

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										Total Marks	
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory			Based on LL & TL		Based on SL					
				CL	TL	LL					FA-TH	SA-TH	Total	Practical		SLA					
							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	<p>TLO 1.1 Sketch the electrical symbols as per requirement in electrical drawings.</p> <p>TLO 1.2 Interpret given electrical power/control wiring diagram.</p> <p>TLO 1.3 Identify types of electrical panel.</p> <p>TLO 1.4 Sketch GA Diagram of Electrical control panel (Assume suitable dimensions).</p>	<p>Unit - I Electrical Drawings.</p> <p>1.1 Symbols: Electrical and Electronic as per SP 30: 2023 Part 1, section 3.</p> <p>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.</p> <p>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.</p> <p>1.4 General Arrangement (GA) diagram of Electrical control panel.</p>	<p>Hands-on Presentations Lecture Using Chalk-Board</p>
2	<p>TLO 2.1 Identify the function of the given components of CAD classic screen.</p> <p>TLO 2.2 Identify the given components of CAD screen.</p> <p>TLO 2.3 Identify the given toolbar and commands.</p>	<p>Unit - II Computer Aided Design (CAD) Introduction.</p> <p>2.1 Components of CAD classic screen.</p> <p>2.2 Menu bar and status bar.</p> <p>2.3 Open and Save file.</p> <p>2.4 CAD Toolbars.</p> <p>2.5 Command Box.</p> <p>2.6 Zoom in and Zoom out.</p>	<p>Hands-on Presentations Demonstration</p>

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	<p>TLO 3.1 Use the coordinate methods and practice basic commands.</p> <p>TLO 3.2 Practice Draw, Modify and Annotation toolbar commands.</p> <p>TLO 3.3 Practice Important CAD Modes.</p>	<p>Unit - III CAD Tools and Commands.</p> <p>3.1 Coordinate Method: Absolute, Relative, Polar. Basic commands: Limits, Units.</p> <p>3.2 Draw Toolbar: Line, Polyline, Circle, Arc, Rectangle, Ellipse, Polygon, Hatch.</p> <p>3.3 Modify Toolbar: Move, Rotate, Trim, Erase, Copy, Cut, Mirror, Fillet, Chamfer, Offset, Explode, Stretch, Scale.</p> <p>3.4 Annotation Toolbar: Multiline Text, Single Line Text, Linear dimension, Aligned dimension, Angular Dimension, Arc Length Dimension, Radius Dimension, Diameter Dimension</p> <p>3.5 Important CAD Modes : Grid, Ortho, Snap, Polar Tracking, Object Snap Tracking.</p>	Hands-on Demonstration Presentations
4	<p>TLO 4.1 Sketch the power wiring diagram, control wiring diagram and GA Diagram of Electrical control panel using CAD</p> <p>TLO 4.2 Sketch the Single line diagram (SLD) of the 11 kV/433 V distribution substation using CAD</p> <p>TLO 4.3 Sketch the Single line diagram (SLD) of residential/commercial unit using CAD</p> <p>TLO 4.4 Sketch the Single line diagram (SLD) of any industrial plant using CAD</p>	<p>Unit - IV Use of CAD in Real World Electrical Engineering Drawings.</p> <p>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.</p> <p>4.2 Applications of electrical CAD software to Single line diagram (SLD) of the 11 kV/433 V distribution substation.</p> <p>4.3 Prepare Single line diagram (SLD) of residential/commercial unit using CAD.</p> <p>4.4 Draw the Single line diagram (SLD) of any industrial electrical installation using CAD.</p>	Hands-on Demonstration Presentations
5	<p>TLO 5.1 Select and use softwares for Electrical and electronic circuit simulations.</p> <p>TLO 5.2 Build, Simulate and Test Basic electric circuits.</p> <p>TLO 5.3 Build, Simulate and Test Basic electronic circuits.</p> <p>TLO 5.4 Measure various electrical parameters and Generate or plot relevant Waveforms/Graphs.</p> <p>TLO 5.5 Develop P.C.B. layout for a given electrical circuit using software.</p>	<p>Unit - V Simulation of Electrical and Electronic Circuits.</p> <p>5.1 Voltage, current, power across (a) Series R-L circuit (b) Series R-C circuit (c) Series R-L-C circuit.</p> <p>5.2 Rectifier circuit, KVL and KCL simulation.</p> <p>5.3 Triac Lamp Dimmer Circuit simulation.</p> <p>5.4 Basic Logic Gate and adder circuit simulation.</p> <p>5.5 Printed Circuit Board (PCB) preparation basic information.</p>	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
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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
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 Text, 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

