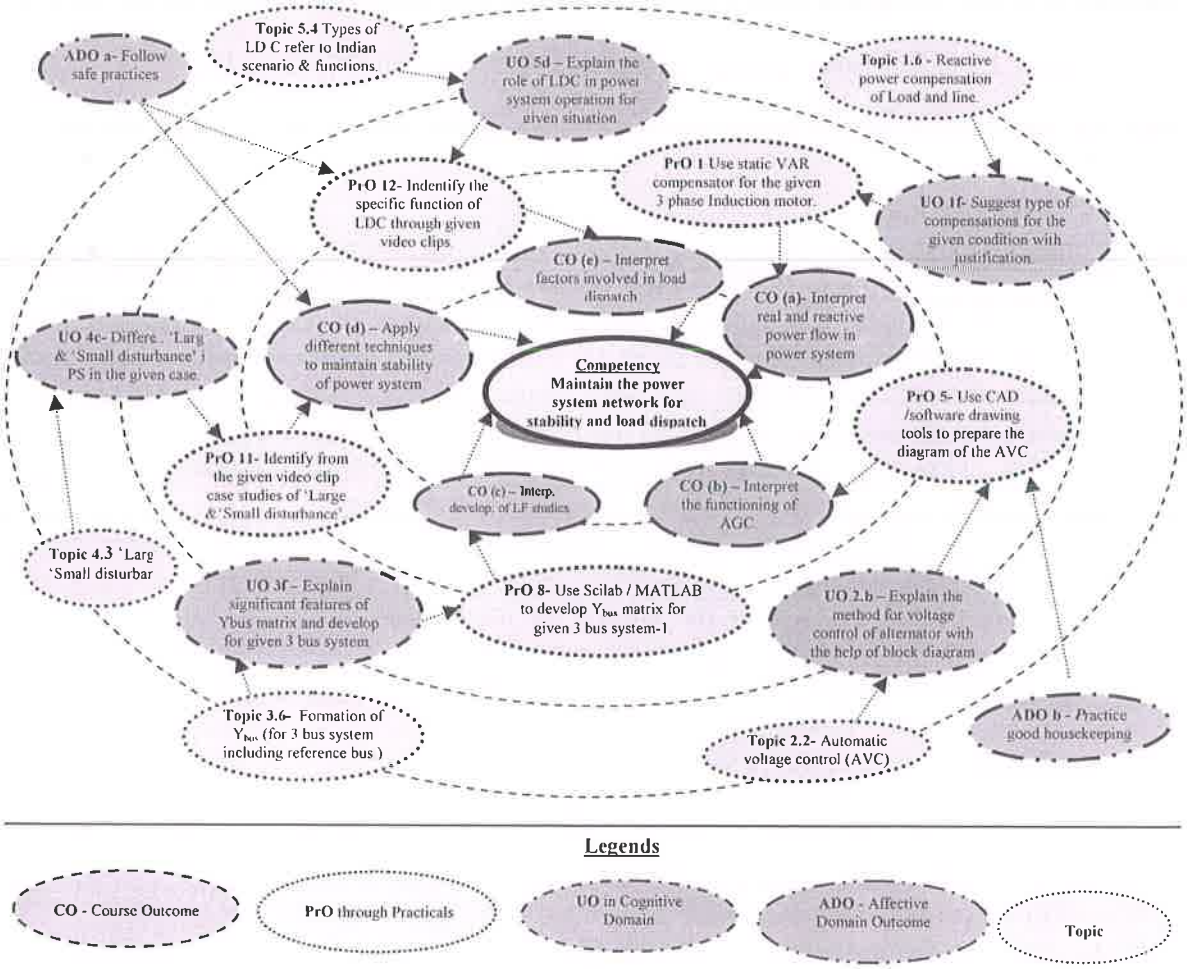


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Use static VAR compensator for the given three phase Induction motor.	I	02*
2	Identify the different voltage controls of H.V. substation with respect to the given video clip with justifications.	I	02
3	Identify the different frequency controls of a power plant with respect to the given video clip with justifications.	I	02
4	Identify different components of Turbo generator control with respect to the given video clip/ animation/chart with justifications.	II	02
5	Use CAD /software drawing tools to prepare the schematic diagram of the Automatic Voltage Control (AVC) for the given condition.	II	02£
6	Use CAD /software drawing tools to prepare the schematic diagram of the Automatic Load Frequency Control (ALFC) for the given condition.	II	02£

