CHAPTER

4

Electrical Engineering Curriculum Structure

(III to VI Semesters)

4.1 List of Programme Core Courses [PC]

S. No.	Course Code	Course Title	Hours per Week			Credits (L+T+P)	Semester
			L	T	P		
1.	EEPC201	Introduction to Electric Generation Systems	3	0	0	3	III
2.	EEPC203	Introduction to Electric Generation Systems Laboratory	0	0	2	1	III
3.	EEPC205	Electrical Circuits	2	1	0	3	III
4.	EEPC207	Electrical Circuits Laboratory	0	0	2	1	III
5.	EEPC209	Electrical and Electronic Measurements	2	1	0	3	III
6.	EEPC211	Electrical and Electronic Measurements Laboratory	0	0	2	1	III
7.	EEPC213	Electric Motors and Transformers	2	1	0	3	III
8.	EEPC215	Electric Motors and Transformers Laboratory	0	0	2	1	III
9.	EEPC217	Renewable Energy Power Plants	3	0	0	3	III
10.	EEPC219	Renewable Energy Power Plants Laboratory	0	0	2	1	III
11.	EEPC202	Fundamentals of Power Electronics	3	0	0	3	IV
12.	EEPC204	Fundamentals of Power Electronics Laboratory	0	0	2	1	IV
13.	EEPC206	Electric Power Transmission and Distribution	3	0	0	3	IV
14.	EEPC208	Electric Power Transmission and Distribution Laboratory	0	0	2	1	IV
15.	EEPC210	Induction, Synchronous and FHP Machines	2	1	0	3	IV
16.	EEPC212	Induction, Synchronous and FHP Machines Laboratory	0	0	2	1	IV
17.	EEPC301	Microcontroller Applications	3	0	0	3	V
18.	EEPC303	Microcontroller Applications Laboratory	0	0	2	1	V
19.	EEPC305	Energy Conservation and Audit	3	0	0	3	V
20.	EEPC307	Energy Conservation and Audit Laboratory	0	0	2	1	V
21.	EEPC302	Building Electrification	3	0	0	3	VI
22.	EEPC304	Building Electrification Laboratory	0	0	2	1	VI
Total			**29**	**4**	**22**	**44**	

4.2 List of Program Elective Courses [PE]

S. No.	Course Code	Course Title	Hours per Week			Credits (L+T+P)	Semester
			L	T	P		
1.	EEPE***	Industrial Instrumentation and Condition Monitoring	3	0	0	3	
2.	EEPE***	Industrial Instrumentation and Condition Monitoring Laboratory	0	0	2	1	
3.	EEPE***	Industrial Automation & Control	3	0	0	3	
4.	EEPE***	Industrial Automation & Control Laboratory	0	0	2	1	
5.	EEPE***	Industrial Drives	3	0	0	3	
6.	EEPE***	Industrial Drives Laboratory	0	0	2	1	
7.	EEPE***	Communication Technologies	3	0	0	3	
8.	EEPE***	Communication Technologies Laboratory	0	0	2	1	
9.	EEPE***	Electrical Testing and Commissioning	3	0	0	3	
10.	EEPE***	Electrical Testing and Commissioning Laboratory	0	0	2	1	
11.	EEPE***	Electrical Estimation and Contracting	3	0	0	3	
12.	EEPE***	Electrical Estimation and Contracting Laboratory	0	0	2	1	
13.	EEPE***	Illumination Practices	3	0	0	3	
14.	EEPE***	Illumination Practices Laboratory	0	0	2	1	
15.	EEPE***	Switchgear and Protection	3	0	0	3	
16.	EEPE***	Switchgear and Protection Laboratory	0	0	2	1	
17.	EEPE***	Solar Power Technologies	3	0	0	3	
18.	EEPE***	Solar Power Technologies Laboratory	0	0	2	1	
19.	EEPE***	Wind Power Technologies	3	0	0	3	
20.	EEPE***	Wind Power Technologies Laboratory	0	0	2	1	
21.	EEPE***	Biomass and Micro-hydro Power Plants	3	0	0	3	
22.	EEPE***	Biomass and Micro-hydro Power Plants Laboratory	0	0	2	1	
23.	EEPE***	Electric Vehicles	3	0	0	3	
24.	EEPE***	Electric Vehicles Laboratory	0	0	2	1	
25.	EEPE***	Electric Traction	3	0	0	3	
26.	EEPE***	Electric Traction Laboratory	0	0	2	1	
Total			**39**	**0**	**26**	**52**	

4.3 Semester-wise Detailed Curriculum

Semester III

S.No.	Course Code	Course Title	Hours per Week			Total Contact Hours/ Week	Credits
			L	T	P		
1.	EEPC201	Introduction to Electric Generation Systems	3	0	0	3	3
2.	EEPC203	Introduction to Electric Generation Systems Laboratory	0	0	2	2	1
3.	EEPC205	Electrical Circuits	2	1	0	3	3
4.	EEPC207	Electrical Circuits Laboratory	0	0	2	2	1
5.	EEPC209	Electrical and Electronic Measurements	2	1	0	3	3
6.	EEPC211	Electrical and Electronic Measurements Laboratory	0	0	2	2	1
7.	EEPC213	Electric Motors and Transformers	2	1	0	3	3
8.	EEPC215	Electric Motors and Transformers Laboratory	0	0	2	2	1
9.	EEPC217	Renewable Energy Power Plants	3	0	0	3	3
10.	EEPC219	Renewable Energy Power Plants Laboratory	0	0	2	2	1
11.	SI201	Summer Internship - I	0	0	0	0	2
Total			**12**	**2**	**10**	**25**	**22**

Semester IV

S.No.	Course Code	Course Title	Hours per Week			Total Contact Hours/ Week	Credits
			L	T	P		
1.	EEPC202	Fundamentals of Power Electronics	3	0	0	3	3
2.	EEPC204	Fundamentals of Power Electronics Laboratory	0	0	2	2	1
3.	EEPC206	Electric Power Transmission and Distribution	3	0	0	3	3
4.	EEPC208	Electric Power Transmission and Distribution Laboratory	0	0	2	2	1
5.	EEPC210	Induction, Synchronous and Special Electrical Machines	2	1	0	3	3
6.	EEPC212	Induction, Synchronous and Special Electrical Machines Laboratory	0	0	2	2	1
7.	EEPE***	Elective I	3	0	0	3	3
8.	EEPE***	Elective I Laboratory	0	0	2	2	1
9.	EEPE***	Elective II	3	0	0	3	3
10.	EEPE***	Elective II Laboratory	0	0	2	2	1
11.	PR202	Minor Project	0	0	4	4	2
12.	AU202	Essence of Indian Knowledge and Tradition	2	0	0	2	0
Total			**17**	**0**	**14**	**31**	**22**

Semester V

S. No.	Course Code	Course Title	Hours per Week			Total Contact Hours/ week	Credits
			L	T	P		
1.	EEPC301	Microcontroller Applications	3	0	0	3	3
2.	EEPC303	Microcontroller Applications Laboratory	0	0	2	2	1
3.	EEPC305	Energy Conservation and Audit	3	0	0	3	3
4.	EEPC307	Energy Conservation and Audit Laboratory	0	0	2	2	1
5.	EEPE3**	Elective III	3	0	0	3	3
6.	EEPE3**	Elective III Laboratory	0	0	2	2	1
7.	EEPE3**	Elective IV	3	0	0	3	3
8.	EEPE3**	Elective IV Laboratory	0	0	2	2	1
9.	OE3**	Open Elective I	3	0	0	3	3
10.	SI301	Summer Internship - II	0	0	0	0	3
11.	PR302	Major Project	0	0	2	2	^
Total			**15**	**0**	**10**	**25**	**22**

Semester VI

S. No.	Course Code	Course Title	Hours per Week			Total Contact Hours/ week	Credits
			L	T	P		
1.	EEPC302	Building Electrification	3	0	0	3	3
2.	EEPC304	Building Electrification Laboratory	0	0	2	2	1
3.	HS302	Entrepreneurship and Start -ups	3	1	0	4	4
4.	OE3**	Open Elective II	3	0	0	3	3
5.	OE3**	Open Elective III	3	0	0	3	3
6.	AU302	Indian Constitution	2	0	0	2	0
7.	PR302	Major Project	0	0	6	6	4^
8.	SE302	Seminar	1	0	0	1	1
Total			**15**	**1**	**10**	**24**	**19**

Note: ^one credit is carried forward from the Vth semester major project evaluation.

Semester III

Course Code	:	EEPC201
Course Title	:	INTRODUCTION TO ELECTRIC GENERATION SYSTEMS
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Prerequisites	:	NIL
Course Category	:	PC

Course Objectives:

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

- Maintain the efficient operation of various electric power generating plants.