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

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

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

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Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
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

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
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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-Use-r-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
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/ Architecture and Interior Design/ 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 Software 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/ 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/ Manufacturing Technology/ Medical Electronics/ Metallurgical Engineering/ Production Engineering/ Printing Technology/ Polymer Technology/ Surface Coating Technology/ Computer Science/ Textile Technology/ Electronics & Computer Engg./ Travel and Tourism/ Textile Manufactures
Programme Code	: AA/ AD/ AE/ AI/ AL/ AN/ AO/ AT/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CST/ CW/ DC/ DD/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ FC/ HA/ HM/ IC/ IE/ IF/ IH/ IS/ IX/ IZ/ LE/ ME/ MK/ ML/ MRT/ MU/ MY/ PG/ PN/ PO/ SC/ SE/ TC/ TE/ TR/ TX
Semester	: Fourth / Sixth
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.

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- 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.

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				CL	TL	LL						Practical				SLA					
							FA-TH	SA-TH			Total		FA-PR		SA-PR		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

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1	<p>TLO 1.1 Explain the need of studying environment and its components.</p> <p>TLO 1.2 Investigate the impact of population growth and industrialization on the relevant environmental issues and suggest remedial solutions</p> <p>TLO 1.3 Explain the Concept of 5 R w.r.t. the given situation</p> <p>TLO 1.4 Elaborate the relevance of Sustainable Development Goals in managing the climate change</p> <p>TLO 1.5 Explain the concept of zero carbon-footprint with carbon credit</p>	<p>Unit - I Environment and climate change</p> <p>1.1 Environment and its components, Types of Environments, Need of environmental studies</p> <p>1.2 Environmental Issues- Climate change, Global warming, Acid rain, Ozone layer depletion, nuclear accidents. Effect of population growth and industrialization</p> <p>1.3 Concept of 5R, Individuals' participation in i) 5R policy, ii) segregation of waste, and iii) creating manure from domestic waste</p> <p>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</p> <p>1.5 Zero Carbon footprint for sustainable development, (IKS-Environment conservation in vedic and pre-vedic India)</p>	Lecture Using Chalk-Board Presentations
2	<p>TLO 2.1 Justify the importance of natural resources in sustainable development</p> <p>TLO 2.2 Explain the need of optimum use of natural resources to maintain the sustainability</p> <p>TLO 2.3 Differentiate between renewable and non-renewable sources of energy</p> <p>TLO 2.4 Suggest the relevant type of energy source as a green solution to environmental issues</p>	<p>Unit - II Sustainability and Renewable Resources</p> <p>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)</p> <p>2.2 Impact of overexploitation of natural resources on the environment, optimum use of natural resources</p> <p>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</p> <p>2.4 Green Solutions in the form of New Energy Sources such as Hydrogen energy, Ocean energy & Tidal energy</p>	Lecture Using Chalk-Board Presentations
3	<p>TLO 3.1 Explain the characteristics and functions of ecosystem</p> <p>TLO 3.2 Relate the importance of biodiversity and its loss in the environmental sustainability</p> <p>TLO 3.3 Describe biodiversity assessment initiatives in India</p> <p>TLO 3.4 Conduct the SWOT analysis of the biodiversity hot spot in India</p> <p>TLO 3.5 Explain the need of conservation of biodiversity in the given situation</p>	<p>Unit - III Ecosystem and Biodiversity</p> <p>3.1 Ecosystem - Definition, Aspects of ecosystem, Division of ecosystem, General characteristics of ecosystem, Functions of ecosystem</p> <p>3.2 Biodiversity - Definitions, Levels, Value, and loss of biodiversity</p> <p>3.3 Biodiversity Assessment Initiatives in India</p> <p>3.4 SWOT analysis of biodiversity hot spot in India</p> <p>3.5 Conservations of biodiversity - objects, and laws for conservation of biodiversity</p>	Lecture Using Chalk-Board Presentations Video Demonstrations