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
7	Use CAD /software drawing tools to prepare the schematic diagram of the Automatic Generation Control (AGC) for the given condition.	II	02£
8	Use Scilab / MATLAB to develop Y_{bus} matrix for given 3- bus system-1.	III	02#
9	Use Scilab / MATLAB to develop Y_{bus} matrix for given 3- bus system-2.	III	02#
10	During the maintenance outages, determine the effect on SLFE for given power system using relevant software.	III	02*
11	Identify from the given video clip case studies of 'Large disturbance' and 'Small disturbance'.	IV	02*
12	Identify the specific function of Load dispatch center through given video clips.	V	02*
13	Identify specific reasons for Load shedding adopted by DISCOM in specific area from given video clip (case-1).	V	02$
14	Identify specific reasons for Load shedding adopted by DISCOM in specific area from given video clip (case-2).	V	02$
	Total		**28**

Legend: £- Minimum two ; # -Minimum one; $- Minimum one

Note

i. *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 10 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. *The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

S. No.	Performance Indicators	Weightage in %
1	Preparation	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and Recording	10
5	Interpretation of result and Conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
Total		**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a) Follow safety practices.
b) Practice good housekeeping.
c) Practice energy conservation.
d) Work as a leader/a team member.
e) Follow ethical Practices.

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The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organisation Level' in 2nd year
- 'Characterisation Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Induction motor (3phase /1 phase,3kW)	1
2	Ammeters MI Type: AC/ DC 0-5-10Amp (3 in number)	1
3	Voltmeter MI Type: AC/DC, 0-150/300V, 0-250/500V(1 in number)	1
4	Wattmeter: Single phase, single element 2.5/5Amp, 200/400V, (2 in number)	1
5	Dimmer: 3-phase, 5kVA	1
6	Star- delta starter :3phase,3kW	1
7	Load bank: Inductive bank, 3-phase, 5kW, 415V	1
8	Capacitor bank, 3-phase, 5kW, 415V	1
9	Knife switch :10Amp	1
10	Chart relevant to practical	4
11	Electrical –CAD or equivalent software	5,6
12	Software –Scilab / MATLAB or other open sources.	7,8,9
13	Internet facility	2 to 13
14	Videos relevant to different practical	2,3,4,10, 11,12,13

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit-I Real And Reactive Power Flow	1a. Interpret the impact of real and reactive power imbalance for the given data. 1b. Explain the adverse effect of real power imbalance in the given situation for the power system. 1c. Explain the effect of the given condition of the frequency on the specified side in the power system. 1d. Explain the causes for imbalance of reactive power flow in the given situation for the power system. 1e. Explain the effect of the given condition of the voltage on the specified side in the power system 1f. Suggest type of compensations for	1.1 Concept of power flow and real power balance and reactive power balance and its adverse impact. 1.2 Relation between Real power balance and frequency of the system (derivation) 1.3 Need of constant frequency control, adverse impact of variation in frequency on consumers and supply agencies. 1.4 Relation between reactive power balance and voltage of the system (derivation) 1.5 Effect of change in voltage on consumers and supply agencies. 1.6 Reactive power compensation for

