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A.C. MACHINES PERFORMANCE **Course Code : 315333**

Programme Name/s	**: Electrical Engineering/ Electrical and Electronics Engineering/ Electrical Power System**
Programme Code	**: EE/ EK/ EP**
Semester	**: Fifth**
Course Title	**: A.C. MACHINES PERFORMANCE**
Course Code	**: 315333**

I. RATIONALE

AC machines are widely used in various industries and generating stations, while three phase induction motors are work horse of the industries, alternators are used for generating electrical power. This course is designed to enable the diploma students to acquire the knowledge and skills related to operation and maintenance of these AC machines to enhance the employability in the field.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Test the performance of different AC machines in industries.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Test the performance of three phase induction motor.
- CO2 - Control the speed of three phase induction motor using appropriate technique(s).
- CO3 - Use single phase induction motor for industrial applications.
- CO4 - Test the performance of three phase alternator.
- CO5 - Use special purpose electrical machines for industrial applications.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical							
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315333	A.C. MACHINES PERFORMANCE	ACM	DSC	5	-	2	2	9	3	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.* 10 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

A.C. MACHINES PERFORMANCE **Course Code : 315333**

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 Classify three phase AC machines. TLO 1.2 Explain constructional details and working principle of the given induction motor. TLO 1.3 Explain the production of a rotating magnetic field with two and three phases. TLO 1.4 Define synchronous speed. TLO 1.5 Mention the general specifications and ratings of three phase induction motor. TLO 1.6 Analyze the behavior of the rotor under the given conditions. TLO 1.7 Calculate the given parameter related to the induction motor. TLO 1.8 Describe the given method(s) for slip measurement of the given induction motor. TLO 1.9 Interpret the torque-slip characteristics of the given induction motor and state its applications.	**Unit - I Three phase induction motors** 1.1 Three phase AC machines: classification. 1.2 Squirrel cage induction motor and slip ring induction motor: constructional details. 1.3 Concept of rotating magnetic field: production of rotating magnetic field (with two and three phases), synchronous speed. 1.4 Squirrel cage induction motor and slip ring induction motor: working principle, comparison. 1.5 Rotor behavior and relations: standstill and running conditions, speed, slip, frequency of induced emf/currents, power factor. 1.6 Slip measurement methods: tachometer, stroboscope, galvanometer. 1.7 Torques: starting, full load and maximum torque & their ratios. 1.8 Torque-slip (T-S) characteristics. 1.9 Squirrel cage induction motor: losses and power stages.	Lecture Using Chalk-Board, Presentations, Video Demonstrations, Flipped Classroom, Collaborative Learning, Case Study, Industry Visit.
2	TLO 2.1 Justify the need of starter for three phase induction motor. TLO 2.2 Describe constructional details of the given type of starter for the induction motor. TLO 2.3 Explain working of the given starter for three phase induction motors. TLO 2.4 List all the components used in the given soft starter. TLO 2.5 Explain the working of the given soft starter. TLO 2.6 Explain the given method(s) of speed control for the induction motor.	**Unit - II Starting and speed control of three phase induction motors** 2.1 Necessity of starters for three phase induction motors. 2.2 Primary resistance starter, DOL, auto transformer starter, star delta starter, rotor resistance starter: constructional details and working. 2.3 Soft starters: component details and working. 2.4 Speed control methods: stator voltage control, pole changing, rotor resistance, variable frequency drives (VFD).	Lecture Using Chalk-Board, Presentations, Video Demonstrations, Flipped Classroom, Collaborative Learning, Case Study, Industry Visit.

A.C. MACHINES PERFORMANCE **Course Code : 315333**

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 double field revolving theory and its significance in single-phase induction motors. TLO 3.2 Describe the given self-starting technique(s) for the single-phase induction motors. TLO 3.3 Describe the constructional details of the given single-phase induction motor. TLO 3.4 Explain the working principles of the given single-phase induction motor. TLO 3.5 Interpret the torque-slip characteristics of the given single-phase induction motor and state its applications.	**Unit - III Single phase induction motors** 3.1 Necessity of single-phase induction motor 3.2 Double field revolving theory. 3.3 Self starting techniques : phase splitting, shaded pole, reluctance. 3.4 Types : capacitor start-induction run, capacitor start-capacitor run (two value and single value capacitor), shaded pole: construction, working, torque-slip (T-S) characteristics and applications.	Lecture Using Chalk-Board, Presentations, Video Demonstrations, Flipped Classroom, Collaborative Learning, Case Study.
4	TLO 4.1 Describe the constructional details of three phase alternators. TLO 4.2 Explain the working principle of alternator. TLO 4.3 State the advantages of rotating field in turbo alternators. TLO 4.4 Calculate the speed and frequency for the given three phase alternator. TLO 4.5 Calculate the pitch factor, distribution factor and EMF for the given three phase alternator. TLO 4.6 Explain the given type of excitation system used in three phase alternator. TLO 4.7 Explain the significance of synchronous reactance. TLO 4.8 Explain the impact of power factors on performance of the three phase alternator. TLO 4.9 Calculate the voltage regulation of three phase alternators for the given loading conditions. TLO 4.10 Explain the working principle of three phase synchronous motor and its use for power factor improvement. TLO 4.11 Explain necessity of synchronisation and describe the conditions for it.	**Unit - IV Three phase synchronous machines** 4.1 Three phase alternators: constructional details, working principle. Types of alternators and their comparison: turbo alternator and hydro alternator. 4.2 Turbo alternators: advantages of rotating field. 4.3 Relations for speed and frequency. 4.4 Winding: advantages of short pitched winding, relations for pitch factor and distribution factor. 4.5 Excitation system: DC, AC, static. 4.6 E.M.F. equation of alternator. 4.7 Synchronous reactance. 4.8 Armature reaction at various power factors. 4.9 Voltage regulation: direct loading method and synchronous impedance method. 4.10 Synchronisation of alternators: definition, necessity and conditions 4.11 Three phase synchronous motor: principle of operation, significance of load angle. 4.12 Synchronous motor for power factor improvement.	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom Collaborative Learning, Case Study

A.C. MACHINES PERFORMANCE **Course Code : 315333**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Describe construction of the given type of special purpose machine. TLO 5.2 Explain the working principle of the given special purpose machine. TLO 5.3 Select relevant special purpose machine for the specified application.	**Unit - V Special purpose machines** 5.1 Universal motor, synchronous reluctance motor, permanent magnet synchronous motors (PMSM), stepper motors. 5.2 Constructional details and working of linear induction motor. 5.3 Single and double sided linear induction motor. 5.4 Applications of linear induction motor.	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 Identify the different parts of a three phase squirrel cage and slip ring induction motor. LLO 1.2 Reverse the direction of rotation of a three phase induction motors. LLO 1.3 Interpret the nameplate of three phase induction motor.	1	* Identification of different parts of a three phase squirrel cage and slip ring induction motor, interpretation of the nameplate of three phase induction motor and reversal of the direction of rotation	2	CO1
LLO 2.1 Measure slip of a three phase induction motor using tachometer. LLO 2.2 Measure slip of a three phase induction motor using galvanometer. LLO 2.3 Measure slip of a three-phase induction motor using stroboscope.	2	*Measurement of slip of a three-phase induction motor by : a) using Tachometer b) using galvanometer c) using stroboscope	2	CO1
LLO 3.1 Perform brake test on a three-phase induction motor.	3	*Brake test on three-phase induction motor.	2	CO1
LLO 4.1 Measure iron and copper losses in a three-phase induction motor. LLO 4.2 Calculate the efficiency of a three-phase induction motor.	4	* Measurement of iron and copper losses through no-load and blocked rotor test on a three-phase induction motor and calculation of efficiency	2	CO1
LLO 5.1 Start a three phase induction motor using a given starter. LLO 5.2 Set the current rating of DOL/ star-delta starter.	5	* Starting of a three-phase induction motor using (a) auto transformer (b) DOL starter (c) star-delta starter	2	CO2
LLO 6.1 Control the speed of a three phase slip ring induction motor by varying rotor resistance.	6	Speed control of a three-phase slip ring induction motor by varying rotor resistance.	2	CO2
LLO 7.1 Control the speed of a three phase slip ring induction motor by varying rotor resistance. LLO 7.2 Start the three phase induction motor using VFD. LLO 7.3 Control the speed of three phase induction motor using VFD.	7	Starting and controlling the speed of a three-phase induction motor using variable frequency drive (VFD)	2	CO2

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 8.1 Identify different parts of a single phase induction motor. LLO 8.2 Reverse the direction of rotation of a single phase inducction motor.	8	* Identification of different parts of a single phase induction motor and reversing the direction of rotation of a ceiling fan/ single phase induction motor/ universal motor	2	CO3
LLO 9.1 Operate three phase alternator for variable frequency output.	9	Operation of three phase alternator for variable frequency output by controlling speed of its prime mover	2	CO4
LLO 10.1 Perform a direct loading test on a three phase alternator to determine voltage regulation under various loads. LLO 10.2 Calculate up ad down regulation of three phase alternator.	10	Direct loading test of a three-phase alternator for determining voltage regulation with resistive, inductive, and capacitive loads	2	CO4
LLO 11.1 Perform open circuit (OC) and short circuit (SC) test on three-phase alternator. LLO 11.2 Calculate the efficiency of a three-phase alternator. LLO 11.3 Calculate the up and down regulation of three phase alternator.	11	* Open circuit (OC) and short circuit (SC) test on three phase alternator for determining its efficiency and voltage regulation	2	CO4
LLO 12.1 Control the speed of a stepper motor.	12	*Speed control of stepper motor	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

- Calculate starting torque, full load torque and maximum torque for a given 3 phase induction motor connected to a rated power supply.
- Calculate rotor current frequency, synchronous speed and rotor speed for a given slip, number of poles and power supply of 3 phase induction motor.
- Calculate the external resistance to be inserted in rotor circuit to get the maximum torque at the starting conditions for a given slip ring induction motor connected to a rated power supply.
- Calculate the external resistance to be inserted in rotor circuit to get the maximum torque at a given running conditions for a given slip ring induction motor connected to a rated power supply.
- Solve numerical to calculate voltage regulation of alternator.
- Solve numerical to calculate emf of alternator.

Micro project

- Collect information in brochures or other means for setting up VVVF drives.
- Collect information/product brochures on different types of alternators.
- Gather information and product brochures on both AC and DC servomotors commonly employed in robotics, CNC machining, conveyor systems, and other motion control applications.
- Collect information and product brochures, for single-phase induction motors and BLDC motor used in ceiling fans.

- Obtain information and product brochures on stepper motors utilized in precision positioning systems, 3D printers, CNC machines, and other motion control applications.
- Visit an industry and collect information/product brochures on three phase induction motors used for lifts, cranes and hoists and prepare reports covering interpretation of technical specification, name of manufacturer, frame size and applications.
- Visit an industry and collect information/product brochures on three phase induction motors used for floor mills, agricultural solar pumps and prepare reports covering interpretation of technical specification, name of manufacturer, frame size and applications.
- Design a model of a three-phase/single-phase induction motor using software such as CAD, CATIA, or SOLIDWORKS to visualize and understand its constructional details.

Suggested Student Activity

- Note: Sign in to perform below activities in virtual lab : " https://portal.coepvlab.ac.in/vlab/ ". Suggested virtual lab practical are the additional activities to be performed by students for the better understanding of the concepts related to AC machines and should not be considered as a substitute for actual laboratory practical experiences.
- Perform short circuit test on three phase alternator.
- Perform speed control of a slip ring induction motor.
- Perform V and inverted V curves of synchronous motor.
- Perform starting of three phase induction motor with a) stator resistance starter b) auto transformer starter c) star-delta starter.
- Perform no load test on three phase induction motor.

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	Three Phase Induction Motor 3 hp / 5 hp, 415 V, 50 Hz, 1440 RPM Squirrel Cage type with Brake and Pulley arrangement.	1,2,3,4,5,6
2	Three Phase Induction Motor 3 hp / 5 hp, 415 V, 50 Hz, 1440 RPM Slip Ring type.	1,2,4,5,6,7
3	Experimentation kit of speed control of stepper motor for 1.8 degree step angle	12
4	Stroboscope or relative Mobile app (e.g. Strobolight/RPM meter).	2
5	Galvanometer (30-0-30).	2
6	Auto Transformer: 3-Phase, 5kVA, 0 to 470V.	2,3,4,5,6,7,8,9,10,11
7	Ammeters MI Type: AC/DC 0-5-10A, 0-10-20A.	2,3,4,5,6,7,8,9,10,11,12
8	Voltmeters MI Type: AC/DC, 0-150/300V, 0-250/500V.	2,3,4,5,6,7,8,9,10,11,12
9	Clip on Meter Digital/Analog.	2,3,4,5,6,7,8,9,10,11,12
10	Digital Multimeter with standard makes for measurements.	2,3,4,5,6,7,8,9,10,11,12
11	Tachometers: Contact and Non-contact types: 100 to 10000 RPM.	2,3,4,5,6,7,8,9,10,11,12
12	Three Phase Induction Motor 3 hp / 5 hp, 415 V, 50 Hz, 1440 RPM Squirrel Cage type coupled with suitable DC Shunt Machine.	6
13	Wattmeters: Single Phase, Single Element, 2.5/5A, 200/400V.	6,7

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Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
14	Wattmeters: Three Phase Double Element, 5/10A, 250/500V.	6,7
15	Low Power Factor Wattmeter: Single Phase, 2.5/5A, 250/500V.	6,7
16	Single Phase Induction Motor, Permanent Capacitor (single value), 1 hp, 230 V, 50 Hz, 1440 RPM.	8
17	Star- Delta Starter (Auto/Manual), DOL Starter, VFD for 3 to 5 hp Motors.	8
18	Ceiling Fan 230V preferably dismantled.	8
19	Mixer Grinder (as a Universal Motor) 230V, 500W, 2800RPM.	8
20	Frequency Meter.	9
21	Load Bank: Resistive, 3-Phase, 5kW, 415V.	9,10
22	Load Bank: Inductive, 3-Phase, 20A, 415V.	9,10
23	Load Bank: Capacitive, 3-Phase, 20A, 415V.	9,10
24	Three Phase Alternator: 5kVA, 415V, 50 Hz, 4 Pole, 1500 RPM coupled with appropriate DC Shunt Motor.	9,10,11

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

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Three phase induction motors	CO1	19	2	6	12	20
2	II	Starting and speed control of three phase induction motors	CO2	5	2	4	4	10
3	III	Single phase induction motors	CO3	10	2	8	4	14
4	IV	Three phase synchronous machines	CO4	12	2	4	10	16
5	V	Special purpose machines	CO5	4	2	4	4	10
Grand Total				**50**	**10**	**26**	**34**	**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 appropriate percentage weightage to both process and product.
- Rubrics of continuous assessment of practical, including performance indicators, shall be designed by concerned course teacher.

Summative Assessment (Assessment of Learning)

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

XI. SUGGESTED COS - POS MATRIX FORM

A.C. MACHINES PERFORMANCE **Course Code : 315333**

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	-	2	1			
CO2	3	3	-	3	-	2	1			
CO3	3	1	-	3	-	2	1			
CO4	3	1	-	3	1	2	1			
CO5	3	2	1	3	-	2	1			

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

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Theraja B. L., Theraja A. K.	A Textbook of Electrical Technology Vol II	S. Chand and Co. New Delhi ISBN10: 8121924375
2	Ashfaq Husain	Electric Machine	Dhanpat Rai & co. ISBN13: 978-8177001662
3	Kothari D. P. and Nagrath I. J.	Electrical Machines	McGraw Hill, New Delhi ISBN13: 978-9352606405
4	Bhattacharya S. K.	Electrical Machines	Tata McGraw Hill, New Delhi ISBN13: 978-9332902855
5	Dr. P. S. Bimbhra	Electrical Machinery	Khanna Publication ISBN13:978-9389139105
6	Mittle V. N., Arvind Mittle	Design of Electrical Machines	McGraw Hill, New Delhi, ISBN: 9788180141263, 9788180141263
7	Samarjit Ghosh	Electrical Machines	Pearson Education India, 2012; 9788131776025

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://ems-iitr.vlabs.ac.in/exp/speed-control-slip-ring/	Speed Control of Slip Ring Induction Motor (VLAB)
2	https://archive.nptel.ac.in/courses/108/106/108106072/	Operation of Induction Machine and Synchronous Machine
3	https://archive.nptel.ac.in/courses/108/105/108105131/	Construction of Three Phase Induction Motor
4	https://archive.nptel.ac.in/courses/108/102/108102146/	Electromechanical Energy Conversion and Synchronisation of Alternators
5	https://ems-iitr.vlabs.ac.in/exp/lab-equipment-familiarization/index.html	Familiarization of the electrical machine laboratory apparatus (VLAB)

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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ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS **Course Code : 315002**

Programme Name/s	**: Artificial Intelligence/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Software Technology/ Computer Science & Engineering/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Computer Hardware & Maintenance/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Civil & Environmental Engineering/ Computer Science/ Electronics & Computer Engg.**
Programme Code	**: AI/ AN/ AO/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CST/ CW/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ HA/ IE/ IF/ IH/ LE/ SE/ TE**
Semester	**: Fifth**
Course Title	**: ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS**
Course Code	**: 315002**

I. RATIONALE

Entrepreneurship and Startups are introduced in this curriculum to develop the entrepreneurial traits among the students before they enter into professional life. Exposing and interacting with entrepreneurship and startup eco-system, students will develop entrepreneurial mind set. The innovative thinking with risk-taking ability along with other traits will be inculcated in the students through micro-projects and training. This exposure will be instrumental in orienting the students in transforming them to become job generators after completion of Diploma in Engineering.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Develop project proposals for launching small scale enterprises and starts up.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Identify one's entrepreneurial traits.
- CO2 - Use information collected from stakeholder for establishing/setting up/founding starts up
- CO3 - Use support systems available for Starts up
- CO4 - Prepare project plans to manage the enterprise effectively

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	
315002	ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS	ENDS	AEC	1	-	2	-	3	1	-	-	-	-	-	50	20	25@	10	-	-	75

ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS **Course Code : 315002**

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

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 10 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 Compare advantages and disadvantages of Entrepreneurship TLO 1.2 Identify entrepreneurial traits through self-analysis TLO 1.3 Compare risk associated with different type of enterprise	**Unit - I Introduction to Entrepreneurship Development** 1.1 Entrepreneurship as a career – charms, advantages, disadvantages , scope- local and global 1.2 Traits of successful entrepreneur: consistency, creativity, initiative, independent decision making, assertiveness, persuasion, persistence, information seeking, handling business communication, commitment to work contract, calculated risk taking, learning from failure 1.3 Types of enterprises and their features : manufacturing, service and trading	Presentations Lecture Using Chalk-Board
2	TLO 2.1 Explain Important factors essential for selection of product/service and selection of process TLO 2.2 Suggest suitable place for setting up the specified enterprise on the basis of given data/circumstances with justification. TLO 2.3 Suggest steps for the selection process of an enterprise for the specified product or service with justification. TLO 2.4 Plan a market study /survey for the specified enterprise	**Unit - II Startup Selection Process** 2.1 Product/Service selection: Process, core competence, product/service life cycle, new product/ service development process, mortality curve, creativity and innovation in product/ service modification / development 2.2 Process selection: Technology life cycle, forms and cost of transformation, factors affecting process selection, location for an industry, material handling. 2.3 Market study procedures: questionnaire design, sampling, market survey, data analysis 2.4 Getting information from concerned stakeholders such as Maharashtra Centre for Entrepreneurship Development[MCED], National Institute for Micro, Small and Medium Enterprises [NI-MSME], Prime Minister Employment Generation Program [PMEGP], Directorate of Industries[DI], Khadi Village Instries Commission[KVIC]	Presentations Lecture Using Chalk-Board

ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS **Course Code : 315002**

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 categorization of MSME on the basis of turnover and investment TLO 3.2 Describe support system provided by central and state government agencies TLO 3.3 State various schemes of government agencies for promotion of entrepreneurship TLO 3.4 Describe help provided by the non governmental agencies for the specified product/service TLO 3.5 Compute breakeven point, ROI and ROS for the specified business enterprise, stating the assumptions made	**Unit - III Support System for Startup** 3.1 Categorization of MSME, ancillary industries 3.2 Support systems- government agencies: MCED, NI MSME, PMEGP,DI, KVIC 3.3 Support agencies for entrepreneurship guidance, training, registration, technical consultation, technology transfer and quality control, marketing and finance. 3.4 Breakeven point, return on investment (ROI) and return on sales (ROS).	Presentations Lecture Using Chalk-Board
4	TLO 4.1 Explain key elements for the given business plan with respect to their purpose/size TLO 4.2 Justify USP of the given product/ service from marketing point of view. TLO 4.3 Formulate business policy for the given product/service. TLO 4.4 Choose relevant negotiation techniques for the given product/ service with justification TLO 4.5 Identify risks that you may encounter for the given type of business/enterprise with justification. TLO 4.6 Describe role of the incubation centre and accelerators for the given product/service.	**Unit - IV Managing Enterprise** 4.1 Techno commercial Feasibility study, feasibility report preparation and evaluation criteria 4.2 Ownership, Capital, Budgeting, Matching entrepreneur with the project 4.3 Unique Selling Proposition [U.S.P.]: Identification, developing a marketing plan. 4.4 Preparing strategies of handling business: policy making, negotiation and bargaining techniques 4.5 Risk Management: Planning for calculated risk taking, initiation with low cost projects, integrated futuristic planning, definition of startup cycle, ecosystem , angel investors, venture capitalist 4.6 Incubation centers and accelerators : Role and procedure	Presentations Lecture Using Chalk-Board

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 Collect information of successful entrepreneurial traits	1	*Preparation of report on entrepreneurship as	2	CO1
LLO 2.1 Identify different traits as an entrepreneur from various field LLO 2.2 Suggest different traits from identified problem	2	Case study on ‘Traits of Entrepreneur’	2	CO1
LLO 3.1 Explore probable risks for identified enterprise.	3	*Case study on ‘Risks associated with enterprise	2	CO1
LLO 4.1 Identify new product for development LLO 4.2 Prepare a newly developed product	4	*Preparation of report on ‘Development of new Product	2	CO1 CO2

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 5.1 Identify Process for development of product for new startup	5	Preparation of Report on ' Process selection 'for new startup	2	CO1 CO2 CO3
LLO 6.1 Develop questioner for market survey	6	*Market survey for setting up new Start up	2	CO2 CO3
LLO 7.1 Interpret the use of Technology Life Cycle	7	A Case study on ' Technology life cycle' of any successful entrepreneur.	2	CO3
LLO 8.1 Use information related to support of startups from Government and non-government agencies' LLO 8.2 Prepare report for setting up startup	8	*Preparation of report on 'Information for setting up new startup' from MCED/MSME/KVIC etc	2	CO3 CO4
LLO 9.1 Compute ROI of successful enterprise.	9	Case study on 'Return on Investment (ROI)'of any successful startup	2	CO3
LLO 10.1 Calculate of ROS of any successful enterprise	10	Case study on 'Return on sales (ROS)'of any successful startup	2	CO3
LLO 11.1 Calculate Brake even point of any enterprise	11	Preparation of report on 'Brake even point calculation' of any enterprise.	2	CO3 CO4
LLO 12.1 Prepare feasibility report of given business	12	*Preparation of report on 'feasibility of any Techno-commercial business"	2	CO4
LLO 13.1 Plan a USP of any enterprise.	13	*A case study based on 'Unique selling Proposition (USP) of any successful enterprise	2	CO4
LLO 14.1 Prepare a project report using facilities of Atal Incubation center.	14	*Prepare project report for starting new startup using 'Atal incubation center (AIC)	2	CO1 CO2 CO3 CO4

Note : Out of above suggestive LLOs -

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

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

Micro project

- Prepare a 'Pitch- desk' for your start up
- Prepare a business plan for a. Market research b. Advertisement agency c. Placement Agency d. Repair and Maintenance agency e. Tour and Travel agency
- Prepare a 'Social entrepreneurship business plan, plan for CSR funding.
- Prepare a ' Women entrepreneurship business plan ' Choose relevant government scheme for the product/service
- Prepare a business plan for identified projects by using entrepreneurial eco system for the same (Schemes, incentives, incubators etc.)