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	<p>TLO 4.1 Classify the pollution based on the given criteria</p> <p>TLO 4.2 Justify the need of preserving soil as a resource along with the preservation techniques</p> <p>TLO 4.3 Maintain the quality of water in the given location using relevant preventive measures</p> <p>TLO 4.4 State the significance of controlling the air pollution to maintain its ambient quality norms</p> <p>TLO 4.5 Compare the noise level from different zones of city with justification</p> <p>TLO 4.6 Describe the roles and responsibilities of central and state pollution control board</p>	<p>Unit - IV Environmental Pollution</p> <p>4.1 Definition of pollution, types- Natural & Artificial (Man- made)</p> <p>4.2 Soil / Land Pollution – Need of preservation of soil resource, Causes and effects on environment and lives, preventive measures, Soil conservation</p> <p>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</p> <p>4.4 Air pollution - Causes, effects, prevention, CPCB norms of ambient air quality in residential area</p> <p>4.5 Noise pollution - Sources, effects, prevention, noise levels at various zones of the city</p> <p>4.6 Pollution Control Boards at Central and State Government level: Norms, Roles and Responsibilities</p>	Lecture Using Chalk-Board Presentations
5	<p>TLO 5.1 Explain Constitutional provisions related to environmental protection</p> <p>TLO 5.2 Explain importance of public participation (PPP) in enacting the relevant laws</p> <p>TLO 5.3 Use the relevant green technologies to provide sustainable solutions of an environmental problem</p> <p>TLO 5.4 Explain the role of information technology in environment protection</p>	<p>Unit - V Environmental legislation and sustainable practices</p> <p>5.1 Article (48-A) and (51-A (g)) of Indian Constitution regarding environment, Environmental protection and prevention acts</p> <p>5.2 Public awareness about environment. Need of public awareness and individuals' participation. Role of NGOs</p> <p>5.3 Green technologies like solar desalination, green architecture, vertical farming and hydroponics, electric vehicles, plant-based packaging</p> <p>5.4 Role of information technology in environment protection and human health</p>	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 sustainability and cost-benefit

IKS-Study and prepare a note on Vedic and Pre-Vedic techniques of environmental conservation

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 relevance 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 judicious 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 may be 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	Environmental 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 Environmental 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-for-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 Initiative 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 environmental issues
7	https://egyankosh.ac.in/handle/123456789/61136	IGNOU's Initiative for online study material on Environmental studies
8	https://egyankosh.ac.in/handle/123456789/50898	IGNOU's Initiative 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 Environmental studies (Natural Resources, Biodiversity and other topics)
14	https://onlinecourses.nptel.ac.in/noc23_hs155/preview	NPTEL course on environmental studies which encompasses SDGs, Pollution, Climate 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 Sanskrit University publication on Vedic and pre Vedic environmental conservation
Note :		
<ul style="list-style-type: none"> Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students 		

MSBTE Approval Dt. 21/11/2024**Semester - 4 / 6, K Scheme**

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	Paper Duration	Assessment Scheme										Total Marks
				Actual Contact Hrs./Week			SL	LH	NLH			Theory			Based on LL & TL				Based on SL			
				CL	TL	LL						Practical			FA-PR		SA-PR		SLA			
				Max	Max	Max	Min	Max	Min			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	