	the reactive power under given condition with justification.	Load and line.
Unit– II Automatic Generation Control	2a. Explain the specified method used for speed control of the given turbo-generator using schematic diagram. 2b. Explain the specified method for voltage control of given alternator using block diagram. 2c. Explain with sketches the application of Load-frequency control for the given type of control area. 2d. Describe the functioning of the Automatic Load Frequency Control using the block diagram for the given type of generator. 2e. Draw the block diagram of Automatic Generation Control (AGC) for the specified generating system.	2.1 Schematic diagram of Turbo generator speed control (Turbine speed governing system) and its functioning. 2.2 Automatic voltage control (AVC) 2.3 Load frequency control (single area case) 2.4 Schematic diagram of The Automatic Load Frequency Control (ALFC) and its functioning. 2.5 Schematic diagram of The Automatic Generation Control (AGC) and its functioning.
Unit-III Load flow studies	3a. Identify the significance of Load flow analysis for the given power system. 3b. Categorize the data required for Load flow studies for the given power system. 3c. Develop the Static Load Flow Equation (SLFE) for a simple two bus system. 3d. Interpret the Characteristics' of the given SLFE for specified power system.. 3e. Identify the information obtained from the given Load flow study. 3f. Identify significant features of the given Y_{bus} matrix and develop for given 3 bus system.	3.1 Concept of Load flow studies and its need. 3.2 Data required for Load flow studies. 3.3 Static load flow equation (SLFE) for simple two bus system and definition of parameters (only equation). 3.4 Characteristics' of SLFE. 3.5 Information obtained from Load Flow Studies 3.6 Formation of Y_{bus} (for 3 bus system including reference bus).
Unit –IV Power system stability	4a. Explain the specified type of Stability of given power system. 4b. Explain the adverse effects of instability of given power system on consumers and on power utility companies. 4c. Differentiate 'Large disturbance' and 'Small disturbance' in the given power system in specified case. 4d. Identify the type of power system stability condition for the given	4.1 Illustration of terms: Power system stability, overall stability, Stability limit and Instability. 4.2 Adverse effects of instability of power system. 4.3 'Large disturbance' and 'Small disturbance' 4.4 Classification of Stability: i) Steady state stability ii) Transient state stability iii) Dynamic stability 4.5 Stability studies with the help of

	power system. 4e. Explain the different stability condition of the given power system with the help of power angle diagram. 4f. Describe the specified method of improving Steady state stability condition of the given power system. 4g. Explain specified method of improving Transient State Stability condition for the given power system.	power angle diagram (Steady state stability and Transient state stability 4.6 Methods of improving Steady state stability condition. 4.7 Methods of improving Transient State Stability condition (Conventional and New techniques).
Unit-V Load dispatch	5a. Explain the idea of Load dispatch in the given power system. 5b. Explain impact of specified factors on the Load forecasting of the given power system. 5c. Explain impact of the specified factors on Load shedding in power system operation. 5d. Explain the role of Load Dispatch Center in power system operation for the given situation.	5.1 Concept of Load dispatch. 5.2 Load forecasting i) Significance of forecasting. ii) Use of load curve. iii) Environmental and social factors in load forecasting. 5.3 Load shedding and its governing factors 5.4 Types of Load Dispatch Centre refer to Indian scenario and their functions.

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Real And Reactive Power Flow	10	02	04	04	10
II	Automatic Generation Control	08	04	08	00	12
III	Load flow studies	10	02	08	08	18
IV	Power system stability	12	04	04	08	16
V	Load dispatch	08	04	06	04	14
Total		48	**16**	**30**	**24**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct any two of the following activities in group

and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Collect the information about impact of variation in frequency –case study.
b) Collect the information about impact of variation in voltage –case study.
c) Create awareness of Load shedding and its importance among students.
d) Carry out internet survey to collect information related LDCs and their locations with Indian scenario.
e) Write report on power failure in nearby area.
f) Prepare case study on recent Major power failure in India / world.
g) Prepare a report on impact of Wind/Solar farms on Power system operation.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c) About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d) With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e) Guide student(s) in undertaking micro-projects.
f) Use Flash/Animations to explain working of Real power balance and its relation with frequency.
g) Use Flash/Animations to explain working stability of power system.
h) Pre-guided visits to Load dispatch / HV substations centers in which the students will observe functioning of LDC.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project is group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that she/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

a) **Indian National grid and Regional grid:** Collect information and prepare charts with significant details.
b) **Major power failure:** Collect information about power failure in / outside India.
c) **Load dispatch center**: Prepare technical presentation on details of functioning of RLDCs.

d) **Social impact on Load forecasting**: Collect information about nearby social activities which affect Load forecasting.
e) **Environmental impact on Load forecasting**: Collect information about changes in environment which affect Load forecasting.
f) **Load shedding:** Collect information about strategy adopted in specific area.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Modern Power System Analysis	Nagrath, I. J. Kothari, D. P.	McGraw Hill Education, New Delhi 2003 ISBN-0-07-049489-4
2	Electric Power Systems (Analysis ,Stability and Protection)	Gangadhar, K. A.	Khanna Publishers, Delhi. India, 2006. ISBN 9788174090041
3	Elements of Power System; Analysis e-book	Stevenson, William	McGraw-Hill Book Company, New York, 2014 (4th addition) ISBN: 9780070612785
4	Power System Analysis, operation and control	Chakrabarty, Abh ijit	PHI Learning, New Delhi, New Delhi, 2010 ISBN: 788120340152
5	Electrical Power System	Wadhava, C. L.	New Academic Science, UK, 2017 ISBN: 9781781831014
6	An introduction to Reactive Power Control and Voltage Stability in Power Transmission Systems –	Chakrabarti, D P A Kothari, A K Mukhopadhyay, Abhinandan De	PHI Learning, New Delhi, 2015 ISBN: 9788120340503
7	Power Generation Operation and Control	A. J. Wood, B. F. Woolenberg,	John Wiley and Sons, UK ISBN:978-0-471-79055-6