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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	Computers with internet and printer facility	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	Introduction to Entrepreneurship Development	CO1	4	0	0	0	0
2	II	Startup Selection Process	CO2	2	0	0	0	0
3	III	Support System for Startup	CO3	2	0	0	0	0
4	IV	Managing Enterprise	CO4	2	0	0	0	0
Grand Total				**10**	**0**	**0**	**0**	**0**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Assessment during practicals

Summative Assessment (Assessment of Learning)

- End of term 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	2	2	2	-	-	3	2			
CO2	2	2	2	2	-	3	2			
CO3	2	2	2	2	-	3	2			
CO4	2	2	2	2	-	3	2			

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

ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS **Course Code : 315002**

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Dr. Nishith Dubey, Aditya Vyas , Annu Soman , Anupam Singh	Un- boxing Entrepreneurship your self help guide to setup a successful business	Indira Publishing House ISBN 2023,978-93-93577-70-2
2	Gujral, Raman	Reading Material of Entrepreneurship Awareness Camp	Entrepreneurship Development Institute of India (EDI), GOI, 2016 Ahmedabad
3	Chitale, A K	Product Design and Manufacturing	PHI Learning, New Delhi, 2014; ISBN: 9788120348738
4	Charantimath, Poornima	Entrepreneurship Development Small Business Entrepreneurship	Pearson Education India, New Delhi; ISBN: 9788131762264
5	Khanka, S.S.	Entrepreneurship and Small Business Management	S.Chand and Sons, New Delhi, ISBN: 978-93-5161-094-6

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	http://www.mced.nic.in/allproduct.aspx	MCED Product and Plan Details
2	http://niesbud.nic.in/Publication.html	The National Institute for Entrepreneurship and Small Business Development Publications
3	http://niesbud.nic.in/docs/1standardized.pdf	Courses : The National Institute for Entrepreneurship and Small Business Development
4	https://www.nabard.org/Tenders.aspx?cid=501andid=24	NABARD - Information Centre
5	http://www.startupindia.gov.in/pdffile.php?title=Startup%20India%20Action%20Planandtype=Actionandq=Action%20Plan.pdfandc ontent_type=Actionandsubmenupoint=action	Start Up India
6	http://www.ediindia.org/institute.html	About - Entrepreneurship Development Institute of India (EDII)
7	http://www.nstedb.com/training/training.htm	NSTEDB - Training

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. 24/02/2025 **Semester - 5, K Scheme**

INTERNSHIP(12 WEEKS) **Course Code : 315004**

Programme Name/s	**: Automobile Engineering./ Artificial Intelligence/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Software Technology/ Computer Science & Engineering/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Computer Hardware & Maintenance/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Manufacturing Technology/ Metallurgical Engineering/ Production Engineering/ Computer Science/ Electronics & Computer Engg.**
Programme Code	**: AE/ AI/ AN/ AO/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CST/ CW/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ HA/ IE/ IF/ IH/ LE/ ME/ MK/ MRT/ MY/ PG/ SE/ TE**
Semester	**: Fifth**
Course Title	**: INTERNSHIP(12 WEEKS)**
Course Code	**: 315004**

I. RATIONALE

Globalization has prompted organizations to encourage skilled and innovative workforce. Internships are educational and career development opportunities, providing practical/ hands-on experience in a field or discipline. Summer internship is an opportunity for students to get accustomed to modern industry practices, apply the knowledge and skills they've acquired in the classroom to real-world situations and become familiar with industry environments before they enter the professional world. Keeping this in mind, industrial training is incorporated to all diploma programmes as it enables the student to get equipped with practical skills, soft skills and life skills

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences: Apply skills and practices to industrial processes.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Observe time/resource management and industrial safety aspects.
- CO2 - Acquire professional experience of industry environment .
- CO3 - Establish effective communication in working environment.
- CO4 - Prepare report of assigned activities and accomplishments.

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	
315004	INTERNSHIP(12 WEEKS)	ITR	INP	-	-	-	-	36 - 40	10	-	-	-	-	-	100	40	100#	40	-	-	200

INTERNSHIP(12 WEEKS) **Course Code : 315004**

Legends: # External Assessment
Note: Credits for Industrial Training are in-line of guidelines of NCrF : The industrial training is of 12 weeks considering 36-40 hours per week engagement of students (as per Guidlines of GR of Maharashtra Govt.) under Self Learning with guidance of industry supervisor / Mentor

V General guidelines for organizing Industrial training

The Industry/organization selected for Industrial training/ internships shall be Government/Public Limited/ Private limited / Startup /Centre of Excellence/Skill Centers/Skill Parks etc.

1. Duration of Training - 12 weeks students engagement time
2. Period of Time slot - Between 4th and 5th semester (12 weeks) i.e. commencement of internships will be immediately following the 4th semester exams.
3. Industry area - Engineering Programme Allied industries of large, medium or small-scale, Organization/Govt./ Semi Govt Sectors.

VI Role(s) of Department at the Institute:

Following activities are expected to be performed by the concerned department at the Polytechnics.

Table of activities to be completed for Internship

S.No	Activity	Suggested Schedule WEEKS
1	Collection of information about industry available and ready for extending training with its offered capacity of students (**Sample Format 1**)	1st to 3rd week of 4th Semester
2	Allocations of Student and Mentor as per availability (Mentor: Student Ratio (1:15)	4th to 6th week of 4th semester
3	Communication with Industry and obtaining its confirmation Sample letter Format	6th to 8th week of 4th semester
4	Securing consent letter from parents/guardians of students (Sample Format 2)	Before 10th week of 4th semester
5	Enrollment of Students for industrial training (Format 3)	Before 12th week of 4rd semester
6	Issue of letter to industry for training along with details of students and mentor (Format 4)	Before 14th week of 4th Semester
7	Organize Internship Orientation session for students	Before end of 4th Semester
8	Progressive Assessment of industry training by Mentor	Each week during training period
9	Assessment of training by institutional mentor and Industry mentor	5th Semester ESE

Suggestions-

1. Department can take help of alumina or parents of students having contact in different industries for securing placement.

2. Students would normally be placed as per their choices, in case of more demand for a particular industry, students would be allocated considering their potentials. However preference for placement would be given to students who have arranged placement in company with the help of their parents or relatives.

3. Principal/HOD/Faculty should address students about industrial safety norms, rules and discipline to be maintained in the industry during training before relieving students for training.

4. The faculty members during the visit to industry or sometimes through online mode will check the progress of the student in the training, student attendance, discipline, and project report preparation each week.

VII Roles and Responsibilities of students:

1. Students may interact with the mentor to suggest choices for suitable industry, if any. If students have any contact in industry through their parents or relatives then the same may be utilized for securing placement for themselves and their peers.

2. Students have to fill the forms/formats duly signed by institutional authorities along with a training letter and submit it to a training officer/mentor in the industry on the first day of training.

3. Students must carry with him/her Identity card issued by the institute during the training period.

4. Students should follow industrial dressing protocols, if any. In absence of specific protocol students must wear college uniform compulsorily.

5. Students will have to get all necessary information from the training officer/mentor at industry regarding schedule of training, rules and regulation of the industry and safety norms to be followed. Students are expected to observe these rules, regulations and procedures.

6. Students must be fully aware that if they disobey any rule of industry or do not follow the discipline then non-disciplinary action will be taken .

7. Students must maintain a weekly diary (**Format 6**) by noting daily activities undertaken and get it duly signed from industry mentor or Industrial training in charge.

8. In case students face any major problems in industry such as an accident or any disciplinary issue then they should immediately report the same to the mentor at the institute.

9. Prepare a final report about the training for submitting to the department at the time of presentation and viva-voce and get it signed from a mentor as well as industry training in charge.

10. Students must submit the undertaking as provided in **Format 5**.

VIII Typographical guidelines for Industry Training report

Following is the suggestive format for preparing the training report. Actual report may differ slightly depending upon the nature of industry. The training report may contain the following

1. The training report shall be computer typed (English- British) and printed on A4 size paper.

2. Text Font -Times New Roman (TNR), Size-12 point

3. Subsection heading TNR- 12 point bold normal

4. Section heading TNR- 12 capital bold

5. Chapter Name/ Topic Name – TNR- 14 Capital

6. All text should be justified. (Settings in the Paragraph)

7. The report must be typed on one side only with double space with a margin 3.5 cm on the left, 2.5 cm on the top, and 1.25 cm on the right and at bottom.

8. The training report must be hardbound/ Spiralbound with a cover page in black color. The name of the candidate, diploma (department), year of submission, name of the institute shall be printed on the cover.

9. The training report, the title page should be given first then the Certificate followed by the acknowledgment and then contents with page numbers.

IX Suggestive format of industrial training report

Following format may be used for training report. Actual format may differ slightly depending upon the nature of Industry/ Organization.

- Title Page
- Certificate
- Abstract
- Acknowledgement
- Content Page

Chapter 1	Organization structure of Industry and general layout.
Chapter 2	Introduction to Industry / Organization (history, type of products and services, turn over and number of employees etc.)
Chapter 3	Types of Major Equipments/raw materials/ instruments/machines/ hardware/software used in industry with their specifications, approximate cost, specific use and routine maintenance done
Chapter 4	Processes/ Manufacturing Manufacturing techniques and methodologies and material handling procedures
Chapter 5	Testing of Hardware/Software/ Raw materials/ Major material handling product (lifts, cranes, slings, pulleys, jacks, conveyor belts etc.) and material handling procedures.
Chapter 6	Safety procedures followed and safety gears used by industry.
Chapter 7	Particulars of Practical Experiences in Industry/Organization if any in Production/Assembly/Testing/Maintenance
Chapter 8	Detailed report of the tasks undertaken (during the training).
Chapter 9	Special/challenging experiences encountered during training if any (may include students liking & disliking of workplaces).
Chapter 10	Conclusion
Chapter 11	References / sources of information

X Suggested learning strategies during training at Industry

- Students should visit the website of the industry where they are undergoing training to collect information about products, processes, capacity, number of employees, turnover etc.
- They should also refer to the handbook of the major machines and operations, testing, quality control and testing manuals.
- Students may also visit websites related to other industries wherein similar products are being manufactured.

XI Tentative week wise schedule of Industry Training

Industrial training is a common course to all Diploma programmes , therefore the industry selection will depend upon the nature of the programme and its related industry. The training activity may vary according to nature and size of industry.

The following table details of activities to be completed during industrial training.

Details of Activities to be completed during Industry training
Introduction of Industry and departments.
Study of Layout of Industry, Specifications of Machines , raw materials, components available in the industry

Study of setup and manufacturing processes
Execute given project or work assigned to the students, study of safety and maintenance procedures
Validation from industry mentor regarding project or work allocated
Report writing

XII CO-PO Mapping Table to be created by respective Department/faculty.

XIII. Formative Assessment of training : Suggested RUBRIC
(Note : Allot the marks in proportion of presentations and outcome observed. Marks excluding component of week 11 are to be filled by Institute mentor)

Week No	Task to be assessed	Outcome Achievement - Poor	Outcome Achievement - Moderate	Outcome Achievement - High		Week-wise total Marks
		Poor Marks	Average Marks	Good Marks	Excellent Marks	
1	Introduction of Industry	Minimal Knowledge of Departments, processes, products and work culture of the company **(Marks –1)**	Moderate Knowledge of Departments, processes, products and work culture of the company **(Marks –2)**	Good Knowledge of Departments, processes, products and work culture of the company **(Marks –3/4)**	Extensive Knowledge of Departments, processes, products and work culture of the company **(Marks –5)**	
2	Presentation of Layout of Industry, Specifications of Machines, raw materials, components available in the industry	Minimal w.r.t. tasks **(Marks –1)**	Moderate w.r.t. tasks **(Marks –2)**	Good w.r.t. tasks **(Marks –3/4)**	Extensive w.r.t. tasks **(Marks –5)**	
3	Participation in setup and manufacturing processes/platforms	Minimal Participation with poor understanding **(Marks –1-8)**	Moderate Participation with poor understanding **(Marks –9-12)**	Good Participation with poor understanding **(Marks –13-17)**	Extensive Participation with poor understanding **(Marks –18-20)**	
4 to 10	Execution of given project or work to the students, Follow of safety and maintenance procedures	Minimal Participation with poor understanding **(Marks –1-8)**	Moderate Participation with lower level understanding **(Marks – 9-12)**	Good Participation with Good understanding **(Marks – 13-17)**	Extensive Participation with excellent understanding **(Marks – 18-20)**	
11	Validation by industry mentor regarding project or work allocated	Minimal Participation with poor performance **(Marks –1-10)**	Moderate Participation with acceptable performance **(Marks – 11-15)**	Good Participation with Good performance **(Marks – 16-20)**	Extensive Participation with excellent performance **(Marks – 21-25)**	

12	Diary writing	• Results are not Presented properly, • Project work is summarized and concluded not acceptable • Future extensions are not specified **(Marks –1-10)**	• Results are Presented just casually • Project work is summarized and concluded casually • Future extensions are casually specified **(Marks –11-15)**	• Results are Presented well and properly, • Project work is summarized and concluded to a Good level • Future extensions are well specified **(Marks –16-20)**	• Results are Presented exhaustively • Project work is summarized and elaborated in excellent manner , concluded • Future extensions are excellently specified **(Marks –21-25)**	
Total Out of :100						

Marks for (FA) are to be awarded for each week considering the level of completeness of activity observed as per table specified in Sr.No. XIII above, from the daily diary maintained . Feedback from industry supervisor shall also be considered.

XIV Summative Assessment (SA) of training:

Academic year : 20 -20

i) Suggested RUBRIC for SA

	Observations from Orals				**Presentations**				**Total (100)**
Enrollment Number	Tasks undertaken (20)	Overall Understanding (20)	Creativity /Innovation demonstrated (10)	Knowledge acquired (10)	Speech Clarity (10)	Body Language (10)	Presentations (10)	Diary , Report writing and / Product (10)	

Name of mentor:
Signature of Mentor

XV FORMATS

Format-1: Collecting Information about Industry/Organization available for training along with capacity

1) Name of the industry/organization:
2) Address/communication details with email :
3) Contact person details:
   a) Name:
   b) Designation:
   c) Email
   d) Contact number/s:

4) Type:

   Govt / PSU / Pvt /

   Large scale / Medium scale / Small scale …..

5) Products/services offered by industry:

6) a) Whether willing to offer Industrial training facility during May/ June for Diploma in Engineering students: **Yes / No.**
   b) If yes, whether you offer 12 weeks training: **Yes/No**
   c) Possible Industrial Capacity:

Students	Programme name/ Title					Total
	Civil	Mechanical	Chemical			
Male						
Female						
Total						

7) Whether accommodation available for interns **Yes / No.**
If yes capacity:_____

8) Whether internship is charged or free:
If charged please specify amount per candidate: _____

Signature of responsible person at Industry:

Format-2: Obtaining Consent Letter from parents/guardians

(Undertaking from Parents)

To,

The Principal,
_____,

Subject: Consent for Industrial Training.
Sir/Madam,

I am fully aware that -
i) My ward studying in _____ semester at your _____ institute has to undergo 12 weeks of Industrial training for partial fulfillment towards completion of Diploma in _____ Engineering.
ii) For this fulfillment he/she has been deputed at_____ industry, located at _____ for Industrial training /internship for the period from _____ to _____ .
With respect to above I give my full consent for my ward to travel to and from the mentioned industry. Further I undertake that –
a) My ward will undergo the training at his/her own cost and risk during training and/or stay.
b) My ward will be entirely under the discipline of the organization where he/she will be placed and will abide by the rules and regulations in face of the said organization.
c) My ward is NOT entitled to any leave during the training period.
d) My ward will regularly submit a prescribed weekly diary, duly filled and countersigned by the training supervisor of the organization to the mentor faculty of the polytechnic.

I have explained the contents of the letter to my ward, who has also promised to adhere strictly to the requirements. I assure that my ward will be properly instructed to take his own care to avoid any accidents/injuries in the industry. In case of any accident neither industry nor the institute will be held responsible.

Signature :
Name : _____
Address : _____

Phone Number :

INTERNSHIP(12 WEEKS) **Course Code : 315004**

Format-3: Students Enrollment for Industrial Training

(Academic Year –)

Sr No	Enrollment Number	Name of Student	Name of Industry	Name of Mentor at Institute

Format-4: Issue Letter to the Industry/Organization for the training along with details of students and mentors

To,

The HR Manager,

_____

Subject: Placement for Industrial training of ___ weeks in your organization….

Reference: Your consent letter no: ….

Sir,

With reference to the above we are honored to place the following students from this institute for Industrial training in your esteemed organization as per the arrangement arrived at.

The purpose of this training is to equip the student with some essential skills relevant to the demands of the industry and world of work, as well as to provide exposure to the professional environment and work culture. It is hoped that this training may enhance his/her employability and livelihood opportunities. In view of the above, we kindly request your support in facilitating this Industrial Training for the student. He/she has been adequately oriented and guided on the expectations of this training, including the maintenance of a daily diary during the training period. Additionally, the institute has secured the necessary consent and undertaking from the parent/guardian regarding the guidelines for exit training. In view of all the above industry shall refrain from involving students into the mundane and housekeeping activities. Your cooperation in this regard will be highly appreciated.

Diploma programme in _____ Engg.

Sr.No	Enrollment No	Name of Student	Name and designation of Mentor

Diploma programme in _____ Engg.

Sr.No	Enrollment No	Name of Student	Name and Designation of Mentor

Kindly extend all possible cooperation to the students for above.

Thanking you

Yours sincerely,

(Principal)
Name of the Institute:
with Seal

Cc- To HoD/Mentor

Format-5: Undertaking by the students

TO

Principal

Subject: Undertaking regarding Placement for Industrial training of 12/16/18 weeks duration

I …….Reg No:…….. S/o/D/o. ……Studying in ---------- ---------- at ---------- Institute at ----------fully aware of the Industrial Training requirement and related responsibilities and participation in the ……, Industrial training between From: …… To……..

I assure you that I will be of good behavior and be obedient to the staff and mentor during the ……/Industrial training. I will also abide and will not participate in all activity. I will also discipline myself within the rules and regulations of the Institution. I am also aware that I am participating in the …….. at my own risk and I will not hold the ----------Institute responsible in any way in any eventuality namely Accident /Injury/death or whatever mishap and I myself will be solely responsible for my safety.

Place :Signature of the student

Date :Reg. No.

INTERNSHIP(12 WEEKS) **Course Code : 315004**

Format-6: Internships Daily Diary

Name of the Student: _____ Name of the mentor (Faculty) : _____

Enrollment Number: _____ Semester: _____ Academic Year _____

Week	Day & Date	Discussion Topics/Activity	Details of Work Allotted Till Next Session /Corrections Suggested/Faculty Remarks	Signature of Industry Mentor
Week 01	Mon, Date			
	Tue, Date			
	Wed, Date			
	Thu, Date			
	Fri, Date			
	Sat, Date			
.	Mon, Date			
	Tue, Date			
.	Wed, Date			
	Thu, Date			
.	Fri, Date			
	Sat, Date			
Week n	Mon, Date			
	Tue, Date			
	Wed, Date			
	Thu, Date			
	Fri, Date			
	Sat, Date			

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POWER SYSTEM OPERATION AND CONTROL **Course Code : 315336**

Programme Name/s : **Electrical Engineering/ Electrical Power System**
Programme Code : **EE/ EP**
Semester : **Fifth**
Course Title : **POWER SYSTEM OPERATION AND CONTROL**
Course Code : **315336**

I. RATIONALE

Electrical power system operation and control plays a significant role in electric power transfer from generation to consumer's end. The diploma engineers working in power sector have to perform operation and control of power system. He should have understanding about the reactive power control strategies, system stability and role of load dispatch center. 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 effective functioning and operation of electrical power transfer from generation to the consumer's end.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Represent power system by reactance diagram using per unit method
- CO2 - Manage real and reactive power balance within a power system network.
- CO3 - Ensure the effective operation of an automatic generation control system.
- CO4 - Apply various techniques to maintain power system stability.
- CO5 - Operate and manage a load dispatch center.

