Maharashtra State Board Of Technical Education, Mumbai

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

Programme Name : Diploma In Electrical Engineering / Electrical Power System

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

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

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

Sr No	Course Title	Abbrevation	Course Type	Course Code	Total IKS Hrs for Sem.	Learning Scheme					Credits	Assessment Scheme												
						Actual Contact Hrs./Week			Self Learning (Activity/ Assignment /Micro Project)	Notional Learning Hrs /Week		Paper Duration (hrs.)	Theory				Based on LL & TL				Based on Self Learning		Total Marks
																	Practical						
						CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
													Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
(All Compulsory)																								
1	ELECTRICAL CIRCUITS AND NETWORK	ECN	DSC	313332	-	4	-	4	-	8	4	3	30	70	100	40	25	10	50#	20	-	-	175
2	ELECTRICAL POWER GENERATION,TRANSMISSION AND DISTRIBUTION	GTD	DSC	313333	-	4	-	2	2	8	4	3	30	70	100	40	25	10	25@	10	25	10	175
3	ELECTRICAL AND ELECTRONIC MEASUREMENT	EEM	DSC	313334	-	3	-	4	1	8	4	3	30	70	100	40	25	10	25#	10	25	10	175
4	FUNDAMENTALS OF POWER ELECTRONICS	FPE	SEC	313335	-	3	-	4	1	8	4	3	30	70	100	40	25	10	25@	10	25	10	175
5	ESSENCE OF INDIAN CONSTITUTION	EIC	VEC	313002	-	1	-	-	1	2	1	-	-	-	-	-	-	-	-	-	50	20	50
6	ELECTRICAL MATERIAL AND WIRING PRACTICE	EMW	SEC	313015	-	1	-	4	1	6	3	-	-	-	-	-	50	20	25@	10	25	10	100
Total					**0**	**16**	**0**	**18**	**6**		**20**		**120**	**280**	**400**		**150**		**150**		**150**		**850**

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

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

Note :

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

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

ELECTRICAL CIRCUITS AND NETWORK **Course Code : 313332**

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

I. RATIONALE

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

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

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

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

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

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

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

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

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

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

ELECTRICAL CIRCUITS AND NETWORK **Course Code : 313332**

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

ELECTRICAL CIRCUITS AND NETWORK **Course Code : 313332**

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

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

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

ELECTRICAL CIRCUITS AND NETWORK **Course Code : 313332**

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

ELECTRICAL CIRCUITS AND NETWORK **Course Code : 313332**

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

ELECTRICAL CIRCUITS AND NETWORK **Course Code : 313332**

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

Note : Out of above suggestive LLOs -

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

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

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

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

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

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

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

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

Summative Assessment (Assessment of Learning)

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

XI. SUGGESTED COS - POS MATRIX FORM

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

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

XII. SUGGESTED LEARNING MATERIALS / BOOKS

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

XIII . LEARNING WEBSITES & PORTALS

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

ELECTRICAL CIRCUITS AND NETWORK **Course Code : 313332**

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

Note :

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

MSBTE Approval Dt. 02/07/2024 **Semester - 3, K Scheme**

ELECTRICAL POWER GENERATION,TRANSMISSION AND DISTRIBUTION **Course Code : 313333**

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

I. RATIONALE

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

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

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

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

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

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

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

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
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Note :

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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.

ELECTRICAL POWER GENERATION,TRANSMISSION AND DISTRIBUTION **Course Code : 313333**

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

ELECTRICAL POWER GENERATION,TRANSMISSION AND DISTRIBUTION **Course Code : 313333**

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

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

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

ELECTRICAL POWER GENERATION,TRANSMISSION AND DISTRIBUTION **Course Code : 313333**

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

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

Note : Out of above suggestive LLOs -

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

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

Visit

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

Assignment

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

Micro project

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

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

Survey

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

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- 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	Video Programme/Animation/Demonstration Model of Thermal Power Plant.	1,2
2	Video Programme/Animation/Demonstration Model of Transmission/Distribution Substation.	10,11,15
3	Video Programme/Animation/Demonstration Model of Hydro Power Plant.	3,4,5
4	Video Programme/Animation/Demonstration Model/Chart Demonstration of Electric Power System.	9
5	Video Programme/Animation/Demonstration Model of different Supporting structures / Insulators/ Conductors of Transmission Line.	9,10,13,14,16,17