14. SOFTWARE/LEARNING WEBSITES

a) https://mahatransco.in/information/details/load_despatch
b) ieee.org/houston/files/2018/04/Fundamentals-oF-Turbine-Generator-Speed-Control.pdf
c) https://www.electrical4u.com/power-system-stability/
d) https://mahatransco.in/information/details/load_despatch
e) http://nptel.ac.in/courses/108101040/
f) http://www.electrical-engineering-portal.com/
g) http://nptel.iitm.ac.in/courses.php
h) https://www.youtube.com/watch?v=ouWOhk1INjo

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Program Name : **Electrical Engineering Program Group**

Program Code : **EE/EP/EU**

Semester : **Sixth**

Course Title : **Electrical Substation Practices (Elective-II)**

Course Code : **22633**

1. RATIONALE

The electrical power for many industries is made available through their own substations. This course will empower the students with the necessary knowledge of operations and maintenance of substation equipment. This course will also be useful for students to observe the safety while working in substations as well as to improve the quality of power system. In this course new type of substation like Gas Insulated substation is also included.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Maintain the safe working of different types of electrical substations.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following ***industry oriented*** COs associated with the above mentioned competency:

a) Follow safety rules for Substation.
b) Maintain substation earthing and neutral grounding.
c) Maintain the Sub-station Equipment and Bus bar layout
d) Interpret single line diagram of substation.
e) Maintain Gas insulated Substation

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
				Theory							Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **ESE** -End Semester Examination; **PA** - Progressive Assessment*