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	
315336	POWER SYSTEM OPERATION AND CONTROL	PSO	DSE	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150

POWER SYSTEM OPERATION AND CONTROL **Course Code : 315336**

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.* 10 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe the basic structure of the given power system network. TLO 1.2 Explain the requirements of the given type of power system. TLO 1.3 Develop power system representation using the given single line diagram. TLO 1.4 Explain the concept of per unit method. TLO 1.5 Draw reactance diagram for the given power system by using per unit method.	**Unit - I Representation of Power System.** 1.1 Structure of power system. 1.2 Requirements of stable power system operation. 1.3 Representation of power system by single line diagram, impedance diagram and reactance diagram. 1.4 Concept of per unit method and its advantages. 1.5 Per unit method for representing power system parameters.	Lecture Using Chalk-Board, Model Demonstration Video Demonstrations Flipped Classroom

POWER SYSTEM OPERATION AND CONTROL **Course Code : 315336**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Explain the impact of real and reactive power imbalance for the given power flow data. TLO 2.2 Explain the relation between real power balance and frequency on the system. TLO 2.3 Explain the effect of the given condition of the frequency on the power system. TLO 2.4 Explain the relation between reactive power balance and voltage of the system. TLO 2.5 Explain the effect of the given condition of the voltage on the power system. TLO 2.6 Explain the significance of FACT controllers TLO 2.7 Explain different methods of second-generation FACT devices used for Reactive power injection.	**Unit - II Real And Reactive Power Flow** 2.1 Power flow: real power balance and reactive power balance, impact. 2.2 Relation between real power balance and frequency of the system. 2.3 Impact of variation in frequency on consumers and supply agencies (generation plants). 2.4 Relation between reactive power balance and voltage of the system 2.5 Impact of variation in voltage on consumers and supply agencies (generation plants). 2.6 FACT controllers in reactive power compensation: Need. 2.7 Reactive power injection methods by various second-generation FACT devices 2.7.1. Static synchronous series compensator (SSSC) 2.7.2. Static synchronous shunt compensator (STATCOM) 2.7.3. Unified power flow controller (UPFC) 2.7.4. Interline power flow controller (IPFC) (Introduction Only)	Lecture Using Chalk-Board Video Demonstrations Flipped Classroom Presentations Site/Industry Visit
3	TLO 3.1 Describe the functioning of the automatic load frequency control using the block diagram for the given type of generator. TLO 3.2 Suggest suitable governor controller system for the given type of turbine. TLO 3.3 Explain the automatic voltage control (AVC) system. TLO 3.4 Describe the block diagram of automatic generation control (AGC) for the specified generating system.	**Unit - III Automatic Generation Control** 3.1 Automatic load frequency control (ALFC): Schematic diagram and working. 3.2 Governor controller system- electro hydraulic governor (Digital Governor), Restricted governing mode of operation (RGMO), Free governing mode of operation (FGMO) (Introduction Only) 3.3 Automatic voltage control (AVC): Schematic diagram and working. 3.4 Automatic generation control (AGC): Schematic diagram and working.	Lecture Using Chalk-Board Model Demonstration Video Demonstrations Flipped Classroom Site/Industry Visit

POWER SYSTEM OPERATION AND CONTROL **Course Code : 315336**

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 Define various terms related with stability. TLO 4.2 Explain the effects of power system instability on consumers or power utility companies. TLO 4.3 Differentiate power system related large disturbance and small disturbance in the given specific case. TLO 4.4 Identify the type of power system stability condition for the given power system. TLO 4.5 Explain stability with the help of power angle diagram. TLO 4.6 List the specified method of improving steady state and transient state stability condition of the given power system.	**Unit - IV Power System Stability** 4.1 Power system stability, overall stability, stability limit and instability. 4.2 Effects of power system instability. 4.3 Large disturbance and small disturbance. 4.4 Classification of stability: i) Steady state stability ii) Transient state stability iii) Dynamic stability 4.5 Stability studies with the help of power angle diagram. 4.6 Methods of improving steady state and transient state stability condition.	Lecture Using Chalk-Board Model Demonstration Video Demonstrations Flipped Classroom
5	TLO 5.1 Describe need of load dispatch center in power system operation and control. TLO 5.2 Explain impact of environmental and social factors on load forecasting. TLO 5.3 State the role of load dispatch center in power system operation for the given situation.	**Unit - V Load Dispatch Centre** 5.1 Load dispatch centre: need and importance. 5.2 Load forecasting: significance, environmental and social factors in load forecasting. 5.3 Types of load dispatch center (NLDC, RLDC, SLDC) and their functions.	Lecture Using Chalk-Board Model Demonstration Video Demonstrations Flipped Classroom Site/Industry Visit

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

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Calculate per unit values of parameters of power system components for low voltage power system by using MATLAB/ Scilab	1	*Reactance diagram of low voltage Power system by using per unit method	2	CO1
LLO 2.1 Calculate per unit values of parameters of power system components for high voltage power system by using MATLAB/ Scilab	2	Reactance diagram of high voltage power system by using per unit method	2	CO1
LLO 3.1 Use static VAR compensator for the given three phase induction motor. LLO 3.2 Calculate rating of reactive power compensator.	3	*Balancing reactive power at consumers ends.	2	CO2
LLO 4.1 Control bus voltages through onload tap changer by using Virtual Lab	4	*Voltage control through onload tap changer (OLTC)	2	CO2

POWER SYSTEM OPERATION AND CONTROL **Course Code : 315336**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 5.1 Corelate the relationship between output of alternator and field excitation.	5	*Demonstration of the automatic voltage control system (AVC) in electrical generation by Visit /Animations/ Video programme.	2	CO3
LLO 6.1 Corelate relationship between the different generators in a generating station.	6	Demonstration of the automatic generation control (AGC) in electrical generation by Visit /Animations/ Video programme.	2	CO3
LLO 7.1 Identify the different parts of electro hydro governor system LLO 7.2 Describe the operation of the electro hydraulic governor (digital governor)	7	Observation of electro hydraulic governor (digital governor) by Visit /Animations/ Video programme of Hydro Power station.	2	CO3
LLO 8.1 Identify the different parts of Restricted Governing Mode of Operation (RGMO) and Free Governing Mode of Operation (FGMO). LLO 8.2 Describe the operation of Restricted Governing Mode of Operation (RGMO) and Free Governing Mode of Operation (FGMO)	8	Observation of Restricted Governing Mode of Operation (RGMO) and Free Governing Mode of Operation (FGMO) by Visit /Animations/ Video programme on Thermal Power station.	2	CO3
LLO 9.1 Identify type of disturbance from the given video clip/ case studies on Blackouts in India LLO 9.2 Prepare report with proper reason behind blackout.	9	*Case study of large disturbance and small disturbance.	2	CO4
LLO 10.1 State the specific function of load dispatch center. LLO 10.2 Prepare report on load dispatch center.	10	*Demonstration of load dispatch center operation by Visit /Animations/ Video programme.	2	CO5
LLO 11.1 Identify specific reasons for load shedding adopted by DISCOM in specific area from given video clip. LLO 11.2 Prepare report on reasons and action taken by DISCOM with proper Justification.	11	Case study of load shedding methodology.	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

- Collect the data on Incidents of blackouts happened in India.
- Collect the information on governor used in Hydro Power plant and Thermal Power plant
- Prepare report on role of SCADA in load dispatch center operation.

Micro project

- Prepare a chart/ Model on automatic load frequency control used in power plant.

- Observe power consumption pattern of your Institute or nearby commercial center and prepare daily load curve.
- Prepare a chart/ Model on automatic generation control used in power plant.

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	Software – MATLAB / Scilab or any other open sources.	1,2
2	Induction motor (3phase /1 phase,3kW)	3
3	Ammeters MI Type: AC/ DC 0-5-10Amp (03 Nos.)	3
4	Voltmeter MI Type: AC/DC, 0-150/300V, 0-250/500V (01 No.)	3
5	Wattmeter: Single phase, single element 2.5/5Amp, 200/400V, (02 Nos.)	3
6	Dimmer: 3-phase, 5kVA	3
7	Capacitor bank, 3-phase, 5kW, 415V	3
8	MCB :10Amp	3
9	Virtual Lab (V-Lab)	4
10	Chart relevant to practical	5,6,7,8
11	LCD, PA System, Internet facility	5,6,7,8,9,10,11
12	Relevant videos	5,6,7,8,9,10,11

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

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Representation of Power System.	CO1	8	2	4	6	12
2	II	Real And Reactive Power Flow	CO2	12	4	8	8	20
3	III	Automatic Generation Control	CO3	6	2	4	6	12
4	IV	Power System Stability	CO4	8	4	4	6	14
5	V	Load Dispatch Centre	CO5	6	2	6	4	12
Grand Total				**40**	**14**	**26**	**30**	**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)

POWER SYSTEM OPERATION AND CONTROL **Course Code : 315336**

- End semester assessment of 70 marks through offline mode of examination.
- 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	3	3	3	1	1	2			
CO2	3	2	2	2	2	2	2			
CO3	3	2	2	3	2	2	2			
CO4	3	2	2	1	2	2	2			
CO5	3	2	3	1	2	2	2			

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

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Nagrath I. J., Kothari D. P.	Modern Power System Analysis	5th Edition, McGraw Hill Education, New Delhi 2003 ISBN-978-9354600968
2	Gangadhar K. A.	Electric Power Systems (Analysis, Stability and Protection)	Khanna Publishers, Delhi. India, 2006. ISBN 9788174090041
3	K.R. Padiyar	Facts Controllers in Power Transmission and Distribution	3rd Edition, New Age International Private Limited, 2006. ISBN 978-9389802047
4	Abhijit Chakrabarty	Power System Analysis, operation and control	PHI Learning, New Delhi, New Delhi, 2010 ISBN: 788120340152
5	Chakrabarti, D P A Kothari, A K Mukhopadhyay, D E Abhinandan	An introduction to Reactive Power Control and Voltage Stability in Power Transmission Systems	PHI Learning, New Delhi, 2015 ISBN: 9788120340503
6	A. J. Wood, B. F. Woolenberg,	Power Generation Operation and Control	John Wiley and Sons, UK ISBN:978-0-471-79055-6
7	Prabha S. Kundur, Om P. Malik	Power System Stability and Control	2nd Edition, 2022 McGraw Hill ISBN: 9781260473544

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://iitr.ac.in/Departments/Hydro%20and%20Renewable%20Energy%20Department/static/Modern_hydroelectric_engg/vol_1/Chapter-6_Hydro-Turbine_Governing_System.pdf	Governor Controller System-ElectroHydraulic Governor (Digital Governor)
2	WRLDC-TP-019-Implementation-of-Free-Governor-Mode-of-Operati on-in-Western-Region-of-India-2004.pdf (posoco.in)	Free Governing Mode of Operation (FGMO)

POWER SYSTEM OPERATION AND CONTROL **Course Code : 315336**

Sr.No	Link / Portal	Description
3	https://cercind.gov.in/2017/draft_reg/GC-copy/Power%20System%20Operation%20Corporation%20Limited%20(POSOCO).pdf	Details of Restricted governing mode of operation (RGMO) and free governing mode of operation (FGMO)
4	https://posoco.in/reports/monthly-reports/monthly-reports-2024-25/	Statistics and current scenario of NLDC/RLDC/SLDC
5	https://www.mahatransco.in/information/details/load_despatch	Statistics and current scenario of NLDC/RLDC/SLDC
6	https://sa-nitk.vlabs.ac.in/exp/onload-tap-changes/	Control of Bus Voltages Through Onload Tap Changes
7	https://cercind.gov.in/2016/whatsnew/anx1.pdf	Details of Restricted governing mode of operation (RGMO) and free governing mode of operation (FGMO)

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. 24/02/2025 **Semester - 5, K Scheme**

SEMINAR AND PROJECT INITIATION COURSE **Course Code : 31**

Programme Name/s	**: Automobile Engineering./ Artificial Intelligence/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Software Technology/ Computer Science & Engineering/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Computer Hardware & Maintenance/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Manufacturing Technology/ Metallurgical Engineering/ Production Engineering/ Computer Science Electronics & Computer Engg.**
Programme Code	**: AE/ AI/ AN/ AO/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CST/ CW/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ HA/ IE/ IF/ IH/ LE/ ME/ MK/ MRT/ MY/ PG/ SE/ TE**
Semester	**: Fifth**
Course Title	**: SEMINAR AND PROJECT INITIATION COURSE**
Course Code	**: 315003**

I. RATIONALE

Most of the diploma graduates lack the confidence and fluency while presenting papers or interacting verbally and expressing them with a large gathering. Seminar presentation boosts the confidence of the students and prepares them precisely for facing the aud interviews and group discussions. The course on seminar is to enhance student's ability in the art of academic writing and to presen also helps broaden the minds of the participants. Through this course on Seminar, students will develop new ideas and perspectives subject /themes of emerging technologies and services of their area of studies. Project initiation enhances project planning skill establishes measurable objectives and interaction skills.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences: Present a seminar on the selected theme/area of study effectively and confidently to the specific audience and stakeholde Plan innovative solutions independently or collaboratively to the identified problem statement.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Identify topics of seminar presenting to the large gathering at the institute/conference.
- CO2 - Collect relevant and updated research-based data and information to prepare a paper of seminar presentation.
- CO3 - Apply presentation skills.
- CO4 - Create conducive environment for learning and discussion through seminar presentation.
- CO5 - Identify a problem statement and establish the action plan for the successful completion of the project.

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	
															Practical					
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA	
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min
315003	SEMINAR AND PROJECT INITIATION COURSE	SPI	AEC	-	-	1	2	3	1	-	-	-	-	-	25	10	25@	10	25	10

V. General guidelines for SEMINAR and Project Initiation

- The seminar must be related to emerging trends in engineering / technology programme or may be inter/ multi-disciplinary, base industry expected outcomes of the programme.
- The individual students have different aptitudes and strengths. Therefore, SEMINAR should match the strengths of students. For purpose, students shall be asked to select the TITLE (Theme)of SEMINAR they would like to prepare and present.
- Seminar titles are to be finalized in consultation with the faculty mentor.
- Seminar must involve logic development of applications of various technologies/ processes applicable in industry.
- Seminar must be assigned to the single student. However, support of other students may be sorted while presenting the seminar
- Students are required to prepare using relevant software tools, write ups for presentation

- Students shall submit One Hard copy and one Soft copy each of the presentation and may be encouraged to keep a recorded copy presentation made during the seminar.
- Batch of 3-4 students shall be formed for project initiation.
- Projects give a platform for the students to showcase an attitude of inquiry to identify the problem statement related to the progra Students shall Identify the information suggesting the cause of the problem and possible solutions
- Students shall study and assess the feasibility of different solutions and the financial implications.
- Students should collect relevant data from different sources (books/internet/market/suppliers/experts through surveys/interviews)
- Students shall prepare required drawings/ designs and detailed plan for the successful execution of the work.
- Students may visit the organisation pertaining to the problem statement as part of initial study.

VI.Guidelines for Seminar preparation and presentation :

Once the title/topic of a seminar has been finalized and allotted to the student, the teacher's role is important as guide, mentor an motivator, to promote learning and sustain the interest of the students.

Following should be kept in mind while preparing and presenting the seminar:

- **Seminar Orientation cum -briefing**: the seminar topics/themes should be innovative, novel and relevant to the curriculum of t programme, and also aligned to the expectations of industry.
- **Seminar Literature surve**y: Information search and data collection: the information and data should be authentic, realistic and r to the curriculum of the programme.
- **Seminar Preparation, and presentation**: The seminar shall be present with suitable software tools and supporting handout/note presentation of seminar should not be more than 20 minutes including Q-A session.

The following guidelines may be followed for Project Initiation

- **Establishing project scope:** Determine the boundaries of the project.
- **Defining project objectives:** Set clear and measurable objectives that align with the project's purpose.
- **Stakeholder identification and analysis:** Perform an exercise in identifying all stakeholders involved in the project and analyzi needs and expectations.
- **Team Formation:** Carefully build a team with the necessary skills and expertise to execute the project successfully.
- **Documentation.** Create a project planner showcasing the action plan, define the project's scope, outline the project definition, ar design of the project. The document has to be made available to all stakeholders

VII. Criteria of Assessment /Evaluation of Seminar

A. Formative Assessment (FA) criteria

The assessment of the students in the fifth semester Progressive Assessment (PA) for 50 marks is to be done based on following c

A. Suggestive RUBRICS for assessment

Sr. No.	Criteria	Mar
1	Selection Topic/Theme of seminar	05
2	Literature review and data presentation	05
3	Quality of Preparation and innovativeness	05
4	Q-A handling	05
5	Time Management	05
6	Seminar Presentation report	10

Rubrics for assessment of Project Initiation

Sr. No.	Criteria	M
1	Selection of Theme of Problem Statement and its innovativeness	
2	Stages of development of Action plan	
3	Prototyping	

The total marks as per above out of 50, shall be converted in proportion of 25 marks.

B. Summative Assessment criteria/

The summative assessment of the students in the fifth semester End-Semester-Examination (ESE) for 50 marks is to be done based on following criteria.
This assessment shall be done by the Faculty.

Suggestive **RUBRICS** may be developed by the faculty

Sr. No.	Criteria	Mark
1	Quality of information/Knowledge presented in SEMINAR	
2	Creativity, Innovation in SEMINAR presentation	
3	Response to the question during seminar presentation	
4	Establishment of Innovative Problem Statement and its presentation	
5	Objectives of the project and action plan	

The total obtained marks shall be converted in proportion of 25 marks.

VIII. Suggestive CO-PO Mapping

Course Outcomes (COs)	Programme Outcomes (POs)							Program Specific Outcom (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**
CO-1	3	1	0	-	2	2	3	
CO-2	2		2	-	2	1	3	
CO-3	3	1	1	2	1	2	3	
CO-4	2	0	0	2	1	2	3	
CO-5	3	3	3	2	2	3	3	

VIII.Typographical instructions/guidelines for seminar preparation & presentation

- The seminar PPT shall be computer typed (English- British)
- Text Font -Times New Roman (TNR), Size-12 point
- Subsection heading TNR- 12 point bold normal
- Section heading TNR- 12 capital bold
- Chapter Name/ Topic Name – TNR- 14 Capital
- All text should be justified. (Settings in the Paragraph)
- Different colors text/diagrams /tables may used
- The name of the candidate, diploma (department), year of submission,name of the institute shall be printed on the first slide PPT.

IX.Seminar and Project Initiation Report

On completion and presentation of Seminar, every student will submit a brief report which should contain the following:

- Cover Page (as per annexure 1)
- Title page (as per annexure 2)
- Certificate by the Guide (as per annexure 3)
- Acknowledgment (The candidate may thank all those who helped in the execution of the project).
- Abstract of Paper presented in the seminar (It should be in one page and include the purpose of the seminar & methodology .)
- Index
- List of Figures
- Introduction
- Literature Review
- Information/Chapters related to Seminar topic
- Advantages and Disadvantages
- Conclusion
- Project Initiation : a) Description of problem statement. b) Scope and objectives. c) State holder d) Platform/ Equipment/ Re identification.
- Bibliography
- References

NOTE: Seminar report must contain only relevant – technology or platform or OS or tools used and shall not exceed 25-30 pages

Details of Softcopy to be submitted:
The soft copy of seminar presentation is required to be provided on the back cover of the seminar report in clear packet, which sh
include the following folders and contents:

1.Presentation (should include a PPT about project in not more than 15 slides)
2.Documentation (should include a word file of the project report)

NOTE: Soft copy must be checked for any harmful viruses before submission.

X. Sample Formats

1) Cover Page - Annexure-I

2) Index - Annexure-II

3) Assessment - Annexure-III

Annexure - I

MSBTE LOGO

SEMINAR Report

Institut Logo

"SEMINAR Title_ _ _ _ _ _ _ _ _ _ _ _ _"

as a partial fulfilment of requirement of the

THIRD YEAR DIPLOMA IN

Submitted by

Name of Student **Enrollment Number**

FOR THE ACADEMIC YEAR 20___20___

(H.O.D) **(Principal)**

(Internal Guide) **(External Examiner)**

Annexure - II

Institute Name

(An Affiliated Institute of Maharashtra State Board of Technical Education)

Table of Contents

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***Students can add/remove/edit chapter names as per the discussion with their guide**

Annexure - III

Format for SEMINAR and PROJECT INITIATION Assessment /Evaluation

Formative Assessment

CRITERIA AND WEIGHTAGE

Enrollment No	**1** Selection Topic/Theme of seminar (5)	**2** Literature review and data presentation (5)	**3**. Quality of Preparation and innovativeness (5)	**4** Q-A handling (5)	**5** Time Management (5)	6. Seminar Presentation report (10)	**7** Selection of Theme of Problem Statement and its innovativeness (5)	**8** Stages of development of Action plan (5)	**9.** Prototyping (5)	**10.** Tot (50

SummativeAssessment

CRITERIA AND WEIGHTAGE

Enrollment No	**1.** Quality of information/Knowledge presented in SEMINAR **10**	**2** Creativity, Innovation in SEMINAR presentation 10	**3**. Response to the question during seminar presentation 10	**4** Establishment of Innovative Problem Statement and its presentation 10	**5** Objectives of the project and action plan 10	Total **(50)**	Scale **(2**

SEMINAR AND PROJECT INITIATION COURSE **Course Code : 3**

Sign: **Name: ----------** **(Course Expert/s)**	**Sign:** **Name: ----------** **(Program Head)** **(Information Technology)**

MSBTE Approval Dt. 24/02/2025 **Semester - 5, K Sc**

12-02-2026 01:07:08 PM

SWITCHGEAR AND PROTECTION **Course Code : 315334**

Programme Name/s : **Electrical Engineering/ Electrical Power System**
Programme Code : **EE/ EP**
Semester : **Fifth**
Course Title : **SWITCHGEAR AND PROTECTION**
Course Code : **315334**

I. RATIONALE

Switchgear and Protection plays a vital role in maintaining the reliability and stability of the power system. In order to ensure this, operational principles, selection and testing of Switchgear and Protection schemes must be known to the students while performing their duties in electrical sector.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry/employer expected outcome through various teaching learning experiences: "Select and use different switchgears and protection schemes to maintain the reliability and stability of the power system".

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Recognize the different types of faults occuring in power system.
- CO2 - Select the suitable switchgears for different applications.
- CO3 - Test the performance of different protective relays.
- CO4 - Use suitable protection schemes for alternators, motors, transformers, busbars and transmission lines.
- CO5 - Select suitable protection schemes for power system against over voltages.

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	
315334	SWITCHGEAR AND PROTECTION	SGP	DSC	5	-	2	2	9	3	3	30	70	100	40	25	10	25#	10	25	10	175

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

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 10 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.