D.C. MACHINES AND TRANSFORMERS**Course Code : 314322****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	<p>TLO 1.1 Describe the constructional details of the D.C. Machine.</p> <p>TLO 1.2 Explain the principle of working of the given D.C. Generator.</p> <p>TLO 1.3 Derive EMF equation and calculate the parameters of the given D.C. Generator.</p> <p>TLO 1.4 Identify the given type of D.C. Generator.</p> <p>TLO 1.5 Interpret the characteristics of the given D.C. Generator.</p>	<p>Unit - I D.C. Generator</p> <p>1.1 D.C. Machine: construction, parts-function and material, types of winding (lap and wave)</p> <p>1.2 D.C. Generator: Principle of operation, Faraday's law of electromagnetic induction, Fleming's right hand rule.</p> <p>1.3 E. M. F. equation of D.C. Generator (derivation)</p> <p>1.4 Types of D.C. Generator and it's applications.</p> <p>1.5 Characteristics -internal and external.</p>	<p>Chalk-Board</p> <p>Flipped</p> <p>Classroom Video</p> <p>Demonstrations</p> <p>Model</p> <p>Demonstration</p> <p>Presentations</p>

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

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	<p>TLO 2.1 Explain the working principle of D.C. Motor.</p> <p>TLO 2.2 Apply the back emf equation in the given situation.</p> <p>TLO 2.3 Select relevant D.C. Motor for given application with justification.</p> <p>TLO 2.4 Calculate the torque, speed, output power and efficiency of the given D.C. Motor.</p> <p>TLO 2.5 Explain the various speed control methods of the given D.C. Motor.</p> <p>TLO 2.6 Describe with sketch the working of the starter for the given type of D.C. Motor.</p> <p>TLO 2.7 Describe the procedure of testing a D.C. Motor for the given condition.</p> <p>TLO 2.8 Explain with a diagram the working of the brushless D.C. Motor.</p>	<p>Unit - II D.C. Motor</p> <p>2.1 D.C. Motor: Principle of operation, Lorentz force, Fleming's Left hand rule, Back emf and it's significance, Armature reaction.</p> <p>2.2 Types of D.C. Motors, Torque: armature torque, shaft torque, Break Horse Power (BHP).</p> <p>2.3 D. C. Motor characteristics- speed-armature current, torque- armature current, speed-torque.</p> <p>2.4 Speed control: D.C. shunt and series motor- flux and armature control.</p> <p>2.5 Starters, necessity of starters, two-point starters, three-point starters and four-point starters.</p> <p>2.6 Testing: Break load test, Different types of losses, efficiency.</p> <p>2.7 D.C. Motors applications, advantages and disadvantages</p> <p>2.8 Brushless D.C. Motor: construction working, applications, advantages and disadvantages</p>	<p>Chalk-Board, Flipped Classroom Video, Demonstrations Model, Demonstration Presentations.</p>
3	<p>TLO 3.1 Describe the constructional details of the single-phase transformer.</p> <p>TLO 3.2 Explain the working principle of single-phase transformer.</p> <p>TLO 3.3 Derive the EMF equation of transformer and calculate parameter for the given situations.</p> <p>TLO 3.4 Identify the type of single-phase transformer based on the given criterion.</p> <p>TLO 3.5 Interpret the name plate rating of the given transformer.</p> <p>TLO 3.6 Explain phasor diagram for no load/on load condition for the given type of transformer.</p> <p>TLO 3.7 Calculate regulation and efficiency by O.C. / S.C. tests and direct loading for the given type of transformer.</p>	<p>Unit - III Single Phase Transformer</p> <p>3.1 Single phase transformer: Introduction, construction, parts-functions and material.</p> <p>3.2 Principle of operation, EMF equation, voltage transformation ratio, turns ratio.</p> <p>3.3 Types and losses, significance of transformer ratings.</p> <p>3.4 No-load and On-load test on transformer and it's phasor diagram, Leakage reactance.</p> <p>3.5 Equivalent circuit of transformer with equivalent resistances and reactances.</p> <p>3.6 Voltage regulation and Efficiency: Direct loading. O.C. / S.C. method. All day efficiency, applications.</p>	<p>Chalk-Board, Flipped Classroom Video, Demonstrations Model, Demonstration Presentations.</p>