5. COURSE MAP (with sample COs, PrOs,UOs,ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

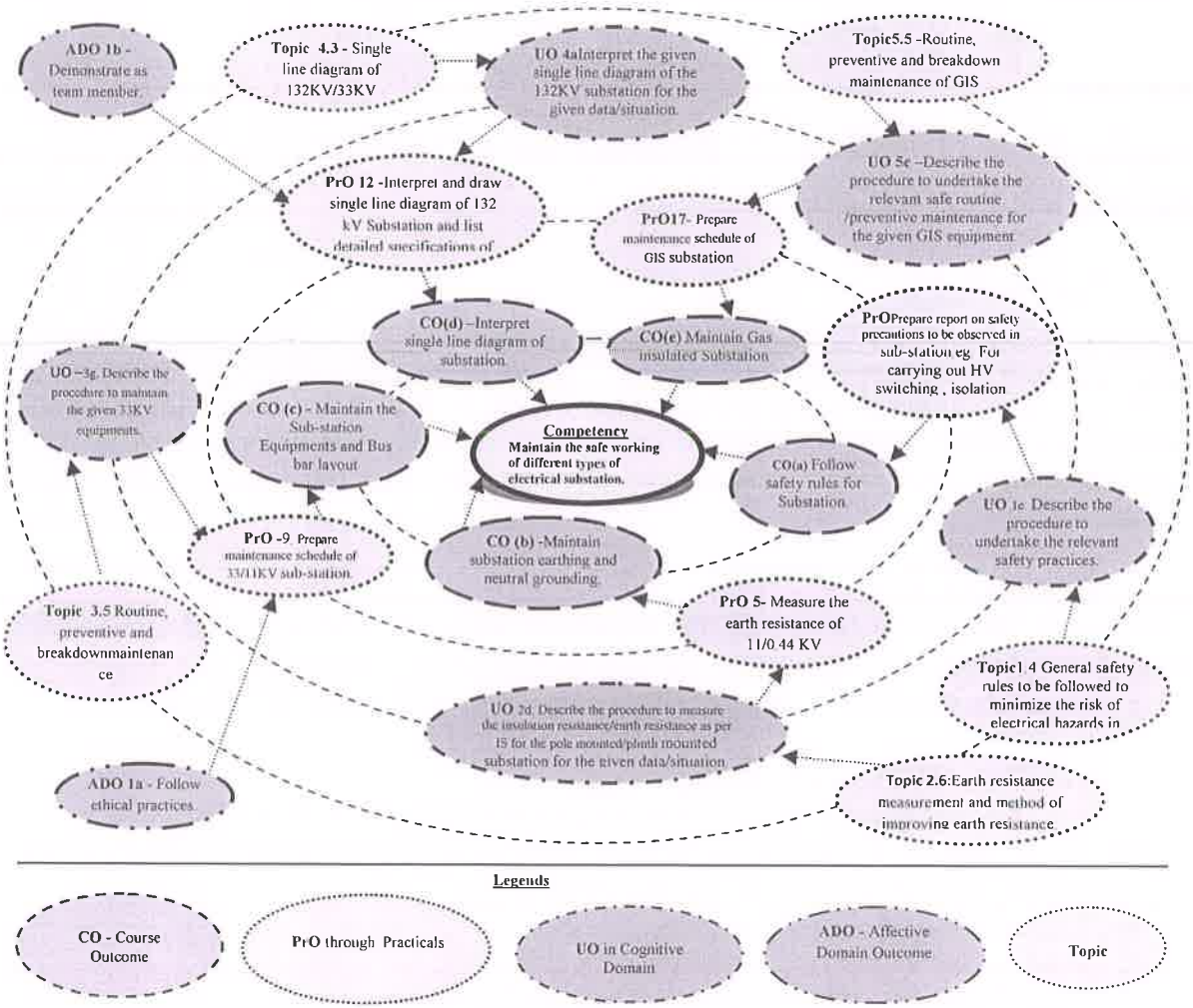


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Prepare report on safety precautions to be observed in sub-station.eg. For carrying out HV switching , isolation from other feeding points etc.	I to V	02*
2	Draw layout and prepare report of 11 KV pole mounted substation earthing after seeing the relevant video clip.	II	02*
3	Draw layout and prepare report of 11 KV plinth mounted substation earthing.	II	02
4	Interpret and draw single line diagram of 11 kV Substation and list detailed specifications of equipment used.	II	02
5	Measure the earth resistance of 11/0.44 KV substation. Compare with standard values and prepare report for improvement of earth resistance.	II	04*
6	Prepare Visit report of 33/11KV sub-station and draw the layout diagram.	III	04*
7	Interpret and draw single line diagram of 33 kV Substation and list detailed specifications of equipment used.	III	04

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
8	Measure the earth resistance and insulation resistance of 33/11KV substation	III	04
9	Prepare maintenance schedule of 33/11KV sub-station.	III	02*
10	Perform BDV (break down voltage) test on power transformer oil	III	04
11	Perform specific gravity test and measure battery voltage and prepare maintenance schedule of Battery	III,IV	02
12	Interpret and drawsingle line diagram of 132 kV Substation and list detailed specifications of equipment used.	IV	04*
13	Locate and record the hot spot(s) in substation equipment, terminals, conductor joints by using non contact type thermal sensor.	IV	04
14	Prepare a report on maintenance of SF6 circuit breakers in sub station	IV	02
15	Use the given firefighting equipment used in 11KV, 33KV and 132KV substation.	IV	02*
16	Interpret and draw single line diagram of 33 KV Gas Insulated sub-station.	V	02*
17	Prepare maintenance schedule of GIS substation.	V	02
	Total		**48**

Note

i. *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory and any 04 from remaining, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. *The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and Recording	10
5	Interpretation of result and conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
	Total	**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a) Follow safety practices.
b) Practice good housekeeping.
c) Practice energy conservation.
d) Work as a leader/a team member.
e) Follow ethical Practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organisation Level' in 2nd year
- Characterisation Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by administrators.