SWITCHGEAR AND PROTECTION **Course Code : 315334**

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe the functions of the given elements of the protective system TLO 1.2 Explain with sketches the given types of faults and abnormalities in a power system TLO 1.3 Explain with sketches the concept of the Backup protection for the given protection zone TLO 1.4 Calculate the short circuit currents of symmetrical faults for the given generators TLO 1.5 Select suitable current limiting reactors for the given situation with justification.	**Unit - I Fundamentals of Protection** 1.1 Protective system: Necessity, functions and components 1.2 Normal and abnormal conditions 1.3 Types of faults and their causes 1.4 Protection zones and backup protection 1.5 Short circuit fault calculations for symmetrical fault on busbars fed through generators 1.6 Current Limiting Reactors : Need, types, arrangements , comparative advantages and disadvantages	Lecture Using Chalk-Board Flipped Classroom Demonstration

SWITCHGEAR AND PROTECTION **Course Code : 315334**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Explain the operation with sketches of the given isolators TLO 2.2 Explain with sketches the given terms related to the specified fuse (s). TLO 2.3 Explain the terms related to arc interruption process of the fuse. TLO 2.4 Explain with sketches arc formation, high resistance and zero current interruption in the given type of circuit breaker. TLO 2.5 Calculate the terms related to circuit interruption based on the given data of the circuit. TLO 2.6 Explain the operation with sketches of the given circuit breaker(s). TLO 2.7 Compare the given circuit interrupting devices on the specified parameters. TLO 2.8 Select the relevant switchgear for the given application with justification. TLO 2.9 Describe the general arrangement of Gas insulated switchgear TLO 2.10 Explain the Insulation coordination for the given installation/machine. TLO 2.11 Classify the Ring main unit switchgear parameters based on given criteria. TLO 2.12 Compare Air Insulated Substation (AIS) and Gas Insulated Substation (GIS)	**Unit - II Circuit Interrupting Devices** 2.1 Isolators- Vertical break, Horizontal break and Pantograph type with its advantages and disadvantages 2.2 HRC fuses – Construction, types, working, Inverse time current characteristics,characteristics of fuse element, Fuse current rating, Minimum fusing current, Fusing factor, Prospective current, Cut off Current. 2.3 Terms related to Arc interruption process of fuse – pre-arcing time, cut off value, arcing time, total operating time, peak of prospective current and applications 2.4 Arc formation process, methods of arc extinction (High resistance and Low resistance). 2.5 Arc voltage, Recovery voltage, Re-striking voltage, Rate of rise of restriking voltage (RRRV). 2.6 HT circuit breakers: Vacuum circuit breaker , Sulphur-hexa Fluoride (SF_6) - Working, construction, specifications and applications 2.7 L.T. circuit breaker: Miniature circuit breakers (MCB), Moulded case circuit breakers (MCCB), Motor Protection Circuit Breaker (MPCB) , Residual Current Circuit Breaker (RCCB) and Earth leakage circuit breaker(ELCB), Air circuit breakers (ACB)- Construction, Working and applications 2.8 Selection of LT and HT circuit breakers 2.9 Isolator, fuses and circuit breaker: Comparison 2.10 Gas insulated switchgear 2.11 Insulation Coordination : Type1 & Type2 coordination 2.12 Ring Main Unit Switchgear: Introduction, classification based on: type of insulation (gas, oil, air), installation (outdoor, indoor). 2.13 Air Insulated Substation (AIS) : Concept, Advantages , Disadvantages ; Gas Insulated Substation (GIS) : Concept, Advantages, Disadvantages	Lecture Using Chalk-Board Presentations Flipped Classroom

SWITCHGEAR AND PROTECTION **Course Code : 315334**

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 given terms related to protective relays TLO 3.2 Calculate the relay time based on the given data in the power system. TLO 3.3 Explain with sketches the working of the given protective relay TLO 3.4 Select relevant protective relay for required application with justification.	**Unit - III Protective Relays** 3.1 Protective Relay: Fundamental quality requirements (Selectivity, Speed, Sensitivity, Reliability, Simplicity, Economy) 3.2 Basic relay terminology- Protective relay, Relay time, Pick up, Reset current, current setting, Plug setting multiplier, Time setting multiplier. 3.3 Electromagnetic disc relay, Thermal relay, over voltage relay, Over current, Earth fault relay: Operation and its characteristics. 3.4 Static, Digital Relay (Microprocessor based): Block diagram, working, advantages and limitations. Numerical relay: Introduction 3.5 Distance relaying- Principle 3.6 Directional relay: Need and operation with block diagram. 3.7 Current and Voltage differential relay: Operation	Lecture Using Chalk-Board Presentations Flipped Classroom
4	TLO 4.1 Describe the causes and remedies of the given faults in the specified machine. TLO 4.2 Explain with sketches the given protection schemes of the specified machine TLO 4.3 Calculate percentage of winding protected for the specified alternator TLO 4.4 Calculate CT ratio of the specified transformer protection scheme. TLO 4.5 Explain the causes and remedies of the given faults in the busbar and transmission line	**Unit - IV Protection of Alternators, Motors, Transformers, Busbars and Transmission lines** 4.1 Abnormalities and Faults occurring in alternator 4.2 Differential, Overcurrent , Earth fault Protection: Schemes 4.3 Reverse power protection: Scheme 4.4 Abnormalities and Faults occurring in transformer 4.5 Differential, over current, earth fault, over heating protection. 4.6 Limitations of differential protection. 4.7 Buchholz relay: Construction, operation. 4.8 Motor: Abnormalities and Faults, Short circuit protection, Overload protection, Single phase preventer. 4.9 Busbar: Faults, busbar protection, differential and fault bus protetion. 4.10 Transmission Line: Faults, Over current, Distance and Pilot wire protection.	Lecture Using Chalk-Board Presentations 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 Test protection system for the earth fault or short circuit fault.	1	*Simulation of Earth Fault/ Short Circuit fault.	2	CO1
LLO 2.1 Test the performance of HRC fuse. LLO 2.2 Validate the performance of HRC fuse by drawing the inverse time current characteristics.	2	*Testing of HRC Fuse.	2	CO2
LLO 3.1 Test the performance of MCB. LLO 3.2 Validate the performance of MCB by drawing the inverse time current characteristics.	3	*Testing of Miniature Circuit Breaker	2	CO2
LLO 4.1 Test Induction type over-current relay by performing load test.	4	*Characteristics of Induction type over-current relay.	2	CO3

SWITCHGEAR AND PROTECTION **Course Code : 315334**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 5.1 Carry out plug and time setting (with PSM, TSM) of induction type electromagnetic relay.	5	*Plug Setting and Time setting Multiplier of Induction type relay.	2	CO3
LLO 6.1 Use Differential protection for protecting the Alternator.	6	*Demonstrate/ Simulate differential protection scheme for different types of faults on Alternator.	2	CO4
LLO 7.1 Use Differential protection for protecting the Transformer.	7	*Demonstrate/ Simulate differential protection scheme for different types of faults on Transformer.	2	CO4
LLO 8.1 Use Single Phase Preventer for protection of three phase Induction Motor.	8	*Testing of single phase preventer for protecting three phase induction motor.	2	CO4
LLO 9.1 Select relevant protection scheme for the given transmission line.	9	Demonstrate/Simulate transmission line protection by using the impedance/over current relay for various faults.	2	CO4
LLO 10.1 Identify different parts of the Lightning Arrestor.	10	*Demonstration of Thyrite type lightning arrester using video /Dismantling the same.	2	CO5
LLO 11.1 Describe the step by step procedure to carry out Neutral Earthing.	11	Demonstrate process of carrying out neutral earthing at different substations / locations or with suitable media.	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)

Micro project

- Installation and commissioning of MCB / ELCB: Calculate load current and finalize the specifications of protection schemes for Electrical Engineering laboratory.
- Alternator/Transformer/Motor/Busbar and Transmission Line protection Relays: Prepare power point presentation on digital and multifunction protection relays used to protect feeder, motor , generator, busbar and Transmission line.
- IEC 61850 communication protocol : Prepare a power point presentation on communication protocol used to provide communication between different equipment located in a substation, such as protection, control, and measurement equipment, as well as (IEDs) intelligent electronic devices.
- Case study of past major grid power failure: Prepare a report after studying the previous power failure in India or abroad

Assignment

- Write a report on causes of overvoltages in power system.
- Write a report on Lightning phenomena.
- Write a report on Protection of power system against travelling waves.
- Write a report on different types of Lightning arrestors.
- Write a report on arcing ground and Neutral grounding.

All Assignments are mandatory as they will contribute to attainment of CO5.

SWITCHGEAR AND PROTECTION **Course Code : 315334**

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	Fuses (5A), MCB(5A) , Connecting wires.	1
2	Earth tester 500 V, hand driven or digital type.	10
3	HRC Fuses:5A	2
4	MCB : 5A	3
5	Induction Overcurrent Relay : 10A or above	4
6	Alternator Differential Protection Scheme Simulation Kit	5
7	Transformer Differential Protection Scheme Simulation Kit.	6
8	Three phase induction motor with Single phase preventer: 3HP or above.	7
9	Transmission line protection simulation kit using impedance/over current relay.	8
10	Thyrite type/ Metal oxide Type Lightning arrester.	9

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

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Fundamentals of Protection	CO1	8	2	4	6	12
2	II	Circuit Interrupting Devices	CO2	10	2	8	6	16
3	III	Protective Relays	CO3	12	4	4	10	18
4	IV	Protection of Alternators, Motors, Transformers, Busbars and Transmission lines	CO4	20	2	8	14	24
Grand Total				**50**	**10**	**24**	**36**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two unit tests of 30 marks will be conducted and average of 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 25 marks for laboratory learning. End semester assessment of 70 marks through offline mode of examination.

XI. SUGGESTED COS - POS MATRIX FORM

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SWITCHGEAR AND PROTECTION **Course Code : 315334**

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	3	2	3	2	2			
CO2	3	1	2	2	3	2	3			
CO3	3	1	2	2	3	2	2			
CO4	3	3	3	2	3	2	2			
CO5	3	1	3	2	3	2	2			

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

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Mehta V. K ; Rohit Mehta	Principles of Power System	S.Chand and Co., New Delhi., 2016 ISBN: 978-93-5501-077-3
2	Rao.Sunil S.	Switchgear and Protection	Khanna Publishers, New Delhi, 2015 ISBN: 978-93-87394-72-8
3	Gupta. J. B.	Switchgear and Protection	S. K. Kataria and Sons, New Delhi, 2015ISBN: 978-93-5014-372-8.
4	Singh, R. P.	Switchgear and Power System Protection	PHI Learning, New Delhi,2015 ISBN: 978-81-203-3660-5.
5	Ram, Badri Vishwakarma D. N.	Power System Protection and Switchgear	McGraw-Hill, New Delhi. 2015 ISBN : 978-00-7107-774-3
6	Veerapan, N., Krishnamurty, S. R.	Switchgear and Protection	S .Chand and Co., New Delhi. 2014 ISBN: 978-81-2193-212-7.

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	www.cgglobal.com	Different types of Switchgears
2	https://nptel.ac.in/courses/108101039	NPTEL course on Power System Protection (Fundamentals of Power System Protection, Fault Analysis, Over current Protection, Directional Overcurrent Protection, Distance Protection, Numerical Relay Fundamentals, Differential Protection of Busbar, Transformer and Generator)
3	https://new.abb.com	Different types of Switchgears, Ring Main Unit (RMU) Switchgears, Relays.
4	https://www.elecspare.com	Different types of Switchgears, Ring Main Unit (RMU) Switchgear

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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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**	**: 12 Weeks (Industry) + 10 Weeks (Institute)**
Semester	**: Fifth** **NCrF Entry Level : 4.0**	**Scheme**	**: K**

Sr No	Course Title	Abbrevation	Course Type	Course Code	Total IKS Hrs for Sem.	Learning Scheme					Credits	Assessment Scheme											
						Actual Contact Hrs./Week			Self Learning (Activity/ Assignment /Micro Project)	Notional Learning Hrs /Week		Paper Duration (hrs.)	Theory				Based on LL & TL				Based on Self Learning		Total Marks
																	Practical						
						CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
													Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
(All Compulsory)																							
1	A.C. MACHINES PERFORMANCE	ACM	DSC	315333	-	5	-	2	2	9	3	3	30	70	100	40	25	10	25#	10	25	10	175
2	SWITCHGEAR AND PROTECTION	SGP	DSC	315334	-	5	-	2	2	9	3	3	30	70	100	40	25	10	25#	10	25	10	175
3	ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS	ENDS	AEC	315002	-	1	-	2	-	3	1	-	-	-	-	-	50	20	25@	10	-	-	75
4	SEMINAR AND PROJECT INITIATION COURSE	SPI	AEC	315003	-	-	-	1	2	3	1	-	-	-	-	-	25	10	25@	10	25	10	75
5	INTERNSHIP(12 WEEKS)	ITR	INP	315004	-	-	-	-	-	36 - 40	10	-	-	-	-	-	100	40	100#	40	-	-	200
Elective-I (Any - One)																							
6	ELECTRIC VEHICLE TECHNOLOGY	EVT	DSE	315335	-	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150
	POWER SYSTEM OPERATION AND CONTROL	PSO	DSE	315336	-	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150
	RENEWABLE ENERGY TECHNOLOGY	RET	DSE	315337	-	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150
Total						**15**		**9**	**6**		**20**		**90**	**210**	**300**		**250**		**225**		**75**		**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.* 10 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. **Note:** Notional learning hours for **internship represents the student engagement hours.**
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)

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BASIC PYTHON PROGRAMMING **Course Code : 313011**

Programme Name/s	**: Automation and Robotics/ Digital Electronics/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Instrumentation & Control/ Industrial Electronics/ Instrumentation/ Medical Laboratory Technology/ Medical Electronics**
Programme Code	**: AO/ DE/ EE/ EJ/ EK/ EP/ ET/ EX/ IC/ IE/ IS/ ML/ MU**
Semester	**: Third / Fourth / Sixth**
Course Title	**: BASIC PYTHON PROGRAMMING**
Course Code	**: 313011**

I. RATIONALE

Electronics based industries needs to deal with creating circuits design, simulation, signal processing and control systems which can be developed using Python. This course deals with the basics of python to enhance the programming skills of diploma students. The course will enable students to write python programs as well as use different python libraries to solve given problems.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to attain the following industry/employer expected outcome through various teaching learning experiences:
Develop programs using python to solve wide-reaching electronics engineering related problems.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Develop script to demonstrate use of basic building blocks of python.
- CO2 - Implement conditional and looping statements for given problem statement.
- CO3 - Perform operations on sequence structures in python.
- CO4 - Implement basics of object oriented programming concepts.
- CO5 - Create modules and packages for given purpose.

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	
313011	BASIC PYTHON PROGRAMMING	BPP	AEC	2	-	2	-	4	2	-	-	-	-	-	25	10	25@	10	-	-	50

BASIC PYTHON PROGRAMMING **Course Code : 313011**

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

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

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe the given Keywords and Constants in Python. TLO 1.2 Use indentation, comments in the given program. TLO 1.3 Use different types of operators for writing expressions. TLO 1.4 Write python program using input output statements.	**Unit - I Basic Python's Constructs** 1.1 Introduction to Python- Python as scripting Language, Programming language Vs Scripting Language (C vs Python), Python's Technical Strength, Application in different domains 1.2 Python's building blocks- Identifiers, Keywords, Variables, Constants, Indentation, Comments in python 1.3 Python's Data Types – Numbers, Strings, List, Tuples, Dictionaries, Sets 1.4 Input and Output statements in python 1.5 Operators in Python- Operators as Arithmetic, Assignment, Unary Minus, Relational, Logical, Boolean, Bitwise, Membership, Identity, Operator precedence and Associativity	Presentations, Lecture Using Chalk-Board, Hands-on
2	TLO 2.1 Develop programs using Conditional Statements. TLO 2.2 Develop programs using Loop statements. TLO 2.3 Use statements to control the loops.	**Unit - II Control Statements in Python** 2.1 Types of Control Statements – Decision making statements, Looping statements 2.2 Decision Making Statements: - if, if….else, else-if ladder ,nested if and switch statement 2.3 Looping statement: - while loop, for loop, nested loop 2.4 Manipulating Loops- use of break, continue and pass statements	Lecture Using Chalk-Board, Demonstration, Hands-on, Flipped Classroom

BASIC PYTHON PROGRAMMING **Course Code : 313011**

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 Develop program to manipulate List for given purpose. TLO 3.2 Develop program to manipulate Tuples for given purpose. TLO 3.3 Develop program to manipulate Sets for given purpose. TLO 3.4 Develop program to manipulate Dictionaries for given purpose.	**Unit - III Data Structures in Python** 3.1 List- Defining List, Creating list, Accessing values from list, Updating the elements of a list, Concatenation of two lists, Repeating of Lists, Membership in list, Aliasing and cloning Lists, Methods to process Lists, Nested Lists 3.2 Tuples- Defining Tuple, Creating Tuples, Accessing the Tuple elements, Inserting elements in a Tuple, modifying elements of a Tuple, Deleting elements from a Tuple, Basic operations in Tuples, Functions to process Tuples, Nested Tuples 3.3 Sets- Defining Set, Creating a Set, Accessing elements from set, Add and update Set, Remove an elements from a Set, Built in functions with Set, Set methods to perform mathematical operations, other relevant set methods 3.4 Dictionaries- Defining Dictionary, Creating Dictionary, Accessing elements from Dictionary, Add and update Dictionary, Delete an element from a Dictionary, Built in functions of Dictionary, Methods to perform Dictionary	Demonstration, Lecture Using Chalk-Board, Hands-on
4	TLO 4.1 Use python built-in functions to perform tasks. TLO 4.2 Develop relevant user defined function for the given purpose. TLO 4.3 Define classes to create and access objects with its methods and attributes.	**Unit - IV Functions with Basic OOP concepts** 4.1 Python Functions- Use of python built in functions (e.g. type/data conversion functions, math and string functions), User defined function- Function definition, function calling, function arguments and parameter passing, Return statement, scope of variables (Global and Local Variables) 4.2 Basic OOP concepts- Introduction to object-oriented programming, Creating classes and objects, Constructors and Destructors in python, Data abstraction and Encapsulation	Demonstration, Lecture Using Chalk-Board, Hands-on
5	TLO 5.1 Develop a python module in python for given purpose. TLO 5.2 Develop a python package for given purpose. TLO 5.3 Use NumPy for performing mathematical operations on arrays. TLO 5.4 Use matplotlib to create data visualization in python.	**Unit - V Modules and Packages in Python** 5.1 Modules- Writing modules, importing module, python built in modules (Numeric and mathematical module, Functional Programming Module) 5.2 Python packages- Introduction, Writing python packages, using standard packages (NumPy, matplotlib) and user defined package statements	Demonstration, Lecture Using Chalk-Board, Hands-on

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

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Install Python Integrated Development Environment.	1	a) Install and configure Python IDE. b) Write Python program to display message on screen.	2	CO1

BASIC PYTHON PROGRAMMING **Course Code : 313011**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 2.1 Use operators in Python.	2	*a) Write simple Python program to calculate equivalent registers connected in series and parallel. Accept values of R1, R2 and R3 from the user. *b) Write simple Python program to calculate value of voltage by applying Ohm's law. Accept value of Current(I) and Resistance(R) from the user.	2	CO1
LLO 3.1 Implement two-way branching statement.	3	Write program to check whether entered frequency is radio frequency or audio frequency.	2	CO2
LLO 4.1 Implement multi-way branching statement.	4	*a)Write program to display various radio frequency bands using if..elseif ladder. *b)Write program to display resistor color code using switch statement.	2	CO2
LLO 5.1 Implement control loops for solving iterative problems.	5	*a. Write a simple Python program to demonstrate use of control loops: i) while ii) do while *b. Create a simple program, to demonstrate use of: for loop in Python (e.g.: various pattern building, printing multiplication table, checking palindrome number etc.)	2	CO2
LLO 6.1 Perform basic operations on the Lists.	6	*Write Python program to perform following operations on List: a) Create b) Access c) Update d) Delete elements from list.	2	CO3
LLO 7.1 Execute various tuple operations.	7	Develop Python program to perform following operations on Tuples: a) Create b) Access c) Update d) Delete Tuple elements	2	CO3
LLO 8.1 Implement various set operations.	8	Write Python program to perform following operations on Set: a) Create b) Access c) Update d) Delete Access Set elements	2	CO3
LLO 9.1 Execute various operations on Dictionaries.	9	*Create a program to perform following operations on Dictionaries in Python: a) Create b) Access c) Update d) Delete e) Looping through Dictionary	2	CO3
LLO 10.1 Use built-in mathematical functions and string functions in python.	10	a) *Create python program to demonstrate use of math built-in function. b) *Create python program to demonstrate use of string built-in function.	2	CO4

BASIC PYTHON PROGRAMMING **Course Code : 313011**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 11.1 Create user defined functions in Python.	11	Write python programs to define function with arguments. a) Calculate factorial of a number b) Swapping of two variables	2	CO4
LLO 12.1 Implement function with default arguments.	12	Write programs to define function with default arguments.	2	CO4
LLO 13.1 Use built-in python mathematical modules.	13	*Create a program to demonstrate use of: Built-in module (e.g. numeric, mathematical functional and programming module) in Python.	2	CO5
LLO 14.1 Write user-defined module in python.	14	Write program to create a user-defined module (e.g.: building calculator) in python.	2	CO5
LLO 15.1 Use python built-in packages.	15	*Develop Python program to demonstrate use of NumPy package for creating, accessing and performing different array operations.	2	CO5
LLO 16.1 Implement user-defined packages in python.	16	Write program to demonstrate the use of user-defined packages in Python.	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)

Micro project

- Not Applicable

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	a) Computer System with all necessary peripherals and internet connectivity. b)Any relevant python IDE like IDLE/PyCharm/VSCode/Jupiter Notebook/Online Python Compiler.	All

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

BASIC PYTHON PROGRAMMING **Course Code : 313011**

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Basic Python's Constructs	CO1	4	0	0	0	0
2	II	Control Statements in Python	CO2	4	0	0	0	0
3	III	Data Structures in Python	CO3	10	0	0	0	0
4	IV	Functions with Basic OOP concepts	CO4	6	0	0	0	0
5	V	Modules and Packages in Python	CO5	6	0	0	0	0
Grand Total				**30**	**0**	**0**	**0**	**0**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Each practical will be assessed considering – 60% weightage to process and – 40% weightage to product.