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

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	<p>TLO 4.1 Describe the constructional details of the three -phase transformer.</p> <p>TLO 4.2 Identify the given type of transformer.</p> <p>TLO 4.3 Describe with diagrams various connections of the given three phase transformers.</p> <p>TLO 4.4 Select appropriate transformer on the given application.</p> <p>TLO 4.5 Describe the requirements for the parallel operation of the transformer.</p> <p>TLO 4.6 Describe the procedure for the given type of test on three phase transformer.</p> <p>TLO 4.7 Explain the importance of 'K' factor of transformers.</p>	<p>Unit - IV Three Phase Transformer</p> <p>4.1 Three phase transformer: Introduction, construction, bank of three single phase transformers. Single unit of three phase transformer.</p> <p>4.2 Working principle of three phase transformer. Types of transformers.</p> <p>4.3 Connections as per IS: 2026 (part IV)-1977. Three phase to two phase conversion (Scott Connection).</p> <p>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.</p> <p>4.5 Need of parallel operation, conditions for parallel operation.</p> <p>4.6 Polarity tests on mutually inductive coils, Phasing out test on Three- phase transformer.</p> <p>4.7 Harmonics and their effects on transformer operation.</p> <p>4.8 'K' factor of transformers: overheating due to non-linear loads and harmonics.</p>	<p>Chalk-Board Flipped Classroom Video, Demonstrations Model, Demonstration Presentations.</p>
5	<p>TLO 5.1 Describe the constructional details of the given type of special purpose transformer.</p> <p>TLO 5.2 Explain the Working principle of the given type of special purpose transformer.</p> <p>TLO 5.3 State the applications of the given type of special purpose transformer.</p>	<p>Unit - V Special Purpose Transformer</p> <p>5.1 Auto transformer: Construction, working and applications for single and three phases.</p> <p>5.2 Instrument Transformers: Construction, working and applications of current transformer and potential transformer.</p> <p>5.3 Isolation transformer: Construction, features and applications.</p> <p>5.4 Single phase welding transformer: Construction, features and applications.</p> <p>5.5 Pulse transformer: Construction, features and applications.</p>	<p>Chalk-Board, Flipped Classroom Video, Demonstrations Model, Demonstration Presentations.</p>

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. Compound Generator.	2	CO1

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

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

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

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

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

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
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)

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)**

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

- 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	Mittle, V.N. and Mittle, Arvind	Basic Electrical Engineering	McGraw Hill Education, New Delhi ISBN-13: 978-0070593572
2	Kothari, D. P. and Nagrath, I. J.	Electrical Machines	McGraw Hill Education, New Delhi ISBN-13:978-9352606405
3	Bhattacharya,S. K	Electrical Machines	McGraw Hill Education, New Delhi ISBN-13:978-0070669215
4	Mehta, V. K. and Mehta, Rohit	Principles of Electrical Machines	S.Chand and Co.Ltd., New Delhi ISBN-13: 978-8121921916
5	Theraja B. L.	Electrical Technology Vol-II (AC and DC machines)	S.Chand and Co.Ltd., New Delhi ISBN-13: 978-8121924375
6	Bandyopadhyay M. N.	Electrical Machines Theory and Practice	PHI Learning Pvt. Ltd., New Delhi ISBN-13:978-8120329973
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=d5iNRWSZb101NvT3	Construction & Working Principle of a D.C. Machine.
2	https://youtu.be/1OfLgpFq6Rc?si=bwN9d7ESIV2Utz6	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

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

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 possess 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	Paper Duration	Assessment Scheme										Total Marks
				Actual Contact Hrs./Week			SLH	NLH			Theory			Based on LL & TL				Based on SL			
				CL	TL	LL					FA-TH	SA-TH	Total	Practical		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	<p>TLO 1.1 Define the given term(s) as related to illumination.</p> <p>TLO 1.2 Explain the construction and working of the given type of lamp(s) and lamp fittings.</p> <p>TLO 1.3 State the laws of illumination</p> <p>TLO 1.4 Select the relevant lamp for the specified application with justification.</p> <p>TLO 1.5 Design simple lighting scheme for the given data.</p> <p>TLO 1.6 Explain factors affecting on quality of lighting system</p>	<p>Unit - I ILLUMINATION</p> <p>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</p> <p>1.2 Various types of Lamps :Fluorescent Tube, CFL, Metal Halide and LED.</p> <p>1.3 Laws of illumination: Inverse squares and Lambert's Cosine law.</p> <p>1.4 Various lighting schemes: Direct, Indirect , Semidirect and Semi indirect :features and application.</p> <p>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)</p> <p>1.6 Domestic and industrial lamp fittings.</p> <p>1.7 Factors affecting on quality of lighting system</p>	<p>Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom</p>