S. No.	Equipment Name with Broad Specifications	PrO.No.
1	Multimeter, clip on meter , voltmeters, ammeters	1 to 17
2	Digital Earth tester	05 , 08
3	Motorized megger (1000 V)	8
4	Hygrometer	11
5	Non contact type thermometer / thermal sensor for locating hot spots	13
6	Oil testing kit (0-60) kv	10

8. UNDERPINNING THEORY COMPONENTS

The following topicsare to betaught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Overview of Sub-stations.	1a. Select the site for the substation for the given data/situation with justification. 1b. Classify the substation based on the given data/situation. 1c. Interpret of symbols used in the given single line diagram. 1d. Describe the procedure to maintain the earth resistance as per IE rules for the given data/situation. 1e. Describe the procedure to undertake the relevant safety practices in substation for the given data/situation.	1.1 Need of electrical substation. Factors governing the selection of the site of the substation, Classification of sub-station based on voltage level, Indoor and Outdoor, configuration, application, various symbols used in single line diagram. 1.2 Conductor used in main bus and auxiliary bus for 11KV, 33KV, 132KV substation. 1.3 Typical earth resistance values of various substation and structures as per IE rules:- 11KV,33KV,132KV substation and double pole structure, transmission tower(tower foot resistance) 1.4 General safety rules to be followed to minimize the risk of electrical hazards in substation.
Unit – II 11KV substation	2a. Draw the layout diagram for the pole mounted/plinth mounted substation for the given	2.1 Need for pole mounted and plinth mounted substation. 2.2 11KV/440V Pole mounted

	data/situation. 2b. Interpret the given single line diagram of the pole mounted/plinth mounted substation for the given data/situation. 2c. Select the relevant equipment and accessories required for the 11KV pole mounted substation for the givendata/situation with justification. 2d. Describe the procedure to measure the insulation resistance/earth resistance as per IS for the pole mounted/plinth mounted substation for the given data/situation. 2e. Describe the procedure to undertake the relevant safe routine /preventive maintenance for the specified11KV substation equipment. 2f. Describe the procedure to maintain the given 11KV equipment.	substation Equipment and accessories: Functions and rating of: Three phase distribution transformer, Lightning arrester(LA), Metering Current transformer (CT), Metering voltage transformer PT, Air break switch (AB switch),Drop out (DO) fuse, insulators and Distribution box. 2.3 Layout and Single line diagram of pole mounted substation. 2.4 Insulation resistance measurement. 2.5 Earthing: Equipment earthing and System earthing. 2.6 Earth resistance measurement and method of improving earth resistance. 2.7 Routine, preventive and breakdown maintenance. 2.8 Safety practices followed during routine, preventive and breakdown maintenance.
Unit – III 33KV substation	3a. Draw the layout diagram for the 33KV substation for the given data/situation. 3b. Interpret the given single line diagram of the 33KV substation for the given data/situation. 3c. Select the relevant equipment and accessories required for the 33KV substation for the given data/situation with justification. 3d. Describe the procedure to undertake the relevant safe routine /preventive maintenance for the given 33KV substation equipment. 3e. Describe the procedure to undertake the measurement of BDV of the transformer oil for the given data/situation. 3f. Describe the procedure to use therelevant fire-fighting equipment for the given situation. 3g. Describe the procedure to maintain the given 33KV equipment.	3.1 Need of 33KV/11KVsubstation. 3.2 33KV/11KVsubstation Equipment and accessories: Functions and rating of:Power transformer, Lightning arrester(LA), Instrument Transformer-Current transformer (CT) and Potential transformer (PT), HT fuses, Isolating switches (Isolator), Insulators, control and relay panel, station transformer, capacitor bank, battery and charger and circuit breaker. 3.3 Layout and Single line diagram of 33KV substation. 3.4 Earthing: Equipment earthing and System earthing 3.5 Routine, preventive and breakdown maintenance. 3.6 BDV (break down voltage) test on power transformer oil. 3.7 Safety practices followed during routine, preventive and breakdown maintenance. 3.8 Fire-fighting equipment for the different situations in the substation.
Unit – IV 132 KV	4a. Interpret the given single line diagram of the 132KV substation	4.1 Need of 132KV/33KVsubstation. 4.2 132KV/33KVsubstation