Course Contents:

Unit – I Thermal Power Plants: Coal, Gas/ Diesel and Nuclear-based

Layout and working of a typical thermal power plant with steam turbines and electric generators.

Properties of conventional fuels used in the energy conversion equipment used in thermal power plants: Coal, Gas/ diesel, Nuclear fuels –fusion and fission action

Safe Practices and working of various thermal power plants: coal-based, gas-based, diesel-based, nuclear-based.

Functions of the following types of thermal power plants and their major auxiliaries:

Coal fired boilers: fire tube and water tube.

Gas/diesel based combustion engines

Types of nuclear reactors: Disposal of nuclear waste and nuclear shielding.

Thermal power plants in Maharashtra.

Unit – II Large and Micro-Hydro Power Plants

Energy conversion process of hydro power plant.

Classification of hydro power plant: High, medium and low head.

Construction and working of hydro turbines used in different types of hydro power plant:

a. High head – Pelton turbine

b. Medium head – Francis turbine

c. Low head – Kaplan turbine.

Safe Practices for hydro power plants.

Different types of micro- hydro turbines for different heads: Pelton, Francis and Kaplan turbines

Locations of these different types of large and micro-hydro power plants in Maharashtra

Potential locations of micro-hydro power plants in Maharashtra.

Unit– III Solar and Biomass based Power Plants

Solar Map of India: Global solar power radiation.

Solar Power Technology

a. Concentrated Solar Power (CSP) plants, construction and working of: Power Tower, Parabolic Trough, Parabolic Dish, Fresnel Reflectors

b. Solar Photovoltaic (PV) power plant: layout, construction, working.

Biomass-based Power Plants

a. Layout of a Bio-chemical based (e.g. biogas) power plant:

b. Layout of a Thermo-chemical based (e.g. Municipal waste) power plant

c. Layout of an Agro-chemical based (e.g. bio-diesel) power plant

Features of the solid, liquid and gas biomasses as fuel for biomass power plant.

Unit– IV Wind Power Plants

Wind Map of India**:** Wind power density in watts per square meter

Layout of Horizontal axis large wind power plant:

Geared wind power plant.

Direct-drive wind power plant.

Salient Features of electric generators used in large wind power plants:

Constant Speed Electric Generators: Squirrel Cage Induction Generators (SCIG), Wound Rotor Induction Generator (WRIG)

Variable Speed Electric Generators: Doubly-fed induction generator (DFIG), wound rotor synchronous generator (WRSG), permanent magnet synchronous generator (PMSG)

Unit– V Economics of Power Generation and Interconnected Power System

Related terms: connected load, firm power, cold reserve, hot reserve, spinning reserve. Base load and peak load plants; Load curve, load duration curve, integrated duration curve

Cost of generation: Average demand, maximum demand, demand factor, plant capacity factor, plant use factor, diversity factor, load factor and plant load factor.

Choice of size and number of generator units, combined operation of power station.

Causes and Impact and reasons of Grid system fault: State grid, national grid, brownout and black out; sample blackouts at national and international level

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5. Solanki, Chetan Singh, – Solar Photovoltaics: Fundamentals, Technologies and Applications, PHI Learning, New Delhi, ISBN: 9788120351110

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Course Outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Maintain the optimised working of the thermal power plant.
b) Maintain the optimised working of large and micro hydro power plants.
c) Maintain the optimised working of solar and biomass-based power plants.
d) Maintain the optimised working of wind power plants.
e) Select the adequate mix of power generation based on economic operation.

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Course Code	:	EEPC203
Course Title	:	INTRODUCTION TO ELECTRIC GENERATION SYSTEMS LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites	:	NIL
Course Category	:	PC

Course Objectives:

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

- Maintain the efficient operation of various electric power generating plants.

Practicals:

1. Identify the routine maintenance parts of the coal fired thermal power plant after watching a video programme
2. Identify the routine maintenance parts of the gas fired thermal power plant after watching a video programme
3. Assemble and dismantle a small diesel generator power plant.
4. Identify the routine maintenance parts of the nuclear fired thermal power plant after watching a video programme.
5. Identify the routine maintenance parts of the large hydro power plant after watching a video programme
6. Identify the routine maintenance parts of the micro hydro power plant after watching a video programme.
7. Assemble a micro hydro power plant and then dismantle it.

8. Assemble the parabolic trough or parabolic dish Concentrated Solar Power (CSP) plant.
9. Dismantle the parabolic trough or parabolic dish CSP plant.
10. Assemble the solar PV plant to produce electric power and then dismantle it.
11. Assemble a small biogas plant to generate electric power
12. Dismantle the biogas plant.
13. Identify the routine maintenance parts of the large wind power plant after watching a video programme.
14. Assemble a horizontal axis small wind turbine to produce electric power
15. Dismantle a horizontal axis small wind turbine.
16. Assemble a vertical axis small wind turbine to produce electric power and then dismantle it.
17. Identify the routine maintenance parts of the horizontal axis small wind turbine after watching a video programme.
18. Identify the routine maintenance parts of the vertical axis small wind turbine after watching a video programme.

Course Ouctomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Maintain the optimised working of the thermal power plant.
b) Maintain the optimised working of large and micro hydro power plants.
c) Maintain the optimised working of solar and biomass-based power plants.
d) Maintain the optimised working of wind power plants.
e) Select the adequate mix of power generation based on economic operation.

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Course Code	:	EEPC205
Course Title	:	ELECTRIC CIRCUITS
Number of Credits	:	3 (L: 2, T: 1, P: 0)
Prerequisites (Course code)	:	NIL
Course Category	:	PC

Course Objectives:

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

- Maintain electrical systems applying AC and DC circuit fundamentals.

Course Contents:

Unit – I Single Phase A.C Series Circuits

Generation of alternating voltage, Phasor representation of sinusoidal quantities

R, L, C circuit elements its voltage and current response

R-L, R-C, R-L-C combination of A.C series circuit, impedance, reactance, impedance

triangle, Power factor, active power, reactive power, apparent power, power triangle and vector diagram

Resonance, Bandwidth, Quality factor and voltage magnification in series R-L, R-C, R-L-C circuit

Unit – II Single Phase A.C Parallel Circuits

R-L, R-C and R-L-C parallel combination of A.C. circuits. Impedance, reactance, phasor diagram, impedance triangle

R-L, R-C, R-L-C parallel A.C. circuits power factor, active power, apparent power, reactive power, power triangle

Resonance in parallel R-L, R-C, R-L-C circuit, Bandwidth, Quality factor and voltage magnification

Unit– III Three Phase Circuits

Phasor and complex representation of three phase supply

Phase sequence and polarity

Types of three-phase connections, Phase and line quantities in three phase star and delta system

Balanced and unbalanced load, neutral shift in unbalanced load

Three phase power, active, reactive and apparent power in star and delta system.

Unit– IV Network Reduction and Principles of Circuit Analysis

Source transformation

Star/delta and delta/star transformation

Mesh Analysis

Node Analysis

Unit– V Network Theorems

Superposition theorem.

Thevenin's theorem.

Norton's theorem

Maximum power transfer theorem

Reciprocity theorem

Duality in electric circuits

References:

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Course Outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Troubleshoot problems related to single phase A.C series circuits.
b) Troubleshoot problems related to single phase A.C parallel circuits.
c) Troubleshoot problems related to three phase circuits.
d) Use principles of circuit analysis to troubleshoot electric circuits.
e) Apply network theorems to troubleshoot electric circuits.

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Course Code	:	EEPC207
Course Title	:	ELECTRIC CIRCUITS LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites	:	NIL
Course Category	:	PC

Course objectives:

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

- Maintain electrical systems applying AC and DC circuit fundamentals.

Practicals:

1. Use dual trace oscilloscope to determine A.C voltage and current response in given R, L, C circuit.
2. Use voltmeter, ammeter, wattmeter to determine active, reactive and apparent power consumed in given R-L series circuit. Draw phasor diagram.
3. Use voltmeter, ammeter to determine active, reactive and apparent power consumed in given R-C series circuit. Draw phasor diagram.
4. Use voltmeter, ammeter, wattmeter to determine active, reactive and apparent power consumed in given R-L-C series circuit. Draw phasor diagram.
5. Use variable frequency supply to create resonance in given series R-L-C circuit or by using variable inductor or variable capacitor.