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

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	<p>TLO 2.1 Explain construction, working principle and classification of the specified electrical heating system.</p> <p>TLO 2.2 Recommend the relevant heating system for the given application with proper justification.</p> <p>TLO 2.3 Design the heating element of the given type of furnace from the specified data.</p> <p>TLO 2.4 Solve simple numerical on estimation of size of induction furnace</p> <p>TLO 2.5 Estimate voltage and power requirement in dielectric heating</p>	<p>Unit - II ELECTRIC HEATING</p> <p>2.1 Concept of electrical heating, Advantages and classification of electric heating, modes of heat transfer.</p> <p>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</p> <p>2.3 Arc Heating - Construction and Operation of Direct Arc Furnace, Indirect Arc Furnace. Applications of Arc Heating.</p> <p>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).</p> <p>2.5 Dielectric Heating: Principle of Dielectric Heating, Advantages of Dielectric Heating</p> <p>2.6 Limitations of Dielectric Heating, Applications of Dielectric Heating (Simple Numericals)</p>	<p>Lecture Using Chalk-Board Video Demonstrations Site/Industry Visit Case Study</p>
3	<p>TLO 3.1 Select the relevant welding system for the specified application with justification.</p> <p>TLO 3.2 Describe the working principle and construction of special type of transformer used in welding.</p> <p>TLO 3.3 Describe the working principle of Electric Welding and its types</p> <p>TLO 3.4 State the applications of modern welding techniques</p>	<p>Unit - III ELECTRIC WELDING</p> <p>3.1 Electric Welding: Principles of electric resistance welding.</p> <p>3.2 Methods of Electric Welding – Electric arc welding, resistance welding.</p> <p>3.3 Resistance Welding – Principles, Advantages, types of resistance welding.</p> <p>3.4 Electric Arc Welding- Formation and Characteristics of electric arc, effects of arc length.</p> <p>3.5 Principle of electric arc welding: Types, advantages, disadvantages and applications of all types.</p> <p>3.6 Comparison with resistance welding and Electric Arc Welding</p> <p>3.7 2.7 Modern welding techniques like Ultrasonic, Laser, under water welding, IGBT controlled welding.</p>	<p>Lecture Using Chalk-Board Video Demonstrations Presentations Site/Industry Visit</p>

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	<p>TLO 4.1 Differentiate the salient features between the given types of electric drives.</p> <p>TLO 4.2 Recommend the relevant motor for the given application with justification.</p> <p>TLO 4.3 Select the relevant enclosure for the given atmospheric condition with justification.</p> <p>TLO 4.4 Select the power transmission drive of the electric motor for the given application with justification.</p> <p>TLO 4.5 Estimate the relevant size and rating of electric motor for the specified load cycles.</p> <p>TLO 4.6 Select relevant elevator machine and electric motor for the specified application with justification.</p> <p>TLO 4.7 Describe the procedure to maintain the given electric drive and elevator.</p>	<p>Unit - IV ELECTRIC DRIVES AND ELEVATORS</p> <p>4.1 Electric drives : Concept, factors governing selection of electric drives(motor).</p> <p>4.2 Types of electrical drives : Individual and Group drive, Applications.</p> <p>4.3 Mechanical features of drives: Types and applications various types of enclosures.</p> <p>4.4 Transmission of Mechanical Power: Direct and Indirect drive (Belt, Rope, Chain, Gear), Vertical drives and its applications.</p> <p>4.5 Bearing: Types and applications.</p> <p>4.6 Size and Rating of motor : (Simple numerical on this topic)</p> <p>4.7 Load Cycles : Concept with graphical representation.</p> <p>4.8 Load Equalization : Concept , and methods and condition of load equalization.</p> <p>4.9 Elevators: Function, Application, types, safety and precautions, case study of latest Elevator.</p> <p>4.10 Factors on which shape and size of car depends.</p>	<p>Lecture Using Chalk-Board Video Demonstrations Site/Industry Visit Case Study</p>