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	2						1			
CO2	2			1			2			
CO3	1	1	1	2			2			
CO4	1	2	2	2			2			
CO5	1	1	1	2			2			

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

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Giancarlo Zaccone	Natural Computing with Python	BPB, ISBN:9789388511612
2	Martin C. Brown	Python: The Complete Reference	Tata McGraw Hill ISBN: 9789387572942
3	Yashwant Kanetkar	Let Us Python	BPB, ISBN: 978-9391392253
4	Kumar Naveen, Taneja Sheetal.	Python Programming: A modular approach	Pearson, ISBN: 978-9352861293
5	Mark Lutz and David Ascher	Learning Python	O'Reilly, ISBN: 978-1449355739
6	Paul Barry	Head First Python	O'Reilly, ISBN: 978-1449382674
7	John Guttag	Introduction to Computation and Programming Using Python	MIT Press, ISBN: 978-0262529624

BASIC PYTHON PROGRAMMING **Course Code : 313011**

Sr.No	Author	Title	Publisher with ISBN Number
8	David Beazley	Python Essential Reference	Addison-Wesley Professional, ISBN: 978-0672329784
9	Dr. R. Nageswara Rao	Core Python Programming	DREAMTECH PRESS, ISBN: 978-9386052308

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.programiz.com/python-programming	Python Programming
2	https://python-iitk.vlabs.ac.in/Introduction.html	Virtual Lab for Python Programming-Basic Constructs in Python
3	https://www.geeksforgeeks.org/python-programming-language/	Python Programming
4	https://intellipaat.com/academy/course/introduction-to-python-programming-free-course/	Online Course-Python Programming
5	https://www.w3schools.com/python/	Python Programming
6	https://www.tutorialspoint.com/python/index.htm	Python Programming
7	https://www.python.org/	Python Programming
8	https://spoken-tutorial.org/tutorial-search/?search_foss=Python+3.4.3&search_language=English	Spoken Tutorial on Python Programming

Note :

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

CAPSTONE PROJECT **Course Code : 316004**

Programme Name/s	**: Automobile Engineering./ Artificial Intelligence/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Software Technology/ Computer Science & Engineering/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Computer Hardware & Maintenance/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Manufacturing Technology/ Metallurgical Engineering/ Production Engineering/ Computer Science/ Electronics & Computer Engg.**
Programme Code	**: AE/ AI/ AN/ AO/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CST/ CW/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ HA/ IE/ IF/ IH/ LE/ ME/ MK/ MRT/ MY/ PG/ SE/ TE**
Semester	**: Sixth**
Course Title	**: CAPSTONE PROJECT**
Course Code	**: 316004**

I. RATIONALE

Capstone projects in engineering study are considered important as it allow students to integrate and apply the knowledge and skills acquired throughout their academic program and effectively demonstrating their learning of programme by tackling a real-world problem, ultimately keeping them well prepared for the job market. The capstone project is usually the final assignment and plays a vital role in preparing students for the world of work to its practical applications and ability to help hone students' professional knowledge and skills. Normally, capstone projects are developed in collaboration with industries or businesses, providing students with valuable insights. Capstone projects has been considered as an integral part of diploma curriculum. It helps learners to perform and demonstrate skills gained due to early courses of Diploma study independent. Therefore, this is considered as a course of final year/semester study.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- Apply professional skills for solving , executing and demonstrating solutions to real-world problems

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Elaborate the identified field problem from the perspective of project work at institute.
- CO2 - Conduct feasibility & viability analysis (using data collection, experiments, Simulation , Coding) to validate required resources, cost, support of the project work.
- CO3 - Apply the acquired knowledge and skills in providing solutions to the real field/industrial problems.
- CO4 - Present Project and its output/ findings / achievements alongwith its exhibits.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

CAPSTONE PROJECT **Course Code : 316004**

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	
316004	CAPSTONE PROJECT	CPE	INP	-	-	2	2	4	2	-	-	-	-	-	50	20	50#	20	50	20	150

V. General guidelines for PROJECT WORK

- The Project- problems must be related to the programme or may be interdisciplinary, based on the industry expected outcomes.
- The individual students have different aptitudes and strengths. Project work, therefore, should match the strengths of students. For this purpose, students should be asked to identify the type of project work they would like to execute.
- Project titles are to be finalized in co-ordination/consultation with the Faculty mentor. However, faculty may form a team of students as per specific roles- Literature survey/data collection, data Analysts, model/prototype developers, testers, Project managers using IoTs ITES and software /application development. Study type project is NOT advisable.
- Project must be assigned to a group of 3-4 students under the guidance of identified faculty mentor.
- Students are required to prepare a prototype/working model/software of the Project and simultaneously prepare a report.
- Students shall Submit One Hard copy and one Soft copy each of Project Report and soft-copy of the project code or the working model.
- Students must maintain a project execution diary having the progress steps and details. The concerned faculty should check the diary on a weekly basis and accordingly interact with students based on the progress shown and keep proper record with feedback if any.
- Project shall address National Thrust area such as Environment, Digitization, Automation, sustainability and similar domains.
- Student shall try to use the national and international standards wherever possible (processes / materials / equipments etc ..)

VI. Project facilitation guidelines:

Once the Project statement has been finalized and allotted to the students, the Faculty Mentor role is very important as guide, motivator, catalyser to promote learning and sustain the interest of the students. At the same time the Faculty Mentor is not expected to guide the students on each step, otherwise it will curb the creativity of the students-group. The Faculty Mentor has to work as a mentor. Following should be kept in mind while facilitating the project at the institute:

1.Project orientation cum -briefing: the project should be relevant to the curriculum of the programme. The project shall be cost effective taking safety aspects, ethical issues, environmental issues and confidentiality as per expectation of industry(if any) into consideration, The work may be industry Sponsored.

2.Information search and data collection: the information and data should be realistic and relevant to the problem /project. Hypothetical data is not to be taken into consideration.

3.Implementation and Monitoring: The project must have important steps /milestones to achieve as per the time frame/action plan prepared by students and faculty. The monitoring mechanism such as daily/weekly dairy (**Format given below)** must be clearly explained and delineated for the students.

VII.Criteria of Assessment /Evaluation of Project work

A. Formative Assessment (FA) criteria

The **Formative Assessment** (FA) of the students for 50 marks is to be done based on following criteria.

Appropriate RUBRICS may be used for assessment

Rubrics for Assessment of the team

Sr.No.	Criteria	Marks
1	Project Selection & Problem definition	05
2	Literature survey and data collection/ Gathering	05
3	Design / concept of project/ Working - Execution of Project	10
4	Stage wise progress as per Action plan/milestone	05
5	Quality Report Writing	05

Rubrics for Individual Assessment

Sr.No.	Criteria	Marks
1	Contribution as a team member	05
2	Depth of Knowledge	10
3	Presentation	05

B. Summative Assessment Criteria

- The summative assessment for 50 marks is to be done and based on following criteria. This assessment shall be done by the faculty mentor and External examiner.

Sr.No.	Criteria	Marks
1	Capstone Project Completion as per plan	10
2	Project related Requirement Analysis & Designing	10
3	Developing a Solution with proper justifications, Teamwork	10
4	Project Report Writing	10
5	Project Presentation	10

(**NOTE :** Team based and Individual performance based summative assessment may include Innovativeness , Technology used , user friendliness , cost effectiveness , society benefits etc..)

SUGGESTED RUBRIC FOR SUMMATIVE ASSESSMENT OF CAPSTONE PROJECT

PROJECT ASSESSMENT				
Project Title:				
Project Assessment Rubric				
Performance	**Excellent**	**Good**	**Fair**	**Poor**
Criteria	**9-10 marks.**	**6-8 marks.**	**4-5 marks.**	**0-3 marks**
Capstone Project Completion	Excellent **The project is completed as per tasks described in synopsis.**	Good **The project is completed but require minor modifications.**	Fair **The project is completed but require several modifications.**	Poor **The project is not completed as per tasks described in synopsis.**

	9-10 marks.	**6-8 marks.**	**4-5 marks.**	**0-3 marks**
Project related Requirement Analysis & Designing	**Effectively contributed in requirement analysis and designing.**	**Partially Contributed in requirement analysis and designing.**	**Attempted to contribute in requirement analysis and designing**	**No contribution in requirement analysis and designing.**
	9-10 marks.	**6-8 marks.**	**4-5 marks.**	**0-3 marks**
Developing a Solution with proper justifications , Teamwork	**Developed the critical solution modules with Innovation, optimized design and worked very well with the team.**	**Developed some solutions with higher complexity and worked well with the team.**	**Attempted to develop few solutions and worked with the team.**	**No contribution in developing a solution and in the team.**
	9-10 marks.	**6-8 marks.**	**4-5 marks.**	**0-3 marks**
Project Report Writing	**Worked very well to submit an excellent project report .**	**Worked well to submit the project report with covering all the aspects of a standard report.**	**Tried to submit the project report but standard of report was not satisfactory.**	**No contribution in project report writing.**
	9-10 marks.	**6-8 marks.**	**4-5 marks.**	**0-3 marks**
Project Presentation	**Presented the project work flawlessly.**	**Presented the project work very nice.**	**Presented the project work not so well.**	**Presentation skill is not up to the mark.**
Project Group Members				
ROLL NUMBER/Enrollment Number				
NAME				
Comments (if any)				

NOTE : " These are suggestive rubrics Faculty mentor and external examiner may frame different rubrics as per Programme need and assigned Project work "

C. Self Learning Assessment

Self Learning Assessment **Max Marks -50**

Sr.No.	Criteria	Max Marks	Marks Obtained
1	Project Selection & Problem definition	10	
2	Literature survey and data collection/ Gathering	05	
3	Design / concept of project/ Working - Execution of Project	15	
4	Stage wise progress as per Action plan/milestone/ psychomotor motor skills acquired	10	
5	Quality Report Writing	10	

VIII. CO-PO Mapping

CO-PO mapping will vary project wise and shall be prepared by concerned faculty for the given project

IX. Typographical instructions/guidelines for Project report writing

Following is the suggestive format for preparing the Project report. Actual report may differ slightly depending upon the nature of industry. The training report may contain the following.

a. The PROJECT report shall be computer typed (English- British) and printed on A4 size paper.
b. Text Font -Times New Roman (TNR), Size-12 point
c. Subsection heading TNR- 12 point bold normal
d. Section heading TNR- 12 capital bold
e. Chapter Name/ Topic Name – TNR- 14 Capital
f. All text should be justified. (Settings in the Paragraph)
g. The report must be typed on one side only with double space with a margin 3.5 cm on the left, 2.5 cm on the top, and 1.25 cm on the right and at bottom.
h. The training report must be hardbound/ Spiralbound with cover page in black colour. The name of the candidate, diploma (department), year of submission, name of the institute shall be printed on the cover [Refer sample sheet (outer cover)]
i. The training report, the title page [Refer sample sheet (inner cover)] should be given first then the Certificate followed by the acknowledgment and then contents with page numbers.

X. Project Report

On completion of the project work, every student will submit a project report which should contain the following:
1. Cover Page (as per annexure 1)
2. Title page (as per annexure 2)
3. Certificate by the Guide (as per annexure 3)
4. Acknowledgment (The candidate may thank all those who helped in the execution of the project.)
5. Abstract (It should be in one page and include the purpose of the study; the methodology used.)
6. Table of Contents (as per general guidelines): Detailed description of the project (This should be split in various chapters/sections with each chapter/section describing a project activity in totality).

Chapter–1 Introduction (background of the Industry or User based Problem/Task)
Chapter–2 Literature Survey (to finalize and define the Problem Statement)
Chapter–3 Scope of the project
Chapter–4 Methodology/Approach, if any
Chapter-5 Details of designs, working and processes
Chapter-6 Results and Applications

7. Conclusion
8. References (The listing of references should be typed 2 spaces below the heading “REFERENCES” in alphabetical order in single spacing left – justified. It should be numbered consecutively (in square [ ] brackets, throughout the text and should be collected together in the reference list at the end of the report. The references should be numbered in the order they are used in the text. The name of the author/authors should be immediately followed by the year and other details). Typical examples of the references are given below:

NOTE:

1. Project report must contain only a relevant and short mention – technology or platform or tools used. It must be more focussed on project work and its implementation
2. Students can add/remove/edit chapter names as per the discussion with their guide

Formats

Project Report

“Project Title----------”

as a partial fulfilment of requirement of the

THIRD YEAR DIPLOMA IN

Submitted by

1)Name Of Student Enrollment Number

2)Name Of Student Enrollment Number

3)Name Of Student Enrollment Number

4)Name Of Student Enrollment Number

Are the bonafide on

FOR THE ACADEMIC YEAR

20-----20---

(H.O.D)

(Principal)

(Internal Guide) **(External Examiner)**

Department Name

(If NBA Accredited mention that)
Institute Name

(An Affiliated Institute of Maharashtra State Board of Technical Education)

CAPSTONE PROJECT **Course Code : 316004**

Table of Contents

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Note:

***Students can add/remove/edit chapter names as per the discussion with their guide**

CAPSTONE PROJECT **Course Code : 316004**

Annexure

PROJECT DIARY (Weekly/Daily)

Name of the Student : _____

Name of Guide (Faculty) : _____

Enrollment Number : _____ Semester: _____Project batch Number : _____

WEEK : _____

Date	Activity carried out (Details)	Achievement of mile stone/step as per plan	Remark of Faculty
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			

Dated Signature of Faculty **Dated Signature of HOD**

CAPSTONE PROJECT **Course Code : 316004**

MSBTE LOGO INST LOGO

Certificate

This is to certify that

Mr./Ms. *bearing examination seat No.* *has*

Satisfactorily completed his/her ***PROJECT*** *entitled*

Along with his/her batchmates in partial fulfillm ent for the

Diploma Course in

< PROGRAMME NAME>

Of the ***Maharashtra State Board of Technical Education*** *at our Polytechnic during the Academic Year20 -20 .*

The Project is completed by a group consisting of Persons under the guidance of the Faculty Guide

Faculty Name and Signature (Internal)	**Faculty Name and Signature (External if applicable)**	**HOD Name and Signature with Department Stamp**
Date and Time		

12-02-2026 01:17:14 PM

EMERGING TRENDS IN ELECTRICAL ENGINEERING **Course Code : 316326**

Programme Name/s	**: Electrical Engineering/ Electrical and Electronics Engineering/ Electrical Power System**
Programme Code	**: EE/ EK/ EP**
Semester	**: Sixth**
Course Title	**: EMERGING TRENDS IN ELECTRICAL ENGINEERING**
Course Code	**: 316326**

I. RATIONALE

Emerging technologies evolve rapidly in all the field of engineering and it is essential for technologists to stay updated on these aspects to face the day to day challenges in the industry as well as in the society. This course aims to prepare Diploma Engineers with insights into the emerging technological trends like smart systems, AI, intelligent motor controls and digitization.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following Industry identified outcome through various teaching learning experiences: .

- **Acquire relevant knowledge of Emerging techniques in electrical engineering fields.**

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Suggest the relevant IoT technologies for electrical systems.
- CO2 - Elaborate the use relevant IoT and SCADA for Automation of electrical Grid systems.
- CO3 - Implement electrical engineering related emerging trends to develop smart city.
- CO4 - Suggest the relevant IMCC for the given application (s).
- CO5 - Select the relevant improved tariff and billing solution for the specified type of consumer.

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	
316326	EMERGING TRENDS IN ELECTRICAL ENGINEERING	ETE	DSC	4	-	-	-	4	2	1.5	30	70*#	100	40	-	-	-	-	-	-	100

EMERGING TRENDS IN ELECTRICAL ENGINEERING **Course Code : 316326**

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 specified Industrial Revolution with respect to the driving force behind it. TLO 1.2 Explain the Industrial Revolution 4.0 with respect to the specified component (s). TLO 1.3 Explain the changes in Industry 4.0 with respect to AIML and 5G. TLO 1.4 Explain the Importance of Industrial revolution 5.0. TLO 1.5 Explain the Principle and features of IoT. TLO 1.6 Apply the concepts of IoT in the given electrical systems.	**Unit - I Digitization beyond Automation** 1.1 Industrial Revolutions: Versions 1.0, 2.0, 3.0 and 4.0; the driving force for these revolutions. 1.2 Components of Industrial Revolution 4.0: Digitization, CPS (Cyber Physical Systems), IoT (Internet of Things), Cloud Computing and Cloud Manufacturing. 1.3 Role of 5G Communication, Machine learning (ML) and AI in Industry 4.0. 1.4 Industry Revolution 5.0: Introduction and Key Features. 1.5 IoT: Principle and features. 1.6 Applications of IoT in Industrial drives, Transmission System, Distribution System, Illumination system and Renewable energy.	Lecture Using Chalk-Board Video Demonstrations Flipped Classroom Presentations

EMERGING TRENDS IN ELECTRICAL ENGINEERING **Course Code : 316326**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Describe the smart grid with respect to the need, layout and its components. TLO 2.2 Explain the concept and formation of micro grid. TLO 2.3 Explain the given Distributed Generation technology(ies) in the power sector. TLO 2.4 Describe the role of Distributed Generation in the given Grid system. TLO 2.5 Use features of Automation System in smart substation. TLO 2.6 Identify specific application of IoT and SCADA for particular Grid.	**Unit - II Smart Grid** 2.1 Smart Grid: Need and evolution, layout and its components, advantages and barriers, Smart Grid projects in India. 2.2 Micro-Grid: Need and formation of Micro Grid. 2.3 Distributed Energy Resources: Distributed generation systems and distributed generation technologies. 2.4 Role of distributed generation in Smart Grid and Micro Grid. 2.5 Substation Automation System (SAS): Need, layout and components, salient features of substation automation. 2.6 IoT and SCADA application in Grid systems.	Lecture Using Chalk-Board Video Demonstrations Flipped Classroom Presentations Site/Industry Visit
3	TLO 3.1 Describe the smart city with respect to the needs, components and its challenges. TLO 3.2 Explain relevant technology associated with Metro/ EV. TLO 3.3 Compare various EV's based on the given criteria (s). TLO 3.4 Describe smart home on the basis of the given criteria (s). TLO 3.5 Implement the Renewable energy related policies in smart city.	**Unit - III Smart City (Electrical Features)** 3.1 Smart City: Features, components, objectives and challenges of smart cities in India. 3.2 Intercity Transportation: EV / Metro: Types, data-driven operations, automated train operation (ATO), autonomous driving technology, efficient charging infrastructure, wireless charging: opportunities and challenges. 3.3 Comparison between various types of Electric Vehicles: technology, type of motor, efficiency, batteries etc. 3.4 Smart Home: Features and components, role of AI powered illumination system and advancement in luminaries. smart appliance control principles (block diagram/s). 3.5 Renewable Energy: Role, opportunities, government policies: center / state.	Lecture Using Chalk-Board Video Demonstrations Flipped Classroom Presentations Site/Industry Visit

EMERGING TRENDS IN ELECTRICAL ENGINEERING **Course Code : 316326**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Describe the conventional MCC considering the given points. TLO 4.2 Explain the IMCC based on the given point (s). TLO 4.3 Describe advantages and limitations of modern MCCs including lack of networking and diagnostics. TLO 4.4 Describe the salient features of the given basic components of intelligent system. TLO 4.5 Describe the salient features of the given components and devices of IMCC. TLO 4.6 Compare intelligent and conventional MCC on the basis of the given criteria.	**Unit - IV Intelligent Motor Control Centers** 4.1 Conventional Motor Control Center (MCC): Role in motor protection and management, typical block diagram and architecture, components: symbols and functions. 4.2 Intelligent or Smart MCCs (IMCCs): Need and evolution from traditional MCCs. Functional block diagram and general arrangement, integration of industrial IoT (IIoT) and cloud-based real-time monitoring. 4.3 Applications, advantages and limitations in modern MCCs including lack of networking and diagnostics. 4.4 Basic Components of Intelligent Systems: Microprocessor / microcontroller-based control; networking technologies (Ethernet / IP, Modbus, PROFINET) replacing hard wiring, enhanced diagnostics, AI-based predictive maintenance, smart sensors, and edge computing for real-time diagnostics and wireless communication (Bluetooth, Zigbee) for remote control. 4.5 IMCC Components and Devices: Intelligent relays, digital fuses, cybersecurity features, dedicated software and advanced control devices. 4.6 Selection of MCC: Comparison between Intelligent and conventional MCC; Energy efficiency, cybersecurity, networking, and automation. Smart power management with power factor correction (PFC) and harmonic filtering for efficiency.	Lecture Using Chalk-Board Video Demonstrations Flipped Classroom Presentations Site/Industry Visit
5	TLO 5.1 Describe the given term(s) related to tariff economics. TLO 5.2 Explain the key factors required for the given type of tariff design. TLO 5.3 Explain the communication technologies used in the given type (s) of smart meters. TLO 5.4 State the relevant MERC rules applicable for Net-metering billing. TLO 5.5 Describe the use of deep learning model and communication methods in MRI / AMR.	**Unit - V Tariff and Smart Billing** 5.1 Tariff: Power purchase, Power purchase agreements (PPA), Power purchase cost. 5.2 Tariff Design: Key factors for tariff design, major components of an electricity bill, various slabs in billing, electricity duty, tax on electricity and cross subsidy. 5.3 Smart Metering: Components working principle, types of smart meters, features, communication technologies, advantages, challenges, role in Grid System. 5.4 Metering and Bill Management: Working of net metering and gross metering, MERC rules for net-metering bill (Latest Amendment), application of net metering for integration of micro-generators with grid system. 5.5 Meter reading techniques: use of deep learning model and communication methods in MRI / AMR.	Lecture Using Chalk-Board Video Demonstrations Flipped Classroom Presentations

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

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

Micro project

- Prepare a report on grid maintenance by using Drone
- Prepare a report on Role of 3D printer in Electrical Model design.

- Prepare a report on Flexible Electricity Billing System
- Prepare a report on Role of Smart CCTV in Smart City

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	Not Applicable	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	Digitization beyond Automation	CO1	12	6	6	2	14
2	II	Smart Grid	CO2	10	6	6	2	14
3	III	Smart City (Electrical Features)	CO3	12	4	6	4	14
4	IV	Intelligent Motor Control Centers	CO4	14	6	6	2	14
5	V	Tariff and Smart Billing	CO5	12	6	6	2	14
Grand Total				**60**	**28**	**30**	**12**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Formative assessment (Assessment for Learning) Two unit tests of 30 marks will be conducted and average of two unit tests considered.