6. Use voltmeter, ammeter, wattmeter to determine current, p.f. , active, reactive and apparent power in R-C parallel A.C. circuit.
7. Use voltmeter, ammeter, wattmeter, p.f meter to determine current, p.f., active, reactive and apparent power for given R-L-C parallel circuit with series connection of resistor and inductor in parallel with capacitor.
8. Use variable frequency supply create resonance in given parallel R-L-C circuit or by using variable inductor or capacitor.
9. Use voltmeter, ammeter, wattmeter, p.f meter to determine line and phase quantities of voltage and current for balanced three phase star and delta connected load and calculate active, reactive, and apparent power. Draw phasor diagram.
10. Use voltmeter, ammeter, wattmeter, p.f meter to determine line and phase quantities of voltage and current for unbalanced three phase star and delta connected load and calculate active, reactive, and apparent power. Draw phasor diagram.
11. Use voltmeter, ammeter to determine current through the given branch of a electric network by applying mesh analysis.
12. Use voltmeter, ammeter to determine current through the given branch of a electric network by applying node analysis.
13. Use voltmeter, ammeter to determine current through the given branch and voltage across the given element of circuit by applying superposition theorem.
14. Use voltmeter, ammeter to determine equivalent circuit parameter in a given circuit by applying Thevenin's theorem
15. Use voltmeter, ammeter to determine equivalent circuit parameter in a given circuit by applying Norton's theorem
16. Use voltmeter, ammeter to determine load resistance for maximum power transfer for a given circuit by applying maximum power transfer theorem.

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Troubleshoot problems related to single phase A.C series circuits.
b) Troubleshoot problems related to single phase A.C parallel circuits.
c) Troubleshoot problems related to three phase circuits.
d) Use principles of circuit analysis to troubleshoot electric circuits.
e) Apply network theorems to troubleshoot electric circuits.

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Course Code	:	EEPC209
Course Title	:	ELECTRICAL AND ELECTRONIC MEASUREMENTS
Number of Credits	:	3 (L: 2, T: 1, P: 0)
Prerequisites	:	NIL
Course Category	:	PC

Course objectives:

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

- Use relevant measuring instrument in different electrical applications.

Course contents:

Unit – I Fundamentals of Measurements

Measurement: Significance, units, fundamental quantities and standards

Classification of Instrument Systems:

Null and deflection type instruments

Absolute and secondary instruments

Analog and digital instruments

Static and dynamic characteristics, types of errors

Calibration: need and procedure

Classification of measuring instruments: indicating, recording and integrating instruments.

Essential requirements of an indicating instruments

Unit – II Measurement of voltage and current

DC Ammeter: Basic, Multi range, Universal shunt,

DC Voltmeter: Basic, Multi-range, concept of loading effect and sensitivity

AC voltmeter: Rectifier type (half wave and full wave)

CT and PT: construction, working and applications.

Clamp-on meter.

Unit– III Measurement of Electric Power

Analog meters: Permanent magnet moving coil (PMMC) and Permanent magnet moving iron (PMMI) meter, their construction, working, salient features, merits and demerits

Dynamometer type wattmeter: Construction and working

Range: Multiplying factor and extension of range using CT and PT

Errors and compensations.

Active and reactive power measurement: One, two and three wattmeter method.

Effect of Power factor on wattmeter reading in two wattmeter method.

Maximum Demand indicator

Unit– IV Measurement of Electric Energy

Single and three phase electronic energy meter: Constructional features and working principle.

Errors and their compensations.

Calibration of single phase electronic energy meter using direct loading.

Unit– V Circuit Parameter Measurement, CRO and Other Meters

Measurement of resistance:

Low resistance: Kelvin's double bridge,

Medium Resistance: Voltmeter and ammeter method

High resistance: Megger and Ohm meter: Series and shunt

Measurement of inductance using Anderson bridge (no derivation and phasor diagram)

Measurement of capacitance using Schering bridge (no derivation and phasor diagram)

Single beam/single trace CRO, Digital storage Oscilloscope**:** Basic block diagram, working, Cathode ray tube, electrostatic deflection, vertical amplifier, time base generator, horizontal amplifier, measurement of voltage/ amplitude/ time period/ frequency/ phase angle delay line, specifications.

Other meters: Earth tester, Digital Multimeter; L-C-R meter, Frequency meter (ferromagnetic and Weston type), Phase sequence indicator, power factor meter (single phase and three phase dynamometer type), Synchro scope, Tri-vector meter

Signal generator: need, working and basic block diagram.

Function generator: need, working and basic block diagram, function of symmetry.

References:

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Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Check the working of the electrical measuring instrument.
b) Use different types of measuring instruments for measuring voltage and current.
c) Use different types of measuring instruments for measuring electric power
d) Use different types of measuring instruments for measuring electric energy.
e) Use different types of electrical instruments for measuring various ranges of electrical parameters.

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Course Code	:	EEPC211
Course Title	:	ELECTRICAL AND ELECTRONIC MEASUREMENTS LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites	:	NIL
Course Category	:	PC

Course objectives:

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

- Use relevant measuring instrument in different electrical applications.

Practicals:

1. Identify measuring instruments on the basis of symbols on dial, type, accuracy, class position and scale.
2. Identify the components of PMMC and MI instruments.
3. Troubleshoot PMMC and MI instruments.
4. Measure AC and DC quantities in a working circuit.
5. Extend range of ammeter and voltmeter by using (i) shunt and multiplier (ii) CT and PT.
6. Use Clamp-on meter for measurement of AC/DC current, AC/DC voltage.
7. Use electro-dynamic watt-meter for measurement of power in a single phase circuit
8. Troubleshoot electrodynamic watt-meter for measurement of power in a single phase circuit
9. Use single wattmeter for measurement of active and reactive power of three phase balanced load.
10. Use two watt-meters for measuring active power of three-phase balanced load.
11. Calibrate single phase electronic energy meter by direct loading.
12. Troubleshoot single phase electronic energy meter.
13. Use digital multi-meter for measurement of AC/DC current, AC/DC voltage.
14. Use Kelvin's double bridge for measurement of low resistance.
15. Use voltmeter and ammeter method for measurement of medium resistance.
16. Use Megger for insulation resistance measurements.
17. Use earth tester for measurement of earth resistance.
18. Use CRO for the Measurement of supply frequency in single-phase circuit.
19. Use Tri-vector meter for measuring kW, kVAr and kVA of a power line.

COURSE OUTCOMES:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Check the working of the electrical measuring instrument.
b) Use different types of measuring instruments for measuring voltage and current.
c) Use different types of measuring instruments for measuring electric power

d) Use different types of measuring instruments for measuring electric energy.

e) Use different types of electrical instruments for measuring electrical parameters of various ranges.

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Course Code	:	EEPC213
Course Title	:	ELECTRIC MOTORS AND TRANSFORMERS
Number of Credits	:	3 (L: 2, T: 1, P: 0)
Prerequisites	:	NIL
Course Category	:	PC

Course objectives:

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

- Maintain electric motors and transformers.

Course contents

Unit – I DC Generators

DC generator: construction, parts, materials and their functions.

Principle of operation of DC generator: Fleming's right hand rule, schematic

diagrams, e.m.f. equation of generator, armature reaction, commutation and.

Applications of DC generators. Classification of measuring instruments: indicating, recording and integrating instruments.

Unit – II D.C. Motors

DC motor: Types of DC motors. Fleming's left hand rule, Principle of operation of, Back e.m.f. and its significance, Voltage equation of DC motor.

Torque and Speed; Armature torque, Shaft torque, BHP, Brake test, losses, efficiency.

DC motor starters: Necessity, two point and three point starters.

Speed control of DC shunt and series motor: Flux and Armature control.

Brushless DC Motor: Construction and working.

Unit– III Single Phase Transformers

Types of transformers: Shell type and core type; Construction: Parts and functions, materials used for different parts: CRGO, CRNGO, HRGO, amorphous cores,

Transformer: Principle of operation, EMF equation of transformer: Derivation, Voltage transformation ratio,

Significance of transformer ratings

Transformer No-load and on-load phasor diagram, Leakage reactance,

Equivalent circuit of transformer: Equivalent resistance and reactance.

Voltage regulation and Efficiency: Direct loading, OC/SC method, All day efficiency.

Unit– IV Three Phase Transformers

Bank of three single phase transformers, Single unit of three phase transformer Distribution

and Power transformers.

Construction, cooling, Three phase transformers connections as per IS:2026 (part IV)-1977, Three phase to two phase conversion (Scott Connection), Selection of transformer as per IS: 10028 (Part I)-1985, Criteria for selection of distribution transformer, and power transformer, Amorphous Core type Distribution Transformer, Specifications of three-phase distribution transformers as per IS:1180 (part I)-1989

Need of parallel operation of three phase transformer, Conditions for parallel operation.

Polarity tests on mutually inductive coils and single phase transformers; Polarity test, Phasing out test on Three-phase transformer.

Unit– V Special Purpose Transformers

Single phase and three phase auto transformers: Construction, working and applications.

Instrument Transformers: Construction, working and applications of Current transformer and Potential transformer.

Isolation transformer: Constructional Features and applications.