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

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	<p>TLO 5.1 Recommend relevant traction system for the given application with justification.</p> <p>TLO 5.2 Select the relevant track electrification system for the specified traction services with justification.</p> <p>TLO 5.3 Differentiate the salient features between the given types of track electrification system.</p> <p>TLO 5.4 Draw the speed-time curve for the specified electric traction application.</p> <p>TLO 5.5 Differentiate between the given types of traction services based on the given criteria .</p> <p>TLO 5.6 Determine average and schedule speed for the given traction service.</p>	<p>Unit - V ELECTRIC TRACTION</p> <p>5.1 Introduction of electric traction system, Requirements of ideal traction system</p> <p>5.2 System of Track Electrification: DC; Single phase 25kV AC, Composite system.</p> <p>5.3 Traction Mechanics : Block diagram of AC electric locomotive and function of each part, Nomenclature of Locomotivesiv</p> <p>5.4 Crest, Average and Schedule Speed; definition and factors affecting them.</p> <p>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)</p> <p>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)</p> <p>5.7 Introduction of Metro and Mono Rail (main features between the two of them).</p>	<p>Lecture Using Chalk-Board</p> <p>Video</p> <p>Demonstrations</p> <p>Site/Industry Visit</p> <p>Presentations</p>

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	*Comparison 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 illumination level 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	*Demonstration of different electrical and safety equipments used for arc welding.	2	CO2

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

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

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

- 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 judicious 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 may be considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Fluorescent 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)**

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

- 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 practice 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

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 : 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	Paper Duration	Assessment Scheme										
				Actual Contact Hrs./Week			SL	H	NL			H	Theory			Based on LL & TL				Based on SL		Total Marks
				CL	TL	LL							Practical			FA-PR		SA-PR		SLA		
				Max	Max	Max	Min	Max	Min			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	<p>TLO 1.1 Recognize and convert the given number into the specified number system.</p> <p>TLO 1.2 Perform the binary and BCD arithmetic operation on the given numbers.</p> <p>TLO 1.3 Develop the basic gates using the given NAND/NOR gate as universal gate.</p> <p>TLO 1.4 Construct adder and subtractor circuit using logic gates.</p>	<p>Unit - I Number System and Logic Gates</p> <p>1.1 Number System : Decimal, Binary, octal, hexadecimal, BCD. Conversion of one system into other.</p> <p>1.2 Binary Arithmetic: - Addition, Subtraction (1's and 2's complement) Multiplication, Division. BCD addition.</p> <p>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).</p> <p>1.4 Arithmetic Circuits: Half and full Adder, Half and full subtractor with its truth table, boolean expression and circuits using logic gates.</p>	<p>Chalk-Board Presentations</p> <p>Demonstration</p> <p>Flipped Classroom</p>
2	<p>TLO 2.1 Draw MUX/DEMUX tree for the given number of input and output lines.</p> <p>TLO 2.2 Describe the building process of the specified type of flip-flop.</p> <p>TLO 2.3 Use excitation table of the given flip-flop to design asynchronous counter.</p>	<p>Unit - II Digital Logic Circuits</p> <p>2.1 Multiplexer and Demultiplexer: working , truth table and applications of Multiplexers and Demultiplexers.</p> <p>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.</p> <p>2.3 Counters: Types (Asynchronous, Synchronous) and their applications.,4 bit asynchronous counter – Circuit diagram and truth table.</p>	<p>Chalk-Board Presentations</p> <p>Video Demonstrations</p> <p>Flipped Classroom</p>

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 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
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

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

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

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

Sr.No	Author	Title	Publisher with ISBN Number
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
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