Summative Assessment (Assessment of Learning)

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

XI. SUGGESTED COS - POS MATRIX FORM

EMERGING TRENDS IN ELECTRICAL ENGINEERING **Course Code : 316326**

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

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

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	S K Bhattacharya	Control of Electrical Machines	New Age International ISBN13: 8122409970, 9788122409970
2	Akihiko Yokoyama	Smart Grid: Fundamentals, Design, Technology, Applications, Communication and Security, An Indian Adaptation	Wiley, 1 April 2021 Edition ISBN-13: 978-9354243219
3	Frank D. Petruzella	Electrical Motor Control Systems	McGraw-Hill College, 22 November 2019, ISBN-13: 978-1260439397
4	Merizalde	Encyclopaedia of Applied Intelligent Control of Induction Motor Drives	Auris Reference (1 April 2018) ISBN-13: 978-1788022651
5	P K Pandey	IOT (Internet of things) and Its Application	T Balaji Publication (1 January 2020) ISBN 13:978-8194136385
6	Pandian Vasant	Artificial Intelligence in Industry 4.0 and 5G Technology	Wiley 30 June 2022 ISBN-13: 978-1119798767

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	41.-30.12.2019-Grid-Interactive-RRE-Regulations2019-English. pdf	MERC rules for net-metering bill
2	https://youtu.be/Xpb9XKmRsyw?si=0oLY-lKVyvPWiBSE	History of Industrial Revolution
3	https://www.geeksforgeeks.org/introduction-to-internet-of-things-iot-set-1/	Introduction to Internet of Things (IoT)
4	https://www.researchgate.net/publication/321529309_Sustainable_Smart_Cities_in_India_Challenges_and_Future_Perspectives	Sustainable Smart Cities in India: Challenges and Future Perspectives
5	https://www.iea.org/energy-system/electricity/smart-grids	Electricity smart grid
6	https://electricalengineerpro.com/latest-trends-in-electrical-engineering/	Trends in Electrical Engineering
7	https://www.youtube.com/watch?v=MTqML_JCpsY	Intelligence motor control system for engineers (Hindi)

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EMERGING TRENDS IN ELECTRICAL ENGINEERING **Course Code : 316326**

Sr.No	Link / Portal	Description
8	https://www.youtube.com/watch?v=IEsmG83IxLs	IMCC Drawing, IMCC RDOL Drawing, IMCC Panel drawing, IMCC PRO V DRAWING, IMCC Simocode drawing

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. 04/09/2025 **Semester - 6, K Scheme**

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ENERGY CONSERVATION AND AUDIT **Course Code : 316327**

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

Programme Code : **EE/ EP**

Semester : **Sixth**

Course Title : **ENERGY CONSERVATION AND AUDIT**

Course Code : **316327**

I. RATIONALE

Due to rapid industrialization, urbanization, and population growth, the world is experiencing an increasing demand for electrical energy. The fossil fuels prime source for generation of electrical energy are depleting at faster rate. One unit of saving of electricity is equivalent to two units of electricity generated. Hence conserving energy is responsibility of every citizen. This curriculum enables the diploma students with the skill sets of carrying out energy audit and conserve electrical energy in electrical systems.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry-identified competency through various teaching-learning experiences :

- **Implement energy-saving measures and conduct comprehensive energy audits.**

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Interpret energy conservation policies in India.
- CO2 - Implement energy conservation techniques in electrical machines.
- CO3 - Apply energy conservation techniques in electrical installations.
- CO4 - Use Co-generation and relevant tariff for reducing losses in facilities.
- CO5 - Carryout energy audit for electrical 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	
316327	ENERGY CONSERVATION AND AUDIT	ECA	DSC	4	-	2	2	8	4	3	30	70	100	40	25	10	25#	10	25	10	175

ENERGY CONSERVATION AND AUDIT **Course Code : 316327**

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 Present the current scenario of conventional and non-conventional energy sources in India. TLO 1.2 Differentiate between energy management, energy efficiency, energy conservation and energy audit. TLO 1.3 Explain the salient features of Energy conservation act 2001. TLO 1.4 Describe the role of BEE, MEDA and MNRE. TLO 1.5 Interpret the Star Labeling of the given electrical equipment. TLO 1.6 Explain the Concept of energy conservation and its benefits. TLO 1.7 Describe the key features of ECBC and green buildings.	**Unit - I Fundamentals of Energy Conservation and Management** 1.1 Energy Scenario: Primary and secondary energy sources, energy demand and supply at National level. 1.2 Energy management, energy efficiency, energy conservation and energy audit: Objectives, concepts and difference. 1.3 Energy Conservation Act 2001 with latest amendments: Key provisions and relevant clauses. 1.4 Role of: Bureau of Energy Efficiency (BEE), Maharashtra Energy Development Agency (MEDA) and Ministry of New and Renewable Energy (MNRE). 1.5 Star labeling: Need, significance and benefits. 1.6 Concept of energy conservation and benefits. 1.7 Energy Conservation Building Codes (ECBC) with latest revision, concept of green buildings.	Lecture Using Chalk-Board Flipped Classroom Video Demonstrations Case Study Presentations

ENERGY CONSERVATION AND AUDIT **Course Code : 316327**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Justify the need and significance of energy conservation in induction motor and transformer. TLO 2.2 Enlist the energy conservation techniques for a given three phase induction motor. TLO 2.3 Describe the energy conservation techniques for a given Transformer. TLO 2.4 Describe the key features and working of a given energy conservation equipment. TLO 2.5 Compare energy efficient motor with standard motor. TLO 2.6 Compare energy efficient transformer with standard transformer. TLO 2.7 State the energy conservation strategies in compressors pumps, fans and blowers.	**Unit - II Energy Conservation in Electrical Machines** 2.1 Need and significance of energy conservation in induction motor and transformer. 2.2 Energy conservation techniques in induction motor by: Improving power quality, motor survey, matching motor with loading, minimizing the idle and redundant running of motor, operating in star mode, rewinding of motor, replacement by energy efficient motor, periodic maintenance, by using sensor based motors. 2.3 Energy conservation techniques in transformer: Load sharing, parallel operation, isolating techniques, replacement by energy efficient transformers, periodic maintenance. 2.4 Energy conservation equipment- key features and working of: Soft starters, Automatic star delta convertor, Variable Frequency Drives (VFD). 2.5 Energy efficient motor: Key features, merits, demerits, comparison with standard motor. 2.6 Energy efficient transformers: Amorphous transformers, epoxy resin-cast transformer and dry-type of transformer. 2.7 Methods and techniques of energy conservation in compressors pumps, fans and blowers.	Lecture Using Chalk-Board Flipped Classroom Video Demonstrations Case Study Site/Industry Visit
3	TLO 3.1 Interpret losses in the given power system. TLO 3.2 Explain the method to reduce the specified technical loss in the given electrical installation. TLO 3.3 Explain the method to reduce the specified commercial loss in the given electrical installation. TLO 3.4 Select the relevant energy conservation equipment for the given system with justification. TLO 3.5 Explain energy conservation measures for the specified lighting installation. TLO 3.6 State the energy conservation strategies in fan and regulator. TLO 3.7 Describe energy conservation techniques in EVs and batteries.	**Unit - III Energy conservation in Electrical Installation system** 3.1 Aggregate technical and commercial losses (ATC). 3.2 Technical losses: Causes and remedies-Controlling copper losses, optimizing distribution voltage, balancing phase currents, compensating reactive power flow. 3.3 Commercial losses: Causes and remedies. 3.4 Energy conservation equipment: Maximum Demand Controller, kVAR Controller, Capacitor bank, Automatic Power Factor controller (APFC), Intelligent Power Factor Controller (IPFC) and Active Harmonic Filters (AHF). 3.5 Energy Conservation in Lighting systems: Replacing Lamp sources, using energy efficient luminaries, using light controlled gears, Installation of separate transformer / servo stabilizer for lighting, use of sensors- motion, occupancy, proximity, color, photo sensitive sensors, Periodic survey and adequate maintenance programs. 3.6 Energy conservation techniques in fans, electronic regulators using solid state devices. 3.7 Energy conservation techniques in electric vehicles and batteries.	Lecture Using Chalk-Board Flipped Classroom Case Study Video Demonstrations Site/Industry Visit

ENERGY CONSERVATION AND AUDIT **Course Code : 316327**

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 Enumerate the factors governing the selection of co-generation system. TLO 4.2 Describe suitable type of co-generation system for the given facility. TLO 4.3 Describe the function of combined heat and power (CHP) system in the given facility. TLO 4.4 Explain a given type of tariff structure. TLO 4.5 Describe the suitable tariff system for reducing the electricity bill of a given facility. TLO 4.6 Compare two different tariff structure illustrating electrical energy conserved in a given facility.	**Unit - IV Energy Conservation via Cogeneration and Tariff** 4.1 Co-generation: Concept, factors governing the selection of co-generation system and its advantages. 4.2 Types of co-generation: Based on sequence of energy use: Topping cycle, Bottoming cycle, Based on technology: Steam turbine, Gas turbine and Reciprocating engine co-generation. 4.3 Captive Power Plant: Combined Heat and Power (CHP) system. 4.4 Tariff: Concept from the point of view of energy conservation, Types of tariff structure: LT, HT, Special, Time-off-day, Peak-off-day, Power factor tariff, Maximum Demand tariff, Load factor tariff and Availability Based Tariff (ABT), kVAh tariff, Concept of flexible tariff. 4.5 Application of tariff system to reduce energy bill (Numerical). 4.6 Recent tariff structure of different utilities.	Lecture Using Chalk-Board Flipped Classroom Video Demonstrations Case Study Site/Industry Visit
5	TLO 5.1 Define energy audit and list the benefits. TLO 5.2 Justify significance of specific energy consumption. TLO 5.3 Explain the types of energy audit. TLO 5.4 Suggest relevant instrument (s) for the specified energy audit with justification. TLO 5.5 Develop questionnaire for the energy audit of the given facility. TLO 5.6 Develop the energy flow diagram of the given facility/ apparatus. TLO 5.7 Calculate the Simple Pay Back period, IRR for the facility created. TLO 5.8 Describe energy audit procedure followed. TLO 5.9 Prepare the energy audit report for the given facility/ apparatus. TLO 5.10 Describe the roles and responsibilities of energy manager and auditor.	**Unit - V Energy Audit** 5.1 Energy audit: Definition and its benefits. 5.2 Significance of Specific energy consumption pattern. 5.3 Types of energy audit: Walk through and detailed audit. 5.4 Energy audit instruments and their use: Electrical measuring instruments, power analyzer, lux meter, smart energy meter, fuel efficiency monitor, combustion gas analyzer, thermometer, flow meter and tachometer. 5.5 Questionnaire for energy audit projects. 5.6 Energy flow diagram (Sankey diagram). 5.7 Simple payback period, Internal Rate of Return (IRR) (Numerical). 5.8 Energy Audit procedure. 5.9 Typical Energy Audit report format commonly used in industries. 5.10 Roles and responsibilities of energy manager and auditor.	Lecture Using Chalk-Board Flipped Classroom Video Demonstrations Case Study Site/Industry Visit

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

ENERGY CONSERVATION AND AUDIT **Course Code : 316327**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify star labelled appliances and compare them for various star ratings. LLO 1.2 Compare the data sheet of various star rating appliances.	1	*Identification of star labelled electrical appliances/equipment and compare data sheets of various star labelled ratings.	2	CO1
LLO 2.1 Compare energy consumed by a green building with that of a conventional building. LLO 2.2 Use energy conservation instruments to measure the various electrical parameters.	2	Comparison of energy consumption in a green building with a conventional building using energy conservation instruments.	2	CO1
LLO 3.1 Perform an experiment on three phase induction motor both in star and delta mode. LLO 3.2 Measure the effect of voltage reduction in power consumption.	3	*Determination of reduction in power consumption in star mode operation of 3 phase Induction motor compared to delta mode.	2	CO2
LLO 4.1 Perform load test on three phase induction motor for different loading conditions. LLO 4.2 Plot the graph of efficiency verses percentage loading of induction motor.	4	*Performance of load test on three phase induction motor for different loading conditions and plot the curve.	2	CO2
LLO 5.1 Compare energy conserved in two identical transformers where one is a single-phase transformer, and the other one comprises of two single phase transformers in parallel operation (For the same load). LLO 5.2 Observe the effect of load sharing on energy consumption.	5	Comparison of energy conserved in two identical transformers where one is a single-phase transformer and the other one comprises of two single phase transformers in parallel operation. (For the same load).	2	CO2
LLO 6.1 Improve power factor of given load using APFC. LLO 6.2 Using APFC for improving power factor.	6	Power factor improvement using APFC.	2	CO2 CO3
LLO 7.1 Improve power factor of given load using static capacitor. LLO 7.2 Calculate the value of capacitor to change from initial power factor to desired power factor.	7	*Power factor improvement using static capacitor.	2	CO2 CO3
LLO 8.1 Improve power factor of given load using IPFC. LLO 8.2 Using IPFC for improving power factor.	8	Power factor improvement using IPFC.	2	CO2 CO3
LLO 9.1 Compare power consumption of different types of Tube Light with choke, electronic ballast and LED lamps by direct measurement.	9	*Comparison of power consumption of different types of Tube Light with choke, electronic ballast and LED lamps by direct measurement.	2	CO3
LLO 10.1 Determine the reduction in power consumption by replacement of different lamps in a classroom / laboratory by energy efficient lamps.	10	*Comparison of reduction in power by replacement of lamps in a classroom / laboratory by energy efficient lamps.	2	CO3

ENERGY CONSERVATION AND AUDIT **Course Code : 316327**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 11.1 Suggest suitable tariff for energy conservation and reduction of energy bill for an industrial customer. LLO 11.2 Interpreting electricity bill of an industrial consumer.	11	Tariff for industrial consumer for reducing the electricity bill.	2	CO4
LLO 12.1 Suggest suitable tariff for energy conservation and reduction of energy bill for a commercial customer. LLO 12.2 Interpreting electricity bill of a commercial customer.	12	Tariff for commercial consumer for reducing the electricity bill.	2	CO4
LLO 13.1 Suggest suitable tariff for energy conservation and reduction of energy bill for a residential customer. LLO 13.2 Interpreting electricity bill of a residential customer.	13	*Tariff for residential consumer for reducing the electricity bill.	2	CO4
LLO 14.1 Estimate energy saving by improving power factor and load factor for given case.	14	Estimation of Energy saved by improving power factor and load factor for given case.	2	CO3 CO4
LLO 15.1 Prepare a sample energy audit questionnaire for a given facility.	15	Preparation of Energy audit questionnaire for the given facility.	2	CO5
LLO 16.1 Prepare energy audit report of your electrical department.	16	*Preparation of Energy audit report of electrical department.	2	CO5
LLO 17.1 Perform load test on three phase SCIM using DOL, star delta and soft starter. LLO 17.2 Compare the energy consumption in all three cases.	17	Comparison of energy consumption using DOL, star delta and soft starter in a three-phase induction motor.	2	CO2
LLO 18.1 Carryout energy audit using energy audit software such as SafetyCulture (formally iAuditor) or EnergyCAP. LLO 18.2 Use energy audit software SafetyCulture (formally iAuditor) or EnergyCAP.	18	Energy audit using energy audit software such as SafetyCulture (formally iAuditor), EnergyCAP or any other equivalent software.	2	CO5

Note : Out of above suggestive LLOs -

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

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

Micro project

- Collect electricity bill of your institute and suggest suitable measures for energy conservation and reduction of energy bill.
- Prepare Energy conservation chart using different luminaries.
- Prepare an energy audit report of your department/Institute/Workshop using energy audit instruments.
- Visit MEDA website and enlist various energy conservation schemes. Prepare a presentation highlighting the salient features of any one scheme. (objectives, entitlement, methodology and financial assistance etc.)
- Carry out a case study of at least two nearby industries and prepare a report on energy conservation measures adopted by them.

- Carry out internet survey (BEE) to collect information and prepare a report related to any two energy conservation projects.
- Poster preparation and competition on energy conservation (Visit MEDA website).

Assignment

- Visit a facility adopting cogeneration system and prepare a presentation.
- Estimate the payback period, depreciation cost, for the given energy saving equipment in the transmission and distribution system.
- Prepare a report on maintenance procedure followed for improving efficiency of a given lighting scheme.
- Collect information about energy efficient luminaries and prepare a report on it.
- Write report on performance of motor after rewinding.
- Compile the energy saved in at least five star labeled various appliances and prepare a report.
- Prepare a report on various star labeled equipment.
- Compare the energy conserved by an energy efficient motor with a standard motor and prepare a report.
- Prepare a report on BIS standards related to Energy Conservation

Seminar topics

- Energy conservation act 2001.
- Energy conservation equipment
- Cogeneration and its advantages in energy conservation.
- “Bachat Lamp Yojana” Scheme.
- Energy Audit instruments and their working.
- Energy conservation schemes of Maharashtra.

Visit

- Visit to your nearby market/shop for Identifying star labeled electrical apparatus and compare the data for various star ratings. Prepare a chart and submit the report.
- Visit nearby industry which has a captive power plant and observe the working of Captive power plant its inputs and outputs. Prepare a report and submit with the main focus on energy saved due to captive power plant.

Self-learning topics

- Captive Power Plant
- Demand side management.
- Green buildings.
- Energy conservation initiatives in Agricultural sector.

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	Lux meter	15,16

ENERGY CONSERVATION AND AUDIT **Course Code : 316327**

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
2	Soft starter/ DOL starter/ star delta starter.	17
3	Energy audit software such as SafetyCulture (formally iAuditor), EnergyCAP or any other equivalent open-source software.	18
4	Star delta convertor.	3
5	Induction motor: Single phase/three phase.	3,4
6	Clamp on ammeter.	3,4,5,7,9
7	Ammeter: MI type, AC/ DC 0-5-10Amp.	3,4,5,7,9
8	Voltmeter: MI type, AC/DC, 0-150/300V, 0-250/500V.	3,4,5,7,9
9	Wattmeter: Single phase/three phase, single element/double element, 2.5/5Amp -5/10 Amp, 200/400V -250/500V.	3,4,5,7,9,10,17
10	Multi-function meter.	3,4,5,7,9,10,17
11	Single/ three phase power factor meters: AC, 415V, 50 Hz, 5-10 Amp.	4,7
12	Transformer: Single phase.	5
13	Automatic power factor controller.	6
14	Low power factor wattmeter: Single phase, 5/10Amp, 250/500V.	6,8
15	Load bank.	7
16	Single phase capacitor bank.	7
17	Electronic choke, electronics ballast.	7,9
18	Intelligent power factor controller.	8
19	LED lamp/ tube.	9
20	Tube light (Fluorescent Tube/ CFL)	9

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

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Fundamentals of Energy Conservation and Management	CO1	8	2	2	4	8
2	II	Energy Conservation in Electrical Machines	CO2	14	4	4	6	14
3	III	Energy conservation in Electrical Installation system	CO3	14	2	6	8	16
4	IV	Energy Conservation via Cogeneration and Tariff	CO4	14	4	4	8	16
5	V	Energy Audit	CO5	10	2	6	8	16
Grand Total				**60**	**14**	**22**	**34**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two unit tests, each worth 30 marks, will be conducted, and the average of the two tests will be 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. and the average of all practical will be considered.

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.

ENERGY CONSERVATION AND AUDIT **Course Code : 316327**

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	1	-	2	-	3			
CO2	3	2	2	1	2	1	3			
CO3	3	3	3	2	2	1	3			
CO4	3	3	3	2	2	1	3			
CO5	3	3	3	3	2	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	Bureau of Energy Efficiency (BEE)	Guidebooks no. 1 to 4 for National Certification Examination for Energy Managers and Energy Auditors	Bureau of Energy Efficiency (A Statutory body under Ministry of Power, Government of India) (Fourth Edition 2015)
2	Dr. Sanjeev Singh, Dr. Umesh Rathore	Energy Management	S K Kataria & Sons, New Delhi. ISBN-13: 9789350141014
3	V.K.Mehta and Rohit Mehta	Principles of Power System	S. Chand & Co. New Delhi, 2022, ISBN: 9789355010773
4	Anil Kumar, Om Prakash, Prashant Singh Chauhan, Samsher Gautam	Energy Management Conservation and Audits	CRC Press, 2020, ISBN: 9780429325458
5	Stephan A. Roosa, Steve Doty, Wayne C. Turner	Energy Management Handbook	Fairmount Press, New York 2020 ISBN: 9781003151364
6	Murphy W.R.	Energy Management	Butterworth-Heinemann Publication, ISBN: 9788131207383.
7	K.V. Sharma, P. Venkataseshaiah.	Energy Management and Conservation	I K International Publishing House Pvt. Ltd; 2011 ISBN 9789381141298
8	Yogendra V. Talware.	Art of reading Electricity bills.	Dnyatavya Prakashan

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://mnre.gov.in/	Information about new and renewable energy.
2	https://powermin.gov.in/	Indian power scenario.
3	https://aipnpc.org/Guidebooks.aspx	BEE guidebooks 01 to 04.
4	https://akshayurja.gov.in/res/renw-all-india-cp	Akshay Urja Ministry of New and Renewable Energy (MNRE)
5	https://www.mahaurja.com/meda/en/energy_conservation/energy_conservation_program	Energy Conservation Schemes in Maharashtra state (MEDA)

ENERGY CONSERVATION AND AUDIT **Course Code : 316327**

Sr.No	Link / Portal	Description
6	https://www.eia.gov/totalenergy/	U S Energy information administration.
7	https://beeindia.gov.in/sites/default/files/ECBC%20User%20Guide%20V-0.2%20(Public).pdf	Energy Conservation Building Code User Guide.
8	https://iiec.org/	International Institute for Energy Conservation (IIEC)
9	https://cea.nic.in/	Central Electricity Authority

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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MAINTENANCE OF ELECTRICAL EQUIPMENTS **Course Code : 316328**

Programme Name/s : **Electrical Engineering/ Electrical Power System**
Programme Code : **EE/ EP**
Semester : **Sixth**
Course Title : **MAINTENANCE OF ELECTRICAL EQUIPMENTS**
Course Code : **316328**

I. RATIONALE

The electrical engineering technologist is required to carry out the maintenance of the electrical machines and equipment, which includes installation, testing and commissioning. S/he is thus expected to use the relevant skill sets while working in the industry, commercial establishments, and public utility departments such as PWD, irrigation, electricity supply agencies, water supply and sewage board etc. This course aims the students with the skills to inspect various types of installations and test electrical machines as per prevailing standard practices. S/he will also be able to carry out maintenance activities of different types of electrical equipment. S/he will follow the relevant safety practices during such activities.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences: Maintain different types of electrical equipment following safe practices.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Follow safety norms to prevent accidents while using electrical equipment.
- CO2 - Test electrical equipment.
- CO3 - Maintain rotating electrical machines.
- CO4 - Maintain single phase and three phase transformers.
- CO5 - Maintain insulation systems of electrical equipment.