Single phase welding transformer: constructional features and applications.

Pulse transformer: constructional features and applications.

'K' factor of transformers: overheating due to non-linear loads and harmonics.

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2. Mittle, V.N. and Mittle, Arvind., Basic Electrical Engineering, McGraw Hill Education, New Delhi, ISBN: 9780070593572
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6. Theraja, B.L., Electrical Technology Vol-II (AC and DC machines), S. Chand and Co. Ltd., New Delhi, ISBN: 9788121924375
7. Bandyopadhyay, M. N., Electrical Machines Theory and Practice, PHI Learning Pvt. Ltd., New Delhi, ISBN: 9788120329973 Vi
8. Murugesh Kumar, K., DC Machines and Transformers, ISBN: 9788125916055

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Maintain different types of DC generators.

b) Maintain different types of DC motors.
c) Maintain single phase transformer.
d) Maintain three phase transformers.
e) Maintain different types of special purpose transformers used in different applications.

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Course Code	:	EEPC215
Course Title	:	ELECTRIC MOTORS AND TRANSFORMERS LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites	:	NIL
Course Category	:	PC

Course objectives:

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

- Use electric motors and transformers.

Practicals:

1. Dismantle a DC machine.
2. Reverse the direction of rotation of the DC shunt motor.
3. Perform brake test on DC shunt motor.
4. Control the speed of DC shunt motor by different methods.
5. Control the speed of DC series motor by different methods.
6. Perform the brake test on DC series motor.
7. Check the functioning of single phase transformer.
8. Determine regulation and efficiency of single phase transformer by direct loading.
9. Perform open circuit and short circuit test on single phase transformer to determine equivalent circuit constants, voltage regulation and efficiency.
10. Perform parallel operation of two single phase transformers to determine the load current sharing.
11. Perform parallel operation of two single phase transformers and determine the apparent and real power load sharing.
12. Perform polarity test on a single phase transformer whose polarity markings are masked.
13. Perform phasing out test on a three phase transformer whose phase markings are masked.
14. Connect the auto-transformer in step-up and step-down modes noting the input/output readings.
15. Check the functioning of the CT, PT and isolation transformer.
16. Test the pulse transformer.

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Maintain different types of DC generators.
b) Maintain different types of DC motors.
c) Maintain single phase transformer.
d) Maintain three phase transformers.
e) Maintain different types of special purpose transformers used in different applications.

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Course Code	:	EEPC217
Course Title	:	Renewable Energy Power Plants
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Prerequisites (Course code)	:	NIL
Course Category	:	PC

Course objectives:

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

- Maintain the efficient operation of various types of renewable energy power plants.

Course contents:

Unit – I Solar PV and Concentrated Solar Power Plants

Solar Map of India: Global solar power radiation, Solar PV

Concentrated Solar Power (CSP) plants, construction and working of: Power Tower, Parabolic Trough, Parabolic Dish, Fresnel Reflectors

Solar Photovoltaic (PV) power plant: components layout, construction, working.

Rooftop solar PV power system

Unit – II Large Wind Power Plants

Wind Map of India: Wind power density in watts per square meter

Lift and drag principle; long path theory.

Geared type wind power plants: components, layout and working.

Direct drive type wind power plants: components, layout and working.

Constant Speed Electric Generators: Squirrel Cage Induction Generators (SCIG), Wound Rotor Induction Generator (WRIG); Variable Speed Electric Generators: Doubly-fed induction generator (DFIG), wound rotor synchronous generator (WRSG), permanent magnet synchronous generator (PMSG).

Unit– III Small Wind Turbines

Horizontal axis small wind turbine: direct drive type, components and working

Horizontal axis small wind turbine: geared type, components and working

Vertical axis small wind turbine: direct drive and geared, components and working

Types of towers and installation of small wind turbines on roof tops and open fields.

Electric generators used in small wind power plants

Unit– IV Micro-hydro Power Plants

Energy conversion process of hydro power plant.

Classification of hydro power plant: High, medium and low head.

Layouts of micro-hydro power plants

Construction and working of hydro turbines used in different types of hydro power plant:

- High head – Pelton turbine
- Medium head – Francis turbine
- Low head – Kaplan turbine.

Safe Practices for micro hydro power plants.

Unit– V Biomass-based Power Plants

Properties of solid fuel for biomass power plants: bagasse, wood chips, rice husk, municipal waste

Properties of liquid and gaseous fuel for biomass power plants: Jatropha, bio-diesel gobar gas

Layout of a Bio-chemical based (e.g. biogas) power plant:

Layout of a Thermo-chemical based (e.g. Municipal waste) power plant

Layout of a Agro-chemical based (e.g. bio-diesel) power plant

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5. Gipe, Paul: Wind Energy Basics, Chelsea Green Publishing Co; ISBN: 978-1603580304
6. Wizelius, Tore &Earnest, Joshua -PHI Learning, New Delhi, ISBN: 978-8120351660
7. Kothari, D.P. et al: Renewable Energy Sources and Emerging Technologies, PHI Learning, New Delhi, ISBN: -978-81-203-4470-9
8. Bhadra, S.N., Kastha, D., Banerjee, S, Wind Electrical Systems installation; Oxford University Press, New Delhi, ISBN: 9780195670936.
9. O.P. Gupta, Energy Technology, Khanna Publishing House, New Delhi (ISBN: 978-9386173-683)

Course outcomes:

the theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Maintain the optimised working of solar PV and CS power plants.
b) Maintain the optimised working of large wind power plants
c) Maintain the optimised working of small wind turbines.
d) Maintain the optimised working of micro hydro power plants.
e) Maintain the optimised working of biomass-based power plants.

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Course Code	:	EEPC219
Course Title	:	Renewable Energy Power Plants Laboratory
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites	:	NIL
Course Category	:	PC

Course objectives:

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

- Maintain the efficient operation of various renewable energy power plants.

Practicals:

1. Dismantle the parabolic trough CSP plant.
2. Assemble the parabolic trough Concentrated Solar Power (CSP) plant.
3. Assemble the parabolic dish CSP plant.
4. Dismantle the parabolic dish CSP plant.
5. Assemble the solar PV plant to produce electric power.
6. Dismantle the solar PV plant.
7. Identify the routine maintenance parts of the large wind power plant after watching a video programme.
8. Assemble a horizontal axis small wind turbine to produce electric power
9. Dismantle a horizontal axis small wind turbine.
10. Assemble a vertical axis small wind turbine to produce electric power
11. Dismantle a vertical axis small wind turbine.
12. Identify the routine maintenance parts of the micro hydro power plant after watching a video programme.
13. Assemble a micro hydro power plant.
14. Dismantle a micro hydro power plant.
15. Assemble a small biogas plant to generate electric power
16. Dismantle the biogas plant.

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Maintain the optimised working of solar PV and CS power plants.

b) Maintain the optimised working of large wind power plants

c) Maintain the optimised working of small wind turbines.

d) Maintain the optimised working of micro hydro power plants.

e) Maintain the optimised working of biomass-based power plants.

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Semester – IV		
Course Code	:	EEPC202
Course Title	:	Fundamentals of Power Electronics
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Prerequisites	:	NIL
Course Category	:	PC

Course objectives:

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

- Maintain the proper functioning of power electronic devices.

Course contents:

Unit – I Power Electronic Devices

Power electronic devices

Power transistor: construction, working principle, V-I characteristics and uses.

IGBT: Construction, working principle, V-I characteristics and uses.

Concept of single electron transistor (SET) - aspects of Nano- technology.

Unit – II Thyristor Family Devices

SCR: construction, two transistor analogy, types, working and characteristics.

SCR mounting and cooling.

Types of Thyristors: SCR, LASCR, SCS, GTO, UJT, PUT, DIAC and TRIAC

Thyristor family devices: symbol, construction, operating principle and V-I characteristics.

Protection circuits: over-voltage, over-current, Snubber, Crowbar.

Unit– III Turn-on and Turn-off Methods of Thyristors

SCR Turn-On methods: High Voltage thermal triggering, Illumination triggering, dv/dt triggering, Gate triggering.

Gate trigger circuits – Resistance and Resistance-Capacitance circuits.

SCR triggering using UJT, PUT: Relaxation Oscillator and Synchronized UJT circuit.

Pulse transformer and opto-coupler based triggering.

SCR Turn-Off methods: Class A- Series resonant commutation circuit, Class B-Shunt

Resonant commutation circuit, Class C-Complimentary Symmetry commutation circuit, Class D –Auxiliary commutation, Class E- External pulse commutation, Class F- Line or natural commutation.

Unit– IV Phase Controlled Rectifiers

Phase control: firing angle, conduction angle.

Single phase half controlled, full controlled and midpoint controlled rectifier with R, RL

load: Circuit diagram, working, input- output waveforms, equations for DC output and effect of freewheeling diode.