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

MSBTE Approval Dt. 21/11/2024

Semester - 4, K Scheme

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										Total Marks
				Actual Contact Hrs./Week			SL	LH	NLH		Paper Duration	Theory			Based on LL & TL		Based on SL				
				CL	TL	LL						Total	FA-PR	SA-PR	SLA						
							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	<p>TLO 1.1 Apply the principles of NEC 2023 during preparation of the given document.</p> <p>TLO 1.2 State the purpose of preparation of the given type(s) of estimates.</p> <p>TLO 1.3 State the purpose of awarding the given type(s) of contracts.</p> <p>TLO 1.4 Prepare tender documents, quotations, and bills for the specified work.</p>	<p>Unit - I Estimates and Contracts</p> <p>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</p> <p>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.</p> <p>1.3 Contracts: Concepts, types, roles, and qualities of good contractor</p> <p>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.</p>	<p>Lecture Using Chalk-Board Presentations</p>

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	<p>TLO 2.1 Interpret the given electrical installation plan and electrical diagrams.</p> <p>TLO 2.2 Estimate materials required for the given domestic installations.</p> <p>TLO 2.3 Estimate materials required for the given commercial installations.</p> <p>TLO 2.4 Estimate materials required for given type of service connection.</p>	<p>Unit - II Domestic and Commercial Installations</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>2.4 Service Connection: Underground and overhead, it's diagram and description. Calculation of material required for underground and overhead service connection.</p>	<p>Lecture Using Chalk-Board Presentations Case Study Flipped Classroom Site/Industry Visit</p>
3	<p>TLO 3.1 Select wiring types for industrial installations.</p> <p>TLO 3.2 Draw an installation plan, wiring diagrams and single line diagrams for the given industrial installations.</p> <p>TLO 3.3 Describe given design considerations of an industrial installation.</p> <p>TLO 3.4 Carry out estimation for the given industrial installations.</p>	<p>Unit - III Industrial Installations</p> <p>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.</p> <p>3.2 Wiring diagram and single line diagram for single phase and three phase motors. Installation plan.</p> <p>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.</p> <p>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.</p>	<p>Lecture Using Chalk-Board Case Study Flipped Classroom Presentations Site/Industry Visit</p>

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	<p>TLO 4.1 Describe given terms related to public lighting installation.</p> <p>TLO 4.2 Select proper materials for streetlights installation.</p> <p>TLO 4.3 Select proper materials for High-mast lighting installation.</p> <p>TLO 4.4 Carry out estimation of streetlights and High-mast lighting.</p>	<p>Unit - IV Public Lighting Installation</p> <p>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.</p> <p>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.</p> <p>4.3 High-mast pole structure, selection of equipment, wiring diagram.</p> <p>4.4 Design, estimation and costing of streetlights and High-mast lighting.</p>	<p>Lecture Using Chalk-Board Presentations</p> <p>Case Study</p> <p>Flipped Classroom</p> <p>Site/Industry Visit</p>
5	<p>TLO 5.1 Compare the given types of distribution lines.</p> <p>TLO 5.2 Describe the given material required for distribution lines.</p> <p>TLO 5.3 Carry out estimates for the specified distribution lines.</p>	<p>Unit - V Distribution Lines</p> <p>5.1 Block Diagram of Electrical Power system, Types of Distribution lines - Primary and Secondary, Overhead and Underground, and it's comparison.</p> <p>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.</p> <p>5.3 Design, estimation and costing of HT (11kV), LT (415 V) overhead line and underground cabling.</p>	<p>Presentations</p> <p>Lecture Using Chalk-Board</p> <p>Flipped Classroom</p> <p>Case Study</p> <p>Site/Industry Visit</p>

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
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

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

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
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 -				
<ul style="list-style-type: none"> • '*' 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 judicious 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

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=IoMXX6xctlg	Streetlight wiring
6	https://standardsbis.bsbedge.com/	SP:30 NEC 2023
7	https://gem.gov.in/	GeM portal for procurement.

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Sr.No	Link / Portal	Description
Note : <ul style="list-style-type: none">Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students		

MSBTE Approval Dt. 21/11/2024**Semester - 4, K Scheme**