substation	for the given data/situation. 4b. Select the relevant equipment and accessories required for the 132KV/33KV substation for the given data/situation with justification. 4c. Describe the procedure to undertake the relevant safe routine /preventive maintenance for the given 132KV substation equipment. 4d. Describe the procedure to use the relevant fire-fighting equipment for the given situation. 4e. Describe the procedure to maintain the given component(s) of the 132KV substation. 4f. Describe the procedure to locate and record the hot spot(s) in 132KV substation.	Equipment and accessories: Functions and rating of: Power transformer, Lightning arrester (LA), Instrument Transformer-Current transformer (CT) and Potential transformer (PT), Capacitor voltage transformer (CVT),HT fuses, Isolating switches (Isolator), Insulators, control and relay panel, station transformer, capacitor bank, battery and charger, wave trap/wave drum, Power line carrier communication (PLCC) and circuit breaker. 4.3 Single line diagram of 132KV/33KV substation. 4.4 Earthing: Equipment earthing and System earthing. 4.5 Step potential, touch potential, mesh potential, transferred potential, earth mat or grid. 4.6 Routine, preventive and breakdown maintenance; Safety practices followed during routine, preventive and breakdown maintenance. 4.7 Fire-fighting equipment for the different situations in the substation. 4.8 Non-contact type thermal sensor to locate and record hot spot(s) in a substation.
Unit– V Gas Insulated sub-station	5a. Interpret the single line diagram of the GIS for the given data/situation. 5b. Describe the function of the given part(s) of the GIS. 5c. Describe the procedure to undertake the relevant safe routine /preventive maintenance for the given GIS equipment. 5d. Describe the procedure to use the relevant fire-fighting equipment for the given situation. 5e. Describe the procedure to maintain the given GIS equipment.	5.1 Need of gas insulated substation (GIS). 5.2 Essential parts of GIS, advantages of GIS, drawbacks of GIS. 5.3 Single line diagrams of GIS. 5.4 Partial discharge monitoring. 5.5 Routine, preventive and breakdown maintenance of GIS. 5.6 Safety practices followed during routine, preventive and breakdown maintenance. 5.7 Firefighting equipment used in GIS.

***Note**:To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Overview of Sub-stations	06	00	04	02	06
II	11 KV substation	12	04	04	10	18
III	33 KV substation	12	02	04	12	18
IV	132 KV substation	10	04	04	08	16
V	Gas Insulated sub-station	08	02	04	06	12
Total		**48**	**12**	**20**	**38**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare report on market survey of various three phase power and distribution transformers(specification, manufacturer, application, cost)
b) Prepare model of pole mounted distribution transformer.
c) Prepare power point presentation related to substation equipment.
d) Prepare power point presentation related to maintenance of substation.
e) Prepare a single line diagram of substation.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment ofthe various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c) About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d) With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e) Use Flash/Animations to explain various theorems in circuit analysis
f) Guide student(s) in undertaking micro-projects.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so

that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a) **Power / distribution transformer**:Prepare chart showing three phase power / distribution transformer.
b) **Neutral grounding**: Collect specification from different manufacturers and prepare report.
c) **Sub-station equipment:** Collect specification from different manufacturers and prepare report.
d) **Gas Insulated Substation:** Collect photographs with details of Gas Insulated Substationand identify different parts (specification, application, cost, features, manufacturer)
e) **Single line diagram of sub-station:** Prepare Single line diagram of sub-station

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Generation Of Electrical Energy	Gupta, B.R.	Eurasia Publishing House (Pvt.) Ltd, , 1996. ISBN :81-219-0102-2
2	Principles Of Power System	Mehta,V.K.	S.Chand&Co.Ltd, New Delhi 2011. ISBN :81-219-0594-X
3	A Course in Electrical Power	Soni, M. L. Gupta, P.V. U.S. Bhatnagar,	Dhanpat Rai & Co. (P) Ltd., New Delhi 2016, ISBN: 9788177000207
4	Switchgear Protection and Power Systems	Sunil S. Rao	Khanna Publisher,New Delhi, 2008 ISBN: 978-8174092328
5	Elements of Electrical Power Station Design	Deshpande, M.V.	PHI Learning Pvt Limited, New Delhi, 2009, ISBN: 978-8120336476
6	Power Plant Engineering	Nagpal, G.R. S.C. Sharma,	Khanna Publishers-Delhi, 2012 ISBN :978-8174093097

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a) http://nptel.iitm.ac.in
b) http://iitm.vlab.co.in/?sub=46&brch=144&sim=1056&cnt=4
c) http://www.edumedia-sciences.com
d) http://www.engineeringtv.com/video/Texas-Instruments
e) SEQUEL (open source)
f) PSIM
g) PSCAD