Different configurations of bridge controlled rectifiers: Full bridge, half bridge with common anode, common cathode, SCRs in one arm and diodes in another arm.

Unit– V Industrial Control Circuits

Applications: Burglar's alarm system, Battery charger using SCR, Emergency light system, Temperature controller using SCR and; Illumination control / fan speed control TRIAC.

SMPS.

UPS: Offline and Online

SCR based AC and DC circuit breakers.

References:

1. Ramamoorty M., An Introduction to Thyristors and their applications, East-West Press Pvt. Ltd., New Delhi, ISBN: 8185336679.
2. Sugandhi, Rajendra Kumar and Sugandhi, Krishna Kumar, Thyristors: Theory and Applications, New Age International (P) ltd. Publishers, New Delhi, ISBN: 978-0-85226-852-0.
3. Bhattacharya, S.K., Fundamentals of Power Electronics, Vikas Publishing House Pvt. Ltd. Noida. ISBN: 978-8125918530.
4. Jain & Alok , Power Electronics and its Applications, Penram International Publishing (India) Pvt. Ltd, Mumbai, ISBN: 978-8187972228.
5. Rashid , Muhammad, Power Electronics Circuits Devices and Applications, Pearson Education India, Noida, ISBN: 978-0133125900.
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7. Zbar, Paul B., Industrial Electronics: A Text –Lab Manual, McGraw Hill Publishing Co. Ltd., New Delhi, ISBN: 978-0070728226.
8. Grafham D.R., SCR Manual, General Electric Co., ISBN: 978-0137967711.

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Select power electronic devices for specific applications.

b) Maintain the performance of Thyristors.

c) Troubleshoot turn-on and turn-off circuits of Thyristors.

d) Maintain phase controlled rectifiers.

e) Maintain industrial control circuits.

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Course Code	:	EEPC204
Course Title	:	FUNDAMENTALS OF POWER ELECTRONICS LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites	:	NIL
Course Category	:	PC

Course objectives:

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

- Maintain the proper functioning of power electronic devices.

Practicals:

1. Test the proper functioning of power transistor.
2. Test the proper functioning of IGBT.
3. Test the proper functioning of DIAC to determine the break over voltage.
4. Determine the latching current andholding current using V-I characteristics of SCR.
5. Test the variation of R, C in R and RC triggering circuits onfiring angle of SCR.
6. Test the effect of variation of R, C in UJT triggering technique.
7. Perform the operation of Class – A, B, C, turn off circuits.
8. Perform the operation of Class –D, E, F turn off circuits.
9. Use CRO to observe the output waveform of half wave controlled rectifier with resistive load and determine the load voltage.
10. Draw the output waveform of Full wave controlled rectifier with R load, RL load, free wheeling diode and determine the load voltage.
11. Determine the firing angle using DIAC and TRIAC phase controlled circuit on output power under different loads such as lamp, motor or heater
12. Simulate above firing angle control on SCILAB software
13. Test the performance of given SMPS, UPS.
14. Troubleshoot the Burglar's alarm, Emergency light system, Speed control system, Temperature control system.

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Select power electronic devices for specific applications.
b) Maintain the performance of Thyristors.
c) Troubleshoot turn-on and turn-off circuits of Thyristors.
d) Maintain phase controlled rectifiers.
e) Maintain industrial control circuits.

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Course Code	:	EEPC206
Course Title	:	ELECTRIC POWER TRANSMISSION AND DISTRIBUTION
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Prerequisites	:	NIL
Course Category	:	PC

Course objectives:

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

- Maintain the proper functioning of the electrical transmission and distribution systems.

Course contents:

Unit – I Basics of Transmission and Distribution

Single line diagrams with components of the electric supply transmission and distribution systems.

Classification of transmission lines: Primary and secondary transmission; standard voltage level used in India.

Classification of transmission lines: based on type of voltage, voltage level, length and others

Characteristics of high voltage for power transmission.

Method of construction of electric supply transmission system – 110 kV, 220 kV, 400 kV.

Method of construction of electric supply distribution systems – 220 V, 400V, 11 kV, 33 kV

Unit – II Transmission Line Parameters and Performance

Line Parameters: Concepts of R, L and C of line parameters and types of lines.

Performance of short line: Efficiency, regulation and its derivation, effect of power factor, vector diagram for different power factor.

Performance of medium line: representation, nominal 'T', nominal 'π' and end condenser methods.

Transposition of conductors and its necessity.

Skin effect and proximity effect.

Unit– III Extra High Voltage Transmission

Extra High Voltage AC (EHVAC) transmission line**:** Necessity, high voltage substation components such as transformers and other switchgears, advantages, limitations and applications and lines in India. Ferranti and Corona effect.

High Voltage DC (HVDC) Transmission Line**:** Necessity, components, advantages, limitations and applications. Layout of monopolar, bi-Polar and homo-polar transmission lines. Lines in India.

Features of EHVAC and HVDC transmission line.

Flexible AC Transmission line: Features, d types of FACTS controller.

New trends in wireless transmission of electrical power.

Unit– IV A.C Distribution System

AC distribution: Components classification, requirements of an ideal distribution system, primary and secondary distribution system.

Feeder and distributor, factors to be considered in design of feeder and distributor.

Types of different distribution schemes: radial, ring, and grid, layout, advantages, disadvantages and applications.

Voltage drop, sending end and receiving end voltage.

Distribution Sub-Station: Classification, site selection, advantages, disadvantages and applications.

Single Line diagram (layout) of 33/11KV Sub-Station, 11KV/400V sub-station, Symbols and functions of their components.

Unit– V Components of Transmission and Distribution Line

Overhead Conductors**:** Properties of material, types of conductor with trade names, significance of sag.

Line supports: Requirements, types of line structures and their specifications, methods of erection.

Line Insulators**:** Properties of insulating material, selection of material, types of insulators and their applications, causes of insulator failure, derivation of equation of string efficiency for string of three suspension insulator, methods of improving string efficiency.

Underground Cables**:** Requirements, classification, construction, comparison with overhead lines, cable laying and cable jointing.

References:

1. G.C. Garg, Utilization of Electric Power & Electric Traction, Khanna Book Publishing Co., New Delhi (ISBN: 978-93-86173-355)
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5. Theraja, B.L.; Theraja, A.K., A Textbook of Electrical Technology Vol. III, S.Chand and Co. New Delhi, ISBN : 9788121924900
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8. Ned Mohan, Electrical Power System: A First Course, Wiley India Pvt. Ltd. New Delhi, ISBN:9788126541959
9. Gupta, B.R., Power System Analysis and Design, S. Chand and Co. New Delhi, ISBN: 9788121922388
10. Kamraju, V., Electrical Power Distribution System, Tata McGraw-Hill, New Delhi, ISBN:9780070151413

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Interpret the normal operation of the electric transmission and distribution systems.
b) Maintain the functioning of the medium and high voltage transmission system.
c) Interpret the parameters of the extra high voltage transmission system.

d) Maintain the functioning of the low voltage AC distribution system.

e) Maintain the components of the transmission and distribution lines.

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Course Code	:	EEPC208
Course Title	:	ELECTRIC POWER TRANSMISSION AND DISTRIBUTION LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites	:	NIL
Course Category	:	PC

Course objectives:

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

- Maintain the proper functioning of the electrical transmission and distribution systems.

Course contents:

Laboratory work is not applicable for this course.

Following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Prepare a report based on transmission line network in Maharashtra.

b. Collect the information on components of transmission line.

c. Evaluate transmission line performance parameters of a given line.

d. Library/Internet survey of electrical high voltage line and HVDC lines.

e. Visit to 33/11 KV and 11KV/400V Distribution Substation and write a report

Also one micro-project can be assigned to the student. A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

a. Prepare a model showing:
   i. Single line diagram of electric supply system.
   ii. Single line diagram of a given distribution system.
   iii. Short line and medium transmission line.
   iv. Write a report on the same by giving the details of lines in Maharashtra State.

b. Collect different samples of Overhead Conductors, Underground Cables, Line supports and Line Insulators.

c. Prepare a power point presentation:
   i. Extra High Voltage AC Transmission line.
   ii. High Voltage DC Transmission line.
   iii. Flexible AC Transmission line.
   iv. New trends in wireless transmission of electrical power.

d. Collect information on:
   i. A.C Distribution System adjacent to your institute.

ii. Draw a layout diagram of 11KV/400 V substation in your campus/ adjacent substation.

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Interpret the normal operation of the electric transmission and distribution systems.
b) Maintain the functioning of the medium and high voltage transmission system.
c) Interpret the parameters of the extra high voltage transmission system.
d) Maintain the functioning of the low voltage AC distribution system.
e) Maintain the components of the transmission and distribution lines.