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

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

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

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

Summative Assessment (Assessment of Learning)

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

XI. SUGGESTED COS - POS MATRIX FORM

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

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

XII. SUGGESTED LEARNING MATERIALS / BOOKS

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

XIII . LEARNING WEBSITES & PORTALS

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

ELECTRICAL POWER GENERATION,TRANSMISSION AND DISTRIBUTION **Course Code : 313333**

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

Note :

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

MSBTE Approval Dt. 02/07/2024 **Semester - 3, K Scheme**

ELECTRICAL AND ELECTRONIC MEASUREMENT **Course Code : 313334**

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

I. RATIONALE

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

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

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

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

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

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

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

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

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

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

ELECTRICAL AND ELECTRONIC MEASUREMENT **Course Code : 313334**

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

ELECTRICAL AND ELECTRONIC MEASUREMENT **Course Code : 313334**

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

ELECTRICAL AND ELECTRONIC MEASUREMENT **Course Code : 313334**

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

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

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

ELECTRICAL AND ELECTRONIC MEASUREMENT **Course Code : 313334**

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

Note : Out of above suggestive LLOs -

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

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

Assignment

- Write the industrial applications of level transducer.

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

Suggested Student Activity

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

Micro project

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

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- 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	Model of PMMC and PMMI type instrument (up to 50A)	1,2,3
2	Energy meter (analog/digital) (15A/230V)	13,14
3	Smart energy meter.	15
4	Wheatstone bridge, Mega ohm bridge	16,17
5	CRO (up to 100 MHz)	18

ELECTRICAL AND ELECTRONIC MEASUREMENT **Course Code : 313334**

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

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

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

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

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

Summative Assessment (Assessment of Learning)

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

XI. SUGGESTED COS - POS MATRIX FORM

ELECTRICAL AND ELECTRONIC MEASUREMENT **Course Code : 313334**

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

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

XII. SUGGESTED LEARNING MATERIALS / BOOKS

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

XIII . LEARNING WEBSITES & PORTALS

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

Note :

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

FUNDAMENTALS OF POWER ELECTRONICS **Course Code : 313335**

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

I. RATIONALE

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

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Test the Performance of Power Electronic Devices and Circuits.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

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

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

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

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

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

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

FUNDAMENTALS OF POWER ELECTRONICS **Course Code : 313335**

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

FUNDAMENTALS OF POWER ELECTRONICS **Course Code : 313335**

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

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

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

FUNDAMENTALS OF POWER ELECTRONICS **Course Code : 313335**

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

FUNDAMENTALS OF POWER ELECTRONICS **Course Code : 313335**

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

Note : Out of above suggestive LLOs -

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

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

Micro project

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

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

Assignment

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

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- 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	SCR: Irms = 16A, IH = 100mA, IL = 200mA, IGT = 90 to 35 mA, VGT = 3 to 1 V, Vrms = 1600V	1,2,6,7,8,10,11,9,12,13,14,15,16,17,18
2	Power MOSFET: Vds-400V, ID-10A-6.3A Pd-125W	1,3,23,24
3	IGBT: Vces = 1200V, VGE = 20V, IC = 139 to 93A, PD = 650 to 300W	1,4,19,20,21,22
4	TRIAC: It = 4A, IGT = 10mA, Vt = 600V.	1,5
5	Rheostat: Nicrome wire, 300ohm, 10A, 400V	12,13,14,15,16,17,19,20,21,22
6	Variable inductive load: Single phase,250V, 2.5kW continuously variable core type	12,13,14,15,16,17,19,20,21,22
7	CRO/Digital Oscilloscope with probes: 20MHz, dual channel, sensitivity = 1mV/div., Max Input = 400V, Power supply = 230VAC.	12,13,14,15,16,17,19,20,21,22
8	Clamp on meter: Current = 0 to 400A, Voltage = 0 to 600V	2,3,4,5,25,27
9	AC and DC Ammeter: Range = 0 to 20A, Sensitivity = 0.5A/div.	25,27
10	AC and DC Voltmeter: 0 to 300V, Sensitivity = 1V/div.	25,27
11	Multimeter: 2000 count digital display, 1000V DC/750 V AC ranges, 10 A AC/DC ranges	All