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	
316328	MAINTENANCE OF ELECTRICAL EQUIPMENTS	MEE	DSC	4	-	4	2	10	5	3	30	70	100	40	25	10	25#	10	25	10	175

MAINTENANCE OF ELECTRICAL EQUIPMENTS **Course Code : 316328**

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 hazards, safety actions for the given situation. TLO 1.2 Explain the importance of accident prevention. TLO 1.3 Describe the responsibilities and the monitoring actions of the supervisor in the given hazardous or accident situation. TLO 1.4 Describe the operating procedural steps of the given types of fire extinguishers. TLO 1.5 State the principle characteristics and related precautions for safety of equipment earthed by the specified clause. TLO 1.6 State the reasons behind failure of the given electrical equipment. TLO 1.7 State the role of Bureau of Indian Standards in testing, importance of ISI mark in testing and maintenance of electrical equipment.	**Unit - I Safety and prevention of accidents** 1.1 Hazards, accidents, safety 1.2 Dos and Don’ts for electrical supervisors. 1.3 Electric shock: factors influencing severity of shock, rescuing a person from electric shock, different CPR Technique to employed under accidental condition. 1.4 Artificial respiration: types & procedures. 1.5 Precautions against electric fire. 1.6 Types of fire extinguishers, “PASS” & “RACE” in case of fire. 1.7 Objectives of earthing. Earthing of electrical equipment as per IS 3043-1987 1.8 Protection of electrical equipment against electric shock (class 0 to class III). 1.9 Causes of failure of electrical Equipment: internal and external 1.10 Role of BIS in testing of electrical Equipment.	Lecture Using Chalk-Board Model Demonstration Video Demonstrations Case Study Collaborative learning Hands-on Site/Industry Visit

MAINTENANCE OF ELECTRICAL EQUIPMENTS **Course Code : 316328**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Explain the objectives of the testing. TLO 2.2 Describe the procedure of the given testing methods. TLO 2.3 Explain the importance of the given categories of tests. TLO 2.4 Explain the importance of tolerance. TLO 2.5 Explain meaning and importance of ingress protection. TLO 2.6 Explain significance of maintenance of electrical equipment. TLO 2.7 State the given type(s) of maintenance technique. TLO 2.8 Explain the given factor(s) affecting preventive maintenance. TLO 2.9 Describe the procedures for developing preventive maintenance schedule. TLO 2.10 Explain the steps in preparing foundation for the given type of rotating machine. TLO 2.11 Suggest tools for maintenance of the given rotating machine.	**Unit - II Testing and Maintenance** 2.1 Objectives of testing. 2.2 Methods of testing : direct, indirect and regenerative. 2.3 Categories of Tests: routine, type, special and supplementary tests. 2.4 Tolerance. 2.5 Ingress protection, IP marking. 2.6 Significance of maintenance of electrical equipment. 2.7 Types of maintenance-routine, preventive, breakdown maintenance. 2.8 Factors affecting the preventive maintenance schedule. 2.9 Procedure for developing preventive maintenance schedule. 2.10 Foundations: requirements and factors affecting rotating machine foundation. 2.11 Tools/instruments: bearing puller, filler gauge, dial indicator, spirit level, megger, earth tester, growler, test lamps, multimeter, spanner sets, and screwdrivers.	Lecture Using Chalk-Board Presentations Video Demonstrations Model Demonstration Flipped Classroom Collaborative learning Case Study
3	TLO 3.1 Describe the procedural steps to be followed as per IS code of practice for maintenance of the given machine. TLO 3.2 Describe the procedural steps to be followed as per IS code of practice for testing of the given induction motor. TLO 3.3 Describe the procedural steps to be followed as per IS code of practice for testing of the given three - phase alternator and synchronous motor. TLO 3.4 Prepare the trouble shooting chart for the given type of induction motor.	**Unit - III Procedure for developing preventive maintenance schedule of Rotating Machines** 3.1 Recommended maintenance schedules: Single phase and three phase induction motors (IS 900 – 1992), three phase alternators and synchronous motors. 3.2 Induction motor testing: Routine, type and special test of single phase induction motor as per IS 7572 – 1974 and three phase induction motor as per IS4029 -2010. 3.3 Alternator and synchronous motor testing: Routine, type and special test of three phase alternator and synchronous motor as per IS 7132-1973. 3.4 Trouble shooting chart for single phase and three phase induction motor (IS 900 – 1992).	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom Collaborative learning Case Study Site/Industry Visit

MAINTENANCE OF ELECTRICAL EQUIPMENTS **Course Code : 316328**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Describe the procedural steps to be followed as per IS code of practice for maintenance of the given transformer. TLO 4.2 Explain the specified test with its purpose and identify the terminals of a given type of transformer. TLO 4.3 Describe the procedural steps to be followed for finding voltage ratio of given transformer by various methods. TLO 4.4 Describe the Polarity test, Phasing out test, Back to Back test of given transformer. TLO 4.5 Prepare the trouble shooting chart for single phase and three phase transformers. TLO 4.6 Suggest the foundation requirement with sketch for the given type of transformer.	**Unit - IV Testing and trouble shooting of transformers** 4.1 Recommended maintenance schedules: transformers (IS 10028, part III – 1981) 4.2 Routine, type, supplementary, special tests of transformers, nomenclature of transformer terminals as per IS 2026-1981. 4.3 Measurement of voltage ratio by ratio meter, standard transformer, turn testing method. 4.4 Polarity test. 4.5 Phasing out test. 4.6 Back to Back test. 4.7 Trouble-shooting chart for single phase and three phase transformers. 4.8 Foundations: requirements for static machine foundations, factors governing them as per IS 10028 part 2.	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom Collaborative learning Site/Industry Visit Case Study
5	TLO 5.1 Classify the insulation material for electrical equipment as per IS code of practice. TLO 5.2 State the factors affecting the life of insulating material. TLO 5.3 Describe the procedural steps to be adopted for measurement of insulation resistance by different methods. TLO 5.4 State the different properties and contaminating agents of transformer oil. TLO 5.5 Describe the procedural steps to be followed as per IS code of practice for testing of transformer oil. TLO 5.6 Describe the various methods of purification, cleaning of transformer oil and drying and re-varnishing of transformer windings. TLO 5.7 Prepare the sample history sheet for the specified electrical machine.	**Unit - V Testing and reconditioning of electrical machine insulation** 5.1 Classification of insulating materials as per IS 8504- 1994. 5.2 Factors affecting life of insulating materials. 5.3 Measurement of insulation resistance by megger, voltmeter, dielectric absorption, polarisation index. 5.4 Transformer oil: properties, contaminating agents. 5.5 Testing of transformer oil as per IS 1866 : Dielectric strength test, acidity test, sludge test, crackle test, flashpoint and fire point test. 5.6 Reconditioning of insulation: centrifugal purifiers, streamline filter (Vacuum type) for purification and filtering of insulating oil. Cleaning and drying, re-varnishing, construction and working of vacuum Impregnation plant. 5.7 History sheets of transformers and induction motors: [Part A: machine specifications with component specifications (installation information, bearings, oil type, core weight etc. as applicable); Part B: date wise: observations of parameters such as voltage, current, temperature etc., symptoms, works carried out under maintenance).	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom Collaborative learning Case Study

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

MAINTENANCE OF ELECTRICAL EQUIPMENTS **Course Code : 316328**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Use fire extinguishers to extinguish the fire.	1	* Demonstration of Fire extinguisher available in the institute.	2	CO1
LLO 2.1 Apply artificial respiration in case of emergency.	2	* Demonstration of artificial respiration (Any convenient method).	2	CO1
LLO 3.1 Measure earth resistance.	3	* Measurement of earth resistance of electrical laboratory equipment.	2	CO1
LLO 4.1 Identify protective class of a given electric equipment.	4	*Protective class of a given electric equipment.	2	CO1
LLO 5.1 Get acquainted with the procedure for getting ISI mark.	5	* Visit BIS portal (bis.gov.in) for getting ISI mark/obtaining a license for electrical equipments and prepare a report for it.	4	CO1
LLO 6.1 Use tools/accessories applicable in the process. LLO 6.2 Identify the parts of a given motor.	6	* Dismantle and reassemble the given electrical machine and identify the various parts.	2	CO2
LLO 7.1 Use testing instrument for testing electrical equipment.	7	* Use of instruments for testing/maintenance of given electrical equipment.	2	CO2
LLO 8.1 Test given LED for ingress of water to confirm the IP rating.	8	* Testing of given 70 W or higher rating LED for ingress of water to confirm the IP rating	2	CO2
LLO 9.1 Carryout maintenance activities suggested in IS: 900-1992(Annex G) at 5,6,7 and 8 for maintenance of induction motors.	9	Maintainance of given induction motor.	2	CO3
LLO 10.1 Carryout maintenance activities suggested in IS: 10028- part 3 at 1,2,3 and 4for maintenance of transformer.	10	Maintainance of given transformer.	2	CO4
LLO 11.1 Identify the parts of single-phase induction motor. LLO 11.2 Rectify the basic faults in given single phase induction motor	11	Diagnosis and rectification of faults for a ceiling fan running slow.	1	CO3
LLO 12.1 Identify the parts of single-phase induction motor. LLO 12.2 Rectify the basic faults in given single phase induction motor.	12	Diagnosis and rectification of faults for a ceiling fan running in reverse direction.	2	CO3
LLO 13.1 Test the insulation condition of single-phase induction motor (before and after no load running)	13	Measurement of winding resistance of a single-phase induction motor by V-I method.	2	CO3
LLO 14.1 Test the three phase induction motor before commissioning.	14	* Reduced voltage running up test of three phase induction motor	2	CO3
LLO 15.1 Test the insulation condition of three phase induction motor (before and after no load running).	15	Measurement of phase winding resistance of a three-phase induction motor by V-I method.	2	CO3
LLO 16.1 Test the insulation condition of three phase induction motor (before and after conducting brake test).	16	Measurement of phase winding resistance of a three-phase induction motor by V-I method.	2	CO3
LLO 17.1 Identify primary and relevant secondary windings of transformer.	17	* Phasing out test of the three-phase transformer.	2	CO4
LLO 18.1 Identify the polarity of transformer windings.	18	* Polarity test of three phase transformer.	2	CO4

MAINTENANCE OF ELECTRICAL EQUIPMENTS **Course Code : 316328**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 19.1 Apply regenerative method of testing.	19	Back-to-Back test on two identical single-phase transformers.	2	CO4
LLO 20.1 Test the dielectric strength of transformer oil. LLO 20.2 Using transformer testing oil kit.	20	Dielectric strength test of transformer oil.	2	CO5
LLO 21.1 Insulation resistance and dielectric strength of the windings in a single-phase induction motor applying high-voltage, ensuring that the motor can withstand operational voltage without failure	21	Test insulation resistance and dielectric strength of the windings of a single-phase induction motor.	2	CO5
LLO 22.1 Insulation resistance and dielectric strength of the windings in a three-phase induction motor by applying high-voltage, ensuring that the motor can withstand operational voltage without failure	22	Test insulation resistance and dielectric strength of the windings of a three-phase induction motor.	2	CO5
LLO 23.1 Measure insulation resistance of single-phase induction motor.	23	Measurement of insulation resistance of single-phase induction motor.	2	CO5
LLO 24.1 Measure insulation resistance of three phase induction motor.	24	Measurement of insulation resistance of three phase induction motor.	2	CO5
LLO 25.1 Measure insulation resistance of single phase transformer.	25	Measurement of insulation resistance of single-phase transformer.	2	CO5
LLO 26.1 Measure insulation resistance of three phase transformer.	26	Measurement of insulation resistance of three phase transformer.	2	CO5

Note : Out of above suggestive LLOs -

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

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

SUGGESTED STUDENT ACTIVITIES

- Prepare report for step-by-step procedure to be followed for artificial respiration to be given to shock affected person.
- Prepare power point presentation on testing of Induction motor as per IS.
- Prepare power point presentation related to foundation of transformers.
- Collect sample of various class of insulating materials and prepare a chart of it.
- Prepare report for step-by-step procedure to be followed for VFD maintenance.

Assignment

- Elaborate various cooling methods of alternator.
- Prepare excel sheet for carrying out preventive maintenance schedule on any machine in lab.
- Elaborate Cable insulation HV test and cable conductor resistance measurement test using LCR meter.
- Collect information and prepare report on MSEDCL transformer maintenance.
- Elaborate various motor winding temperature measurement methods.
- Elaborate various transformer cooling methods.

Micro project

- Collect information on safety signs used for electrically hazardous areas and prepare charts for display in the laboratory or work place.
- Collect information on CPR Technique and prepare charts for display in the laboratory or work place.

MAINTENANCE OF ELECTRICAL EQUIPMENTS **Course Code : 316328**

- Visit electrical machine manufacturing unit and collect data of various tests conducted on it and submit a detailed report.
- Prepare a report on diagnosis of transformer oil sample by conducting various tests on it and submit a detailed report.
- Collect information of specifications, uses, cost of various tools and equipment needed for carry out maintenance of different electrical machines submit a detailed report.

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	Fire extinguisher (powder type)	1
2	400V/230V, 50 Hz, 3-phase transformer with all phase winding terminals brought out for connections (suitable output in range of 2 kVA to 4 kVA).	10
3	Ceiling fan	11,12
4	AC-DC Ammeter range (0-2.5-5-10A) .	15,16,14
5	AC-DC Voltmeter Range (0-75/150/300V, 0 - 300V /600 V)	15,16,14
6	Single phase auto transformer 0-270 V, 15 A, input single phase, 230 V.	17,18,19
7	Three phase auto transformer 0-450 V, 15 A, input 3 phase, 400 V.	17,18,19
8	At least two identical 230 V/115 V or 400 V/ 230 V 50 Hz, 1 or 2 kVA single phase transformers.	18
9	Dielectric oil testing kit (with input at 230 V).	20
10	HV test kits for motors up-to 400 V.	21,22
11	Earth Resistance tester	3
12	230 V, 50 Hz, single phase capacitor start cage type induction motor (suitable available HP)	6,9
13	3-phase 5 HP, 400 V, 50 Hz, 1500 RPM squirrel cage induction motor with brake load arrangement as required.	6,9
14	Bearing puller, filler gauge, dial indicator, spirit level, megger, earth tester, growler, test lamps, multimeter, spanner sets, and screwdrivers.	7
15	LED lamp (70 W or higher rating)	8
16	3-phase 400V, 50 Hz, 1500 RPM slip ring induction motor about 5 HP.	9
17	Tachometers 0-5000 RPM minimum.	9,11,12,21,22
18	A.C. Watt meters: 0-300/600 V, 5/10 A or 10/20 A as needed.	9,11,12,21,22
19	LPF Wattmeter, 0-300/600 V, 1A to 2A.	9,11,12,21,22

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	Safety and prevention of accidents	CO1	8	2	4	4	10

MAINTENANCE OF ELECTRICAL EQUIPMENTS **Course Code : 316328**

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
2	II	Testing and Maintenance	CO2	18	4	6	10	20
3	III	Procedure for developing preventive maintenance schedule of Rotating Machines	CO3	8	2	4	4	10
4	IV	Testing and trouble shooting of transformers	CO4	18	4	4	12	20
5	V	Testing and reconditioning of electrical machine insulation	CO5	8	2	2	6	10
Grand Total				**60**	**14**	**20**	**36**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- 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.
- Two unit tests of 30 marks will be conducted and an average of two unit tests considered.

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	3	2	3	3	-	3			
CO2	3	3	2	3	2	2	3			
CO3	3	3	2	3	2	2	3			
CO4	3	3	2	3	2	2	3			
CO5	3	3	2	3	2	2	3			

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

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Bhattacharya S. K.	Electrical Machines	McGraw Hill Education. New Delhi, ISBN : 9789332902855
2	Theraja B.L.	Electrical Technology Vol-II (AC and DC machines)	S.Chand and Co.Ltd., New Delhi ISBN : 9788121924375
3	Bandyopadhyay M. N.	Electrical Machines Theory and Practice	PHI Learning Pvt. Ltd., New Delhi, ISBN :9788120329973 VI

MAINTENANCE OF ELECTRICAL EQUIPMENTS **Course Code : 316328**

Sr.No	Author	Title	Publisher with ISBN Number
4	Jean-Claude Trigeassous	Electrical Machine Diagnosis	John Wiley & Sons, IncISBN:978-1-84821-263-3.

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=w4jHpHoYZhk	How to Use a Fire Extinguisher
2	https://www.youtube.com/watch?v=wrawEAaJrrY	Artificial respiration methods
3	https://www.youtube.com/watch?v=CvuDFgFFOa8	Fundamentals of Transformer Commissioning and Maintenance Testing
4	https://www.youtube.com/watch?v=ntOc4h792UE	Motor Maintenance & Troubleshooting
5	https://www.youtube.com/watch?v=uMxK6djp_rI	Electric Motor Repair & Rebuild Instructions
6	https://youtu.be/JvsPnGbUH5M	power transformer oil filtration and treatment
7	https://nptel.ac.in/	Relevant information from NPTEL
8	https://www.electricaltechnology.org/	Relevant information
9	https://www.electrical4u.com/	Relevant information

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. 04/09/2025 **Semester - 6, K Scheme**

MANAGEMENT **Course Code : 315301**

Programme Name/s	**: Architecture Assistantship/ Architecture and Interior Design/ Automobile Engineering./ Artificial Intelligence/ Agricultural Engineering/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Architecture/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Software Technology/ Computer Science & Engineering/ Fashion & Clothing Technology/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Food Technology/ Computer Hardware & Maintenance/ Instrumentation & Control/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Instrumentation/ Interior Design & Decoration/ Interior Design/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Medical Laboratory Technology/ Manufacturing Technology/ Medical Electronics/ Metallurgical Engineering/ Production Engineering/ Printing Technology/ Polymer Technology/ Surface Coating Technology/ Computer Science/ Textile Technology/ Electronics & Computer Engg.**
Programme Code	**: AA/ AD/ AE/ AI/ AL/ AN/ AO/ AT/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CST/ CW/ DC/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ FC/ HA/ IC/ IE/ IF/ IH/ IS/ IX/ IZ/ LE/ ME/ MK/ ML/ MRT/ MU/ MY/ PG/ PN/ PO/ SC/ SE/ TC/ TE**
Semester	**: Fifth / Sixth**
Course Title	**: MANAGEMENT**
Course Code	**: 315301**

I. RATIONALE

Effective management is the cornerstone of success for both organizations and individuals. It empowers diploma engineers/ professionals to accomplish their tasks with finesse and efficiency through strategic planning and thoughtful execution, projects can optimize finances, enhance safety measures, facilitate sound decision-making, foster team collaboration and cultivate a harmonious work environment. The diploma engineers require leadership and management skills with technical knowledge of the core field to carry out various tasks smoothly. This course aims to instill fundamental management techniques, empowering diploma engineers/ professionals to enhance their effectiveness in the workplace.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified outcome through various teaching learning experiences: Apply the relevant managerial skills for achieving optimal results at workplace.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Use relevant management skills to handle work situation
- CO2 - Apply appropriate techniques of product, operations and project management
- CO3 - Use comprehensive tools of recent management practices
- CO4 - Plan suitable marketing strategy for a product / service
- CO5 - Utilize supply chain and human resource management techniques for effective management

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

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MANAGEMENT **Course Code : 315301**

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	
315301	MANAGEMENT	MAN	AEC	3	-	-	1	4	2	1.5	30	70*#	100	40	-	-	-	-	25	10	125

Total IKS Hrs for Sem. : 1 Hrs

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

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

Note :

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

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Justify the importance of management thoughts in Indian knowledge system. TLO 1.2 Describe the importance of management in day to day life. TLO 1.3 Explain Henry Fayol’s principles of management. TLO 1.4 Describe the role of each level of management in its management hierarchy. TLO 1.5 Practice the self management skills for a given situation TLO 1.6 Apply the required managerial skills for a given situation	**Unit - I Introduction to Management** 1.1 Evolution of management thoughts from ancient/medieval to modern times in India (IKS) 1.2 Management: meaning, importance, characteristics, functions & challenges. 1.3 Introduction to scientific management- Taylor's & Fayol's principles of management 1.4 Levels & functions of management at supervisory level. 1.5 Self management skills: Self awareness, self discipline, self motivation, goal setting, time management, decision making, stress management, work life balance and multitasking 1.6 Overview of Managerial Skills: negotiation skills, team management, conflict resolution, feedback, leadership	Presentations Case Study Interactive session Quiz competition Mixed Picture Puzzle

MANAGEMENT **Course Code : 315301**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Identify the appropriate creativity technique for new product development TLO 2.2 Describe the new product development process for a product / service TLO 2.3 Comprehend the importance of various strategic steps Product Management TLO 2.4 Elaborate Agile product management TLO 2.5 Explain the significance of the Project Management TLO 2.6 Describe the various tools of project management	**Unit - II Product, Operations and Project Management** 2.1 Creativity and innovation management: creativity techniques - brainstorming, checklist, reverse brainstorming, morphological analysis, six thinking hats. 2.2 New product development, change management 2.3 Product Management -meaning, strategic steps for sustainable design of a product 2.4 Agile product management- concept, benefits, principles and manifesto 2.5 Project Management: importance, areas within project management,4Ps and phases 2.6 Tools of Project Management: PERT and CPM, GANTT & Chart Overview of Estimate and Budget	Presentations Case Study Video Demonstrations Presentations Role Play
3	TLO 3.1 Understand the importance of quality management tools TLO 3.2 Explain the importance of various techniques for optimization and waste minimization TLO 3.3 State the importance of ISO quality standards TLO 3.4 Describe ERP TLO 3.5 State the importance of ISO TLO 3.6 Recognize the importance of customer satisfaction as a competitive advantage	**Unit - III Management Practices** 3.1 Quality circle, kaizen, Six Sigma, TQM 3.2 5S, Kanban card system, TPM, Lean Manufacturing: Meaning, Steps and Importance 3.3 Quality Standards and ISO: Meaning, ISO 9001:2016, ISO 14000, OSHA 2020 3.4 The overview of ERP along with example 3.5 Service quality and customer/client satisfaction, servicescape	Presentation Case study Interactive session Quiz Video Demonstration Lecture Using Chalk-Board
4	TLO 4.1 Explain the importance of marketing techniques TLO 4.2 Explain the importance of needs, wants and desires in marketing TLO 4.3 Interpret the traditional and digital marketing techniques TLO 4.4 Plan different aspects of an event management	**Unit - IV Marketing Management** 4.1 Marketing management: meaning, significance, Seven P's of Marketing 4.2 Needs, wants and demands in marketing. Customer relationship management 4.3 Types of marketing: traditional and digital marketing 4.4 Event management: types, different aspects of event management, crisis management	Case Study Interactive session based video Role Play Flipped Classroom Presentations

MANAGEMENT **Course Code : 315301**

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 State the importance of supply chain and logistics management TLO 5.2 Explain the components of supply chain and logistics Management TLO 5.3 Describe the role of information technology in supply chain & logistics management TLO 5.4 State the significance of Human Resource Management TLO 5.5 Analyze the various methods of recruitment, selection and training for an organization TLO 5.6 List the qualities of a successful supervisor	**Unit - V Supply Chain & Human Resource Management** 5.1 The overview of Supply Chain and logistics Management 5.2 Components of Supply Chain and logistics Management 5.3 Role of information technology in supply chain & logistics management 5.4 Overview of Human Resource Management-Meaning,significance,scope and principles 5.5 Recruitment, selection and training of human resources. Chalk Circle 5.6 Qualities of a successful supervisor /team leader and types of leadership	Presentations Video Demonstrations Case Study Collaborative learning Video Demonstrations Chalk-Board

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 / Article

- Make a one page note based on a book of management you read.
- Write a short article on inventory management exploring online learning resources.
- Prepare a report on ISO standards applicable to your field. a. IATF 16949-2016 / SLA-TS 16949-2016, - Automotive Industry b. ISO 22000 — Food safety management c. ISO 50001 — Energy management d. ISO/IEC 27001 - Cyber Security e. ISO/DIS 4931-1 - Buildings and civil engineering works
- Prepare a 4 quadrant matrix of time management for managing the tasks.
- Prepare a report on any one software used for Supply Chain and Logistics Management.
- Prepare a GANTT Chart for project management related to your field.