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Course Code	:	EEPC210
Course Title	:	INDUCTION, SYNCHRONOUS AND SPECIAL ELECTRIC MACHINES
Number of Credits	:	3 (L: 2, T: 1, P: 0)
Prerequisites	:	NIL
Course Category	:	PC

Course objectives:

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

- Maintain Induction, Synchronous and FHP Machines used in different applications.

Course contents:

Unit – I Three Phase Induction Motor

Working principle: production of rotating magnetic field, Synchronous speed, rotor speed and slip.

Constructional details of 3 phase induction motors: Squirrel cage induction motor and Slip ring induction motor.

Rotor quantities: frequency, induced emf, power factor at starting and running condition.

Characteristics of torque versus slip (speed), Torques: starting, full load and maximum with relations among them.

Induction motor as a generalized transformer with phasor diagram.

Four quadrant operation, Power flow diagram

Starters: need and types; stator resistance, auto transformer, star delta, rotor resistance and soft starters.

Speed control methods: stator voltage, pole changing, rotor resistance and VVVF.

Motor selection for different applications as per the load torque-speed requirements.

Maintenance of three phase induction motors

Unit – II Single phase induction motors

Double field revolving theory, principle of making these motors self-start.

Construction and working: Resistance start induction run, capacitor start induction run, capacitor start capacitor run, shaded pole, repulsion type, series motor, universal motor, hysteresis motor.

Torque-speed characteristics for all of the above motors.

Motor selection for different applications as per the load torque-speed requirements.

Maintenance of single phase induction motors

Unit– III Three phase Alternators

Principle of working, moving and stationary armatures.

Constructional details: parts and their functions, rotor constructions. Windings: Single and Double layer.

E.M.F. equation of an Alternator with numerical by considering short pitch factor and distribution factor.

Alternator loading: Factors affecting the terminal voltage of alternator; Armature resistance and leakage reactance drops.

Armature reaction at various power factors and synchronous impedance.

Voltage regulation: direct loading and synchronous impedance methods.

Maintenance of alternators

Unit– IV Synchronous motors

Principle of working /operation, significance of load angle.

Torques: starting torque, running torque, pull in torque, pull out torque.

Synchronous motor on load with constant excitation (numerical), effect of excitation at constant load (numerical).

V-Curves and Inverted V-Curves.

Hunting and Phase swinging.

Methods of Starting of Synchronous Motor.

Losses in synchronous motors and efficiency (no numerical).

Applications areas

Unit– V Fractional horse power (FHP) Motors

Construction and working: Synchronous Reluctance Motor, Switched Reluctance Motor, BLDC, Permanent Magnet Synchronous Motors, stepper motors, AC and DC servomotors.

Torque speed characteristics of above motors.

Applications of above motors.

References:

1. P.S. Bimbhra, Electric Machines, Khanna Book Publishing Co., New Delhi (ISBN: 978-93-86173-294)
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6. Sen, S. K., Special Purpose Electrical Machines, Khanna Publishers, New Delhi, ISBN: 9788174091529
7. Janardanan E. G, Special Electrical Machines, Prentice Hall India, New Delhi ISBN: 9788120348806
8. Hughes E., Electrical Technology, ELBS
9. Cotton H., Electrical Technology, ELBS

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Maintain three phase induction motor used in different applications.
b) Maintain single phase induction motor used in different applications.
c) Maintain three phase alternators used in different applications.
d) Maintain synchronous motors used in different applications.
e) Maintain FHP motors used in different applications.

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Course Code	:	EEPC212
Course Title	:	INDUCTION, SYNCHRONOUS AND SPECIAL ELECTRIC MACHINES LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites (Course code)	:	NIL
Course Category	:	PC

Course objectives:

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

- Maintain Induction, Synchronous and FHP Machines used in different applications.

Practicals:

1. Identify the different parts (along with function and materials) for the given single phase and three phase induction motor.
2. Connect and run the three phase squirrel cage induction motors (in both directions) using the DOL, star-delta, auto-transformer starters (any two)
3. Perform the direct load test on the three phase squirrel cage induction motor and plot the i) efficiency versus output, ii) power factor versus output, iii) power factor versus motor current and iv) torque – slip/speed characteristics.
4. Conduct the No-load and Blocked-rotor tests on given 3-ϕ squirrel cage induction motor and determine the equivalent circuit parameters.

5. Conduct the No-load and Blocked-rotor tests on given 3-ϕ squirrel cage induction motor and plot the Circle diagram.
6. Control the speed of the given three phase squirrel cage/slip ring induction motor using the applicable methods: i) auto-transformer, ii) VVVF.
7. Measure the open circuit voltage ratio of the three phase slip ring induction motor.
8. Conduct the direct load test to determine the efficiency and speed regulation for different loads on the given single phase induction motor; plot the efficiency and speed regulation curves with respect to the output power.
9. Perform the direct loading test on the given three phase alternator and determine the regulation and efficiency.
10. Determine the regulation and efficiency of the given three phase alternator from OC and SC tests (Synchronous impedance method)
11. Conduct the test on load or no load to plot the 'V' curves and inverted 'V' curves (at no-load) of 3-ϕ synchronous motor.
12. Dismantling and reassembling of single phase motors used for ceiling fans, universal motor for mixer.
13. Control the speed and reverse the direction of stepper motor
14. Control the speed and reverse the direction of the AC servo motor
15. Control the speed and reverse the direction of the DC servo motor

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Maintain three phase induction motor used in different applications.
b) Maintain single phase induction motor used in different applications.
c) Maintain three phase alternators used in different applications.
d) Maintain synchronous motors used in different applications.
e) Maintain FHP motors used in different applications.

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Course Code	:	EEPC301
Course Title	:	MICROCONTROLLER APPLICATIONS
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Prerequisites (Course code)	:	NIL
Course Category	:	PC

Course objectives:

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 microcontroller based systems.

Course contents:

Unit – I Introduction to Microcontrollers

Evolution of Microcontrollers

Block diagram of Microcomputer, elements of Microcomputer, types of buses

Von Neuman and Harward Architecture

Compare Microprocessor and Microcontrollers

Need of Microcontroller

Family of Microcontrollers and their specifications

Versions of Microcontroller 8951, 89C1051, 89C2051, 89C4051 with their specifications and comparison

Unit – II Architecture of Microcontroller8051

Block diagram of 8051, function of each block

Pin diagram, function of each pin

Concept of Internal memory and External memory (RAM and ROM)

Internal RAM structure

Reset and clock circuit

Various registers and SFRs of 8051

Unit– III 8051 Instruction Set and Programs

Overview of 8051 instruction set

Various addressing modes

Classification of instructions

Data transfer instructions

Arithmetic instructions

Logical instructions

Branching instructions

Bit manipulation instructions

Stack, subroutine and interrupt related instructions

Programs based on above instructions.

Unit– IV Assembly Language Programming

Software development steps

Software development tools like Editor, Assembler, Linker, Loader and Hex converters.

Role of various files created at various levels in running a Assembly program using simulators like RIDE or KEIL.

Various directives of Assembly language programming

Programs using directives.

Unit– V 8051 Internal Peripherals and Related Programs

I/O ports- List, diagram, read write operation, instructions and related SFRs

Timers/counters – list, related SFRs, programming modes, operations with diagram.

Serial communication- Basics of serial communication, baud rate, related SFRs, programming modes, operations with diagram.

Interrupts- related SFRs, types, operations with diagram.

Power saving operation- modes, related SFR.

References:

1. Kenneth, Ayala, 8051 Microcontroller Architecture Programming and Application, PHI Learning, New Delhi,ISBN: 978-1401861582
2. Mazidi, Mohmad Ali; Mazidi, Janice Gelispe; MckinlayRoline D., The 8051 Microcontroller and Embedded system, Pearson Education, Delhi, ISBN 978-8177589030
3. Pal, Ajit, Microcontroller Principle and Application, PHI Learning, New Delhi, ISBN13: 978-81-203-4392-4
4. Deshmukh, Ajay, Microcontroller Theory and Application, McGraw Hill., New Delhi, ISBN- 9780070585959
5. Kamal, Raj, Microcontroller Architecture Programming, Interfacing and System Design, Pearson Education India, Delhi, ISBN: 9788131759905
6. Mathur; Panda, Microprocessors and Microcontrollers, PHI Learning, New Delhi, ISBN:978-81-203-5231-5
7. Krishna Kant, Microprocessors and Microcontrollers: Architecture programming and System Design, PHI Learning, New Delhi, ISBN:978-81-203-4853-0

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Interpret the salient features of various types of microcontrollers.

b) Interpret the salient features of architype of types microcontrollers IC 8051

c) Maintain the program features of the Microcontroller based application

d) Develop assembly language program

e) Develop programs to interface 8051 microcontrollers with LED/SWITCH

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Course Code	:	EEPC303
Course Title	:	MICROCONTROLLER APPLICATIONS LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites	:	NIL
Course Category	:	PC

Course objectives:

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

- Maintain microcontroller based systems.