FUNDAMENTALS OF POWER ELECTRONICS **Course Code : 313335**

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

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

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

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

Summative Assessment (Assessment of Learning)

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

XI. SUGGESTED COS - POS MATRIX FORM

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

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

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number

FUNDAMENTALS OF POWER ELECTRONICS **Course Code : 313335**

Sr.No	Author	Title	Publisher with ISBN Number
1	Muhammad H. Rashid	Power Electronics Handbook	Butterworth-Heinemann Inc, ISBN:978-0128114070
2	P S. Bimbhra	Power Electronics	KHANNA PUBLISHERS, ISBN:978-8174092793
3	Muhammad H. Rashid	Power Electronics: Devices, Circuits, and Applications	Pearson Education, ISBN:978-8120345317
4	M D Singh, K B Khanchnadani	Power Electronics	McGraw Hill Education, ISBN:9780070583894

XIII . LEARNING WEBSITES & PORTALS

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

Note :

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

ESSENCE OF INDIAN CONSTITUTION **Course Code : 313002**

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

I. RATIONALE

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

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

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

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

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

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

ESSENCE OF INDIAN CONSTITUTION **Course Code : 313002**

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

Total IKS Hrs for Sem. : 0 Hrs

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

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

Note :

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

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

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

ESSENCE OF INDIAN CONSTITUTION **Course Code : 313002**

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

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

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

Assignment

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

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

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

Micro project

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

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

Seminar

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

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

Group discussions on current print articles.

-

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

Activity

- Arrange Mock Parliament debates.

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

Cases: Suggestive cases for usage in teaching:

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

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

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

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- 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 : NOT APPLICABLE

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

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

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

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

Summative Assessment (Assessment of Learning)

XI. SUGGESTED COS - POS MATRIX FORM

ESSENCE OF INDIAN CONSTITUTION **Course Code : 313002**

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

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

XII. SUGGESTED LEARNING MATERIALS / BOOKS

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

XIII . LEARNING WEBSITES & PORTALS

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

ESSENCE OF INDIAN CONSTITUTION **Course Code : 313002**

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

Note :

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

MSBTE Approval Dt. 02/07/2024 **Semester - 3, K Scheme**

ELECTRICAL MATERIAL AND WIRING PRACTICE **Course Code : 313015**

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

I. RATIONALE

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

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

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

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

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

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

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

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

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

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

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

ELECTRICAL MATERIAL AND WIRING PRACTICE **Course Code : 313015**

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

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

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

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

Note : Out of above suggestive LLOs -

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

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

Assignment

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

Visit

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

Micro project

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

Self learning topics

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

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- 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	Various fuse mounting units, fuse wire of different rating, ammeter, lamp bank.	10
2	Insulation tester 500V or 1000V	11,13
3	Insulating materials of different classes, electric iron	12

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

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

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

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

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

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Summative Assessment (Assessment of Learning)

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

XI. SUGGESTED COS - POS MATRIX FORM

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

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

XII. SUGGESTED LEARNING MATERIALS / BOOKS

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

XIII . LEARNING WEBSITES & PORTALS

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

Note :

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

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MSBTE Approval Dt. 02/07/2024 **Semester - 3, K Scheme**