Note Taking

- Watch a Tedx Talk Video on managerial skills and take notes in the form of keywords.

Case Study

- Prepare a case study and discuss the same on following topics a.Self Management Skills b.Six Thinking Hats c.Kaizen d.Quality Circle e.Safety Measures in different organizations related to your field
- Study the recruitment and selection process of any organization related to your field.
- Prepare a case study on management lessons based on life of Chhatrapati Shivaji Maharaj
- Conduct outbound training on managerial skills. Make a video and upload on social media.

Quizes

- Participate in online quizzes related to areas of management .

Assignment

- Workshops to be conducted for students on following topics a. creativity techniques b. time management c. stress management d. negotiation and conflict e. goal setting f. meditation new product development

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	Introduction to Management	CO1	13	8	6	4	18
2	II	Product, Operations and Project Management	CO2	8	2	4	6	12
3	III	Management Practices	CO3	8	4	4	6	14
4	IV	Marketing Management	CO4	8	2	4	6	12
5	V	Supply Chain & Human Resource Management	CO5	8	4	4	6	14
Grand Total				**45**	**20**	**22**	**28**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- MCQ Based Class Test, Self Learning Activities / Assignment

Summative Assessment (Assessment of Learning)

- Summative Assessment (Assessment of Learning) MCQ based

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

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CO1	1	1	1	-	-	2	3			
CO2	1	3	3	-	1	3	3			
CO3	1	3	1	-	1	1	3			
CO4	1	2	2	-	1	2	3			
CO5	1	1	2	-	1	2	3			

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

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	A. K. Gupta	Engineering Management	S. Chand, ISBN: 81-219-2812-5, 2007, 2nd Edition
2	O. P. Khanna	Industrial Engineering &management	Dhanpat Rai Publication, ISBN: 978-8189928353, 2018
3	Harold Koontz and Heinz Weinrich	Essentials of Management	Tata McGraw Hill Education ISBN: 9789353168148, 2020, 12th edition
4	E. H. McGrath	Basic Managerial Skills for All	PHI ISBN: 978-8120343146, 2011, 9th Edition
5	Andrew DuBrin	Management Concepts and Cases	Cengage Learning, ISBN: 978-8131510537, 2009, 9th edition
6	K. Dennis Chambers	How Toyota Changed the World	Jaico Books ISBN: 978-81-8495-052-6, 2009
7	Jason D. O'Grandy	How Apple changed the Wolrd	Jaico Publishing House ISBN: 978-81-8495-052-0, 2009
8	Subhash Sharma	Indian Management	New Age International Private Limited ; ISBN-978-9389802412, 2020, 1st edition
9	Chitale, Dubey	Organizational Behaviour Text and Cases	PHI LEARNING PVT. LTD., ISBN: 978-9389347067, 2019, 2nd Edition

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.debonogroup.com/services/core-programs/six-thinking-hats/	Six Thinking Hats
2	https://hbr.org/1981/09/managing-human-resources	HR Management
3	https://theproductmanager.com/topics/agile-product-management/	Agile Product Management
4	https://www.cdlogistics.ca/freight-news/the-5-components-of-supply-chain-management	Supply Chain Management
5	https://www.infosectrain.com/blog/understanding-the-concepts-of-gantt-chart-and-critical-path-methodology-cpm	PERT, CPM, GANTT Chart
6	https://www.simplilearn.com/best-management-tools-article	Management Tools
7	https://www.psychometrica.in/free-online-psychometric-tests.html	Psychometric Tests
8	https://www.investopedia.com/terms/e/erp.asp	ERP
9	https://asq.org/quality-resources/quality-management-system	QMS
10	https://testlify.com/test-library/creative-thinking/	Psychometric Tests
11	https://www.mindtools.com/	Management Skills
12	https://www.investopedia.com/terms/d/digital-marketing.asp	Digital Marketing

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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MANAGEMENT **Course Code : 315301**

MSBTE Approval Dt. 24/02/2025 **Semester - 5 / 6, K Scheme**

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POWER SYSTEM ANALYSIS **Course Code : 316331**

Programme Name/s : **Electrical Engineering/ Electrical Power System**
Programme Code : **EE/ EP**
Semester : **Sixth**
Course Title : **POWER SYSTEM ANALYSIS**
Course Code : **316331**

I. RATIONALE

Power system Analysis is a core subject in electrical engineering, which includes transmission line parameters calculations, Power flow analysis analytically & graphically and load flow study. The Electrical Engineering diploma pass outs working in power sector should be able to analyze transmission lines performance with the concept of 'Generalized Circuit theory'. They should also be able to control and maintain voltages and other parameters like active and reactive power flow on different buses of power system at desired level. This course is important for diploma electrical engineers who wish to work in power generation, transmission and distribution companies to handle different activities in power system.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following industry-identified competency through various teaching-learning experiences ;

- **Analyze the performance of power system networks**.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Calculate Inductance and Capacitance for different types of transmission lines.
- CO2 - Use generalized circuit theory principles for calculations of transmission line performance
- CO3 - Estimate the power at sending and receiving ends of transmission line.
- CO4 - Analyze the performance of transmission lines graphically
- CO5 - Interpret the data required for Load flow studies

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	
316331	POWER SYSTEM ANALYSIS	PSA	DSE	3	-	2	1	6	3	3	30	70	100	40	25	10	25#	10	25	10	175

POWER SYSTEM ANALYSIS **Course Code : 316331**

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

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

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Explain the significance of analysing the given power system. . TLO 1.2 Describe role of power system engineer for analysing the given power system. TLO 1.3 Describe the impact of given parameter in transmission line performance. TLO 1.4 Develop the equation for inductance/capacitance of the given transmission line TLO 1.5 Calculate inductance / capacitance of the given single-phase line with given configuration TLO 1.6 Evaluate Self Geometric Mean Distance(GMD) and Mutual GMD for the given conductor configuration. TLO 1.7 Estimate the inductance/capacitance of three phase line for the given conductor arrangement. TLO 1.8 Estimate the capacitance of line by considering effect of earth field	**Unit - I Transmission Lines Components** 1.1 Aspects of power system analysis and Role of power system engineer. 1.2 Significance of Transmission line Components –Resistance, Inductance, Capacitance and Conductance 1.3 Inductance-Single phase line composed of solid conductors and bundled conductors. 1.4 Geometric Mean Distance (GMD) - Concept of Self GMD and Mutual GMD 1.5 Inductance of three phase line (single circuit) composed of solid conductors with symmetrical and asymmetrical spacing. 1.6 Concept of Potential difference between two conductors placed in a group of parallel conductors , Capacitance of single-phase line composed of solid Conductors and Duplex bundled conductors. 1.7 Capacitance of three phase line (single circuit) with symmetrical and asymmetrical spacing 1.8 Effect of earth field on transmission line capacitance.by method of Images	Lecture Using Chalk-Board Flipped Classroom Case Study Presentations

POWER SYSTEM ANALYSIS **Course Code : 316331**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Explain the concept of generalized circuit for the given type transmission line. TLO 2.2 Calculate the Generalized Circuit Constants (GCC) for the given type transmission line. TLO 2.3 Develop resultant generalized network of the given type combination of networks. TLO 2.4 Describe the benefits of generalised circuit representation of the given type of transmission line.	**Unit - II Generalized circuit representation** 2.1 Generalized Circuit – Concept. 2.2 Generalized circuit constants (GCC) of short, medium transmission line. 2.3 Generalized circuit constants (GCC) of two networks connected in series. 2.4 Generalized circuit constants (GCC) of two networks connected in parallel. 2.5 Advantages of Generalized circuit representation.	Lecture Using Chalk-Board Flipped Classroom Case Study Presentations
3	TLO 3.1 Explain the concept of complex power with reference to the given power system. TLO 3.2 Develop the expression for complex power at given end of the given transmission line. TLO 3.3 Calculate the real/reactive power at given end of given transmission line for the given loading condition. TLO 3.4 Derive the condition for maximum real power flow of given end of the given transmission line	**Unit - III Power flow** 3.1 Complex Power (S=V I*), Real Power and reactive Power. 3.2 Derivation for Complex power, real power, reactive power for receiving end of the transmission line using Generalized Circuit Equation (GCE). 3.3 Derivation for Complex power, real power, reactive power for sending end of the transmission line using Generalized Circuit Equation (GCE). 3.4 Condition for maximum power at receiving end of transmission line. 3.5 Condition for maximum power at sending end of transmission line	Lecture Using Chalk-Board Flipped Classroom Case Study Presentations Video Demonstrations
4	TLO 4.1 Describe the locus of complex power flowing through transmission line at both end TLO 4.2 Draw locus of complex power at receiving end transmission line with given loading condition and evaluate performance parameters. TLO 4.3 Draw locus of complex power at Sending end transmission line with given condition and evaluate performance parameters. TLO 4.4 State the Advantages of graphical analysis by using Circle diagram.	**Unit - IV Line performance by graphical analysis** 4.1 Graphical method for Transmission line performance analysis- circle diagram , Receiving end and Sending end circle diagram 4.2 Procedure to draw circle diagram for Receiving end and derive performance parameter. 4.3 Procedure to draw circle diagram for Sending end and derive performance parameter. 4.4 Transmission line performance parameters calculations by drawing circle diagram. 4.5 Advantages of graphical analysis by using Circle diagram.	Lecture Using Chalk-Board Flipped Classroom Case Study Presentations Video Demonstrations

POWER SYSTEM ANALYSIS **Course Code : 316331**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Explain the significance of Load flow analysis for the given power system. TLO 5.2 State the data required for Load flow studies for the given power system. TLO 5.3 Interpret the Characteristics' of the given SLFE for specified power system TLO 5.4 Identify the information obtained from the given Load flow study. TLO 5.5 Identify significant features of the given Ybus matrix TLO 5.6 Develop Ybus matrix for given 3 bus system.	**Unit - V Load flow studies** 5.1 Load flow studies- Concept and its need. 5.2 Data required for Load flow studies. 5.3 Static Load Flow Equation (SLFE) for simple two bus system and definition of parameters (only equation). 5.4 Characteristics of SLFE. 5.5 Information obtained from Load Flow Studies 5.6 Formation of Ybus (for 3 bus system including reference bus).	Lecture Using Chalk-Board Flipped Classroom Case Study Presentations Video Demonstrations

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

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify type of conductor from given sample of line conductors. LLO 1.2 Calculate self GMD.	1	*Identification of type of conductors and calculate Self GMD.	2	CO1
LLO 2.1 Evaluate Inductance for 3 ø transmission line with symmetrical and unsymmetrical spacing. LLO 2.2 Evaluate capacitance for 3 ø transmission line with symmetrical and unsymmetrical spacing.	2	*Inductance and capacitance for 3 Ø transmission line with symmetrical and unsymmetrical spacing.	2	CO1
LLO 3.1 Evaluate Inductance and capacitance for 1 ø transmission line without ground effect and with ground effect. LLO 3.2 Evaluate Inductance and capacitance for 1 ø transmission line without ground effect and with ground effect.	3	Inductance and capacitance for 1ø transmission line without ground effect and with ground effect.	2	CO1
LLO 4.1 Perform OC and SC Test and evaluate Generalized circuit constant (GCC) of given n model of transmission line.	4	*GCC of given n model of transmission line. by using OC SC test.	2	CO2
LLO 5.1 Perform OC and SC Test and evaluate Generalized circuit constant (GCC) of given T model of transmission line.	5	GCC of given T model of transmission line by using OC SC test.	2	CO2
LLO 6.1 Determine Generalized circuit constant (GCC) of given n (PI) model of transmission line by using Scilab.	6	*GCC of given n (PI) model of transmission line by using software.	2	CO2
LLO 7.1 Determine Generalized circuit constant (GCC) of given T model of transmission line by using Scilab	7	GCC of given T model of transmission line by using software.	2	CO2
LLO 8.1 Perform Load test on given n (PI) model of transmission line and determine the Efficiency and regulation.	8	n (PI) model Transmission line Efficiency and regulation by Load test.	2	CO3
LLO 9.1 Perform Load test on given T model of transmission line and determine the efficiency and regulation.	9	*T model Transmission line Efficiency and regulation by Load test.	2	CO3

POWER SYSTEM ANALYSIS **Course Code : 316331**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 10.1 Evaluate Receiving end complex power by using Scilab for given transmission line under load condition.	10	Transmission line Receiving end complex power evaluation by using software.	2	CO3
LLO 11.1 Evaluate Sending end complex power by using Scilab for given transmission line under given condition.	11	Transmission line Sending end complex power evaluation by using software.	2	CO3
LLO 12.1 Draw Circle Diagram for Receiving end or Sending end for given transmission line under load condition by using scilab / MATLAB.	12	*Transmission line Receiving end or Sending end complex power evaluation by graphical method.	2	CO4
LLO 13.1 Use Scilab / MATLAB to develop Ybus matrix for given 3- bus system-1.	13	*Development of Ybus matrix by using software- case 1.	2	CO5
LLO 14.1 Use Scilab / MATLAB to develop Ybus matrix for given 3- bus system-2.	14	Development of Ybus matrix by using software- case 2.	2	CO5
LLO 15.1 Determine the effect on SLFE for given power system using relevant software like VLAB	15	Determination of effect on SLFE during the maintenance outages for given power system using relevant software.	2	CO5

Note : Out of above suggestive LLOs -

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

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

Assignment

- Calculate inductance and capacitance / km and total loop Inductance of the given 1 ø line / 3 ø line with symmetrical/ unsymmetrical spacing with / without considering ground effect. Vary spacing / size of conductor and observe effect on line parameters.
- A 3 ø line with given equilateral spacing is to be rebuilt with horizontal/vertical spacing as D13 = 2D12 = 2D23. The conductors are to be fully transposed. Find the spacing between adjacent conductor such as that new line has the same inductance as original value.
- Determine ABCD constants, calculate sending end voltage and percentage regulation for 3 ø transmission line with given impedance and admittance and for given loading condition by Using n / T method.
- For given ABCD constants and line details with load condition, determine Sending end power / receiving end power and maximum power that can be delivered Analytically and graphically
- For given ABCD constants and for given loading condition, calculate performance of line - sending end voltage, sending end current, voltage regulation and efficiency by Using n / T method

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.

POWER SYSTEM ANALYSIS **Course Code : 316331**

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Sample of transmission line conductors	1
2	AC ammeter 2.5A, 5A	4,5,8,9
3	AC voltmeter 30V, 300V	4,5,8,9
4	Single Phase Wattmeter –Lpf 2.5A,300 V and unity pf 5A ,75/300V	4,5,8,9
5	Single Phase Auto transformer 0-250 V,10A	4,5,8,9
6	Simulation n model of transmission line or trainer kit	4,8
7	Simulation T model of transmission line or trainer kit.	5,7
8	Open source software ?Scilab 5.5.2 (any other suitable software)	6,7,10,11,12,13,14,15
9	Lamp Bank 1kW, 230 V, 5A	8,9

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

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Transmission Lines Components	CO1	16	4	7	7	18
2	II	Generalized circuit representation	CO2	8	2	7	4	13
3	III	Power flow	CO3	7	2	4	8	14
4	IV	Line performance by graphical analysis	CO4	8	2	6	7	15
5	V	Load flow studies	CO5	6	2	6	2	10
Grand Total				**45**	**12**	**30**	**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.
- 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	2	3	3	2	2	2	3			
CO2	2	3	2	2	2	2	3			

POWER SYSTEM ANALYSIS **Course Code : 316331**

CO3	3	3	2	2	2	2	3			
CO4	2	3	3	3	2	2	2			
CO5	2	2	2	2	2	2	3			

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

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Mehta V. K ; Mehta Rohit	Principles of Power System	S.Chand and Co., New Delhi. . 3rd Edition ISBN-10. 9788121924962 · ISBN-13. 978-8121924962
2	Nagrath I. J. Kothari D. P.	Modern Power System Analysis	McGraw HillEducation, New Delhi 5th Edition. 14 June 2022. ISBN-13: 978-9354600968
3	Stevenson William	Elements of Power System Analysis	McGraw-Hill Book Company, New York, 2014(4th addition) ISBN 10: 0070612781 / ISBN 13: 9780070612785
4	Wadhava C. L.	Electrical Power System	New age international publishers ISBN: 13-978-1-4987-7757-5-(EPUB)
5	Gupta B.R.	Power system Analysis and Design	S. Chand and Co. Ltd., New Delhi Edition: 6 Year: 2011 ISBN: 81-219-2238-0

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://archive.nptel.ac.in/courses/117/105/117105140/	NPTEL Lecture series on power system Analysis
2	https://archive.nptel.ac.in/courses/108/105/108105067/	Lecture series on Transmission line components calculation, load flow studies & Y bus formation.
3	https://www.youtube.com/watch?v=wuT2fqdT2pE	Basics of load flow study
4	https://srmeeevlab.github.io/PSA/3_Formation_of_Bus_admittance_Matrix_(without_mutual_coupling)/simulation.html	Exercises on Y bus & Z bus matrix formation by using VLAB

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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Maharashtra State Board Of Technical Education, Mumbai

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

Programme Name	**: Diploma In Electrical Engineering**		
Programme Code	**: EE**	**With Effect From Academic Year**	**: 2023-24**
Duration Of Programme	**: 6 Semester**	**Duration**	**: 16 WEEKS**
Semester	**: Sixth** **NCrF Entry Level : 4.0**	**Scheme**	**: K**

Sr No	Course Title	Abbrevation	Course Type	Course Code	Total IKS Hrs for Sem.	Learning Scheme					Credits	Assessment Scheme											
						Actual Contact Hrs./Week			Self Learning (Activity/ Assignment /Micro Project)	Notional Learning Hrs /Week		Paper Duration (hrs.)	Theory				Based on LL & TL Practical				Based on Self Learning		Total Marks
						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	MANAGEMENT	MAN	AEC	315301	1	3	-	-	1	4	2	1.5	30	70*#	100	40	-	-	-	-	25	10	125
2	EMERGING TRENDS IN ELECTRICAL ENGINEERING	ETE	DSC	316326	-	4	-	-	-	4	2	1.5	30	70*#	100	40	-	-	-	-	-	-	100
3	ENERGY CONSERVATION AND AUDIT	ECA	DSC	316327	-	4	-	2	2	8	4	3	30	70	100	40	25	10	25#	10	25	10	175
4	MAINTENANCE OF ELECTRICAL EQUIPMENTS	MEE	DSC	316328	-	4	-	4	2	10	5	3	30	70	100	40	25	10	25#	10	25	10	175
5	BASIC PYTHON PROGRAMMING	BPP	AEC	313011	-	2	-	2	-	4	2	-	-	-	-	-	25	10	25@	10	-	-	50
6	CAPSTONE PROJECT	CPE	INP	316004	-	-	-	2	2	4	2	-	-	-	-	-	50	20	50#	20	50	20	150
Elective-II (Any - One)																							
7	INDUSTRIAL AUTOMATION	EIA	DSE	316329	-	3	-	2	1	6	3	3	30	70	100	40	25	10	25#	10	25	10	175
	INDUSTRIAL DRIVES AND CONTROL	IDC	DSE	316330	-	3	-	2	1	6	3	3	30	70	100	40	25	10	25#	10	25	10	175
	POWER SYSTEM ANALYSIS	PSA	DSE	316331	-	3	-	2	1	6	3	3	30	70	100	40	25	10	25#	10	25	10	175
Total					**1**	**20**		**12**	**8**		**20**		**150**	**350**	**500**		**150**		**150**		**150**		**950**

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)