Practicals:

1. Interpret details of Hardware kit for Microcontroller and practice to write and execute programs.
2. Identify different menus available in a simulator software RIDE/KEIL and demonstrate their use.
3. Develop and execute Assembly language programs using Arithmetic Instructions and demonstrate outcome for a given input data
4. Develop and execute Assembly language programs using Logical Instructions and demonstrate outcome for a given input
5. Develop and execute an Assembly language program for Addition of series of 8 bit nos, 16 bit result and demonstrate outcome for a given input data
6. Develop and execute Assembly language program for addition/subtraction of 16 bit no/multibyte nos. and demonstrate outcome for a given input data
7. Develop and execute Assembly language program for Block transfer from and to Internal/External memory using directives and demonstrate outcome for a given input data.
8. Develop and execute Assembly language program Largest/smallest of given series of no. from Internal/External memory and demonstrate outcome for a given input data.
9. Develop and execute Assembly language program arrange no in ascending/descending order from Internal/External memory and demonstrate outcome for a given input data.
10. Develop and execute Assembly language program for LED blinking/LED sequences using delay/timer mode.
11. Develop and execute Assembly language program to interface LED with microcontroller.

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Interpret the salient features of various types of microcontrollers.
b) Interpret the salient features of architype of types microcontrollers IC 8051
c) Maintain the program features of the Microcontroller based application
d) Develop assembly language program
e) Develop program to interface 8051 microcontrollers with LED/SWITCH

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Course Code	:	EEPC305
Course Title	:	ENERGY CONSERVATION AND AUDIT
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Prerequisites	:	NIL
Course Category	:	PC

Course objectives:

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

- Undertake energy conservation and energy audit.

Course contents:

Unit – I Energy Conservation Basics

Energy Scenario: Primary and Secondary Energy, Energy demand and supply,

National scenario.

Energy conservation and Energy audit; concepts and difference

Indian Electricity Act 2001; relevant clauses of energy conservation

BEE and its Roles

MEDA and its Roles

Star Labelling: Need and its benefits.

Unit – II Energy Conservation in Electrical Machines

Need for energy conservation in induction motor and transformer.

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

Energy conservation techniques in Transformer.

Loading sharing

Parallel operation

Isolating techniques.

Replacement by energy efficient transformers. Periodic maintenance.

Energy Conservation Equipment: Soft starters, Automatic star delta convertor, Variable Frequency Drives, Automatic p. f. controller (APFC), Intelligent p. f. controller (IPFC)

Energy efficient motor; significant features, advantages, applications and limitations.

Energy efficient transformers, amorphous transformers; epoxy Resin cast transformer / Dry type of transformer.

Unit– III Energy conservation in Electrical Installation systems

Aggregated Technical and commercial losses (ATC); Power system at state, regional, national and global level.

Technical losses; causes and measures to reduce by.

a) Controlling I^2R losses.
b) Optimizing distribution voltage
c) Balancing phase currents
d) Compensating reactive power flow

Commercial losses: pilferage, causes and remedies

Energy conservation equipment: Maximum Demand Controller , kVAR Controller, Automatic Power Factor controller(APFC)

Energy Conservation in Lighting System

a) Replacing Lamp sources.
b) Using energy efficient luminaries.
c) Using light controlled gears.
d) Installation of separate transformer / servo stabilizer for lighting.
e) Periodic survey and adequate maintenance programs.

Energy Conservation techniques in fans, Electronic regulators.

Unit– IV Energy conservation through Cogeneration and Tariff

Co-generation and Tariff; concept, significance for energy conservation

Co-generation

Types of cogeneration on basis of sequence of energy use (Topping cycle, Bottoming cycle)

Types of cogeneration basis of technology (Steam turbine cogeneration, Gas turbine cogeneration, Reciprocating engine cogeneration).

Factors governing the selection of cogeneration system.

Advantages of cogeneration.

Tariff: Types of tariff structure: Special tariffs; Time-off-day tariff, Peak-off-day tariff, Power factor tariff, Maximum Demand tariff, Load factor tariff.

Application of tariff system to reduce energy bill.

Unit– V Energy Audit of Electrical System

Energy audit (definition as per Energy Conservation Act)

Energy audit instruments and their use.

Questionnaire for energy audit projects.

Energy flow diagram (Sankey diagram)

Simple payback period, Energy Audit procedure (walk through audit and detailed audit).

Energy Audit report format.

References:

1. Guide Books No. 1 and 3 for National Certification Examination for Energy Managers and Energy Auditors, Bureau of Energy Efficiency (BEE), Bureau of Energy Efficiency (A Statutory body under Ministry of Power, Government of India) (Fourth Edition 2015).
2. O.P. Gupta, Energy Technology, Khanna Publishing House, New Delhi
3. Henderson, P. D., India - The Energy Sector, University Press, Delhi, 2016. ISBN*: 978-*0195606539
4. Turner, W. C., Energy Management Handbook, Fairmount Press, 2012, ISBN 9781304520708
5. Sharma, K. V., Venkataseshaiah; P., Energy Management and Conservation, I K International Publishing House Pvt. Ltd; 2011 ISBN 9789381141298
6. Mehta ,V. K., Principles of Power System, S. Chand &Co.New Delhi, 2016, ISBN 9788121905947
7. Singh, Sanjeev; Rathore, Umesh, Energy Management, S K Kataria&Sons,New Delhi ISBN-13: 9789350141014.
8. Desai, B. G.; Rana, J. S.; A. Dinesh, V.; Paraman, R., Efficient Use and Management of Electricity in Industry, Devki Energy Consultancy Pvt. Ltd.
9. Chakrabarti, Aman, Energy Engineering And Management, e-books Kindle Edition

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Interpret energy conservation policies in India.

b) Implement energy conservation techniques in electrical machines.

c) Apply energy conservation techniques in electrical installations.

d) Use Co-generation and relevant tariff for reducing losses in facilities.

e) Undertake energy audit for electrical system.

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Course Code	:	EEPC307
Course Title	:	ENERGY CONSERVATION AND AUDIT LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites	:	NIL
Course Category	:	PC

Course objectives:

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

- Undertake energy conservation and energy audit.

Practicals:

1. Identify star labelled electrical apparatus and compare the data for various star ratings.
2. Determine the '% loading' of the given loaded Induction motor.
3. Determine the reduction in power consumption in star mode operation of Induction motor compared to delta mode.
4. Use APFC unit for improvement of p. f. of electrical load.

5. Compare power consumption of different types of TL with choke, electronic ballast and LED lamps by direct measurements.
6. Determine the reduction in power consumption by replacement of lamps in a class room / laboratory.
7. Determine the reduction in power consumption by replacement of Fans and regulators in a class room / laboratory.
8. Collect electricity bill of an industrial consumer and suggest suitable tariff for energy conservation and its impact on energy bill.
9. Collect electricity bill of a commercial consumer and suggest suitable tariff for conservation and reduction of its energy bill.
10. Collect electricity bill of a residential consumer and suggest suitable means for conservation and reduction of the energy bill.
11. Estimate energy saving by improving power factor and load factor for given cases.
12. Prepare a sample energy audit questionnaire for the given industrial facility.
13. Prepare an energy audit report (Phase-I)
14. Prepare an energy audit report (Phase-II)
15. Prepare an energy audit report (Phase-III)

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Interpret energy conservation policies in India.
b) Implement energy conservation techniques in electrical machines.
c) Apply energy conservation techniques in electrical installations.
d) Use Co-generation and relevant tariff for reducing losses in facilities.
e) Undertake energy audit for electrical system.

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Semester – VI

Course Code	:	EEPC302
Course Title	:	BUILDING ELECTRIFICATION
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Prerequisites	:	NIL
Course Category	:	PC

Course objectives:

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

- Design electrical installation systems in building complexes.

Course contents:

Unit – I Wiring Tools and Accessories

Various tools required for wiring- screwdrivers, pliers, Try square, saws, hacksaw, chisel, hammers, mallet, rawl punch, hand drill machine, portable drilling machine, files, plumb bob, line thread, electricians knife, test lamp, tester and their BIS specifications, application, care & maintenance of tools.

Classification of electrical accessories- controlling, holding, safety, outlet

BIS symbols of following electrical accessories.

Switch – Their types according to construction such as surface switch, flush switch, and pull switch, rotary switch, knife switch, pendent switch, Main-switch (ICDP, ICTP). Their types according to working such as single pole, double pole, two-way, two-way centre off, intermediate, series parallel switch

Holders- Their types such as bayonet cap lamp holder, pendent holder, batten lamp holder, angle holder, bracket holder, tube light holder, screw type Edison and goliath Edison lamp holder, swivel lamp holder.

Socket outlets and plugs- two pin, three-pin, multi pin sockets, two-pin and three-pin plug.

Others- Iron connector, adaptor, and ceiling rose, distribution box, neutral link, bus-bar chamber.

Wooden/ mica boards, Moulded/ MS Concealed boxes of different sizes. Modular accessories.

Unit – II Electrical Wires and Underground Cables

Conductors: - wire, cable, bus bar, stranded conductor, cable, armoured cable,

flexible cable, solid conductor, PVC wires, CTS wire, LC wire, FR (Fire retardant) wire,

Size of wire according to BIS. Tools used for measurement of wire size, Wire jointing

methods.

Classification of cables, low tension, high tension, and extra high tension cables,

solid, oil filled and gas filled type

Cable insulation materials –vulcanized rubber (VIR), polyvinyl chloride (PVC), cross

linked polythene (XLPE), impregnated paper, Selection of suitable cable size and type

from standard data

Cable jointing methods

Cable laying methods.

Factors determining selection of electric cables

Unit– III Wiring Methods and wiring layout

Factors determining the selection of wiring methods.

Classification of wiring methods.

PVC casing-capping wiring- wiring rules according to IS: 732-1983

Conduit wiring- Types of conduit, comparison between Metal and PVC conduit, types of conduit wiring (Surface/Concealed). Conduit wiring accessories, BIS rules for Metal and PVC conduit wiring.

Comparison of various wiring systems.

General BIS rules for domestic installations.

Design, working and drawing of following electrical circuits: Simple light and fan circuits, Stair case wiring, Go-down wiring circuit, Bedroom lighting circuit, Corridor lighting circuit, Series parallel circuit, Master switch control circuit, Different lighting circuit using - Intermediate switch, Call bell circuit using bell indicator, Design of wiring circuits according to user's requirement

Unit– IV Residential Building Electrification

Domestic Dwellings/Residential Buildings: reading of Civil Engineering building drawing, Interpretation of electrical installation plan and electrical diagrams, electrical symbols as per IS: 732.

Electrical installation for residential building as per part I section 9 of NEC-2011

Difference between residential and industrial load, rules/requirements related to lighting load followed in electrical installations, Positioning of equipment.

Lighting and power circuits: Light and fan circuit, Power circuit

Wiring and circuit Schematic diagram according to IS: 2042(Part-I)-1962: multiline and single line representation

Load assessment: Selection of size of conducto, Selection of rating of main switch and protective switch gear.

Design and drawing, estimation and costing of a residential installation having maximum 5 KW load; Sequence to be followed for preparing estimate; Calculation of length of wire and other materials, labour cost

Testing of wiring installation as per IS: 732-1982: Insulation resistance - between earth and conductors, between conductors, polarity test of single pole switches. Testing of earth continuity path.

Residential building Service Connection- types Underground and overhead. Calculation of Material required for service connection

Unit– V Protection of Electrical Installation

Fuse in electric circuit: fuse element, fuse current rating, minimum fusing current, cut-off current, fusing factor, Fuse material

Types of fuses –Re-wirable, cartridge fuses (HRC and LRC), Fuse material Selection of fuse.

Miniature circuit Breaker (MCB)-Construction, Principle rating and uses, Earth Leakage Circuit Breaker (ELCB)-Construction, Principle rating and uses.

System and equipment earthing and its requirements, Earth, earth electrode, earth current, earth terminal, earthing wire, earthing lead, fault current, leakage current, Measurement of earth resistance using earth tester, Methods of reducing earth resistance,

Methods of earthing as per IS 3043: 1987 and their procedure- Driven pipe, pipe and plate earthing, modern methods of earthing,

Unit– V Illumination in Residential Installation

Concept of Luminous flux, Luminous intensity, Lumen, Illumination or illuminance, Lux, Space-height ratio, utilization factor, depreciation factor, luminous efficiency- values for different luminaries.

Laws of Illumination-Inverse Square Law, Cosine Law, illumination received directly underneath, horizontal screen and screen moved horizontally at certain distance

Factors affecting the illumination. Different types of lighting arrangements,

Luminous flux of different types of light sources, Lux level required for different places as per SP 72: 2010.

References:

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2. Allagappan,N. S.Ekambarram, Electrical Estimating and Costing, New Delhi, ISBN-13: 9780074624784
3. Singh, Surjit, Electrical Estimating and Costing, Dhanpat Rai and Co. New Delhi, ISBN: 1234567150995
4. Gupta, J B: A Course in Electrical Installation Estimating and Costing, S K Kataria and Sons,New Delhi, ISBN:978-93-5014-279-0
5. Bureau of Indian Standard, IS: 732-1989, Code of practice for electrical wiring installation
6. Bureau of Indian Standard, SP 30 National Electrical Code 2010
7. Bureau of Indian Standard, SP 72 National Lighting Codes 2010
8. E-REFERENCES:-
   - http://nptel.ac.in/courses/108108076/1 , assessed on 18th January 2016
   - http://www.electrical4u.com, assessed on 18th January 2016
   - https://www.youtube.com/watch?v=A9KSGAnjo2U, assessed on 18th January 2016
   - http://www.electricaltechnology.org/2015/09, assesed on 30 Jan 2016
   - www.slideshare.net/bawaparam/made-by-paramassesed on 30 Jan2016
   - www.electricaltechnology.org/2013/09/electrical-wiring.html assessed on 16 March 2016.

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Select accessories, wires, cables and wiring systems for electrification.
b) Design electrical wiring installation system for residential unit.
c) Design proper illumination scheme for residential unit.
d) Prepare wiring layouts on wiring board.
e) Locate and diagnose faults in electrical wiring installation.
f) Do proper earthing for building electrification.

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Course Code	:	EEPC304
Course Title	:	BUILDING ELECTRIFICATION LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites	:	NIL
Course Category	:	PC

Course objectives:

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

- Design electrical installation systems in building complexes.

Practicals:

1. Prepare series testing board.
2. Select the electric wire using measuring and testing instruments for particular applications.
3. Identify cables of different current ratings.
4. Prepare wiring installation on a board showing control of one lamp, one fan and one socket from one switch board in PVC surface conduit wiring system.
5. Prepare wiring installation on a board.
6. Control one lamp from two different places using PVC surface conduit wiring system.
7. Prepare wiring installation on a board. Control one lamp from three different places using PVC surface conduit wiring system.
8. Prepare wiring installation on a board.
9. Perform go-down wiring for three blocks using PVC casing capping.
10. Design 2 BHK residential installation scheme and estimate the material required. And draw the details required for installation on A4 size sheet.
11. Test wiring installation using megger.

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Select accessories, wires, cables and wiring systems for electrification.
b) Design electrical wiring installation system for residential unit.
c) Design proper illumination scheme for residential unit.
d) Prepare wiring layouts on wiring board.
e) Locate and diagnose faults in electrical wiring installation.
f) Do proper earthing for building electrification.

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PROGRAMME ELECTIVE COURSES (EEPE***) COURSES

Course Code	:	EEPE***
Course Title	:	INDUSTRIAL INSTRUMENTATION AND CONDITION MONITORING
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Prerequisites	:	NIL
Course Category	:	PE

Course objectives:

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

- Use instrumentation equipment for condition monitoring and control.

Course contents:

Unit – I Fundamentals of instrumentation

Basic purpose of instrumentation.

Basic block diagram (transduction, signal conditioning, signal presentation) and their function.

Construction, working and application of switching devices- Push button, limit switch, float switch, pressure switch, thermostat, electromagnetic relay.

Unit – II Transducers

Distinguish between Primary and Secondary, Electrical and Mechanical, Analog and Digital, Active and Passive. Mechanical devices pry. And sec. transducers

Advantages of electric transducers

Required characteristics of transducers.

Factors affecting the choice of transducers

Construction and principle of resistive transducer-Potentiometer –variac and strain gauges -No derivation. Only definition and formula for gauge factor

Types of strain gauges like unbonded, bonded and semiconductor.

Construction and principle of Inductive transducers-L.V.D.T. and R.V.D.T, their applications.

Construction, principle and applications of transducers – Piezo-Electric transducer, photo-conductive cells, photo voltaic cells.

Unit– III Measurement of Non-Electrical Quantities

Temperature measurement - Construction and Working of RTD, Thermistor and Thermocouple, radiation pyrometer, technical specifications and ranges.

Pressure measurement – Construction and working of bourdon tube, bellow diaphragm and strain gauge, Combination of diaphragm and inductive transducer, Bourdon tube and LVDT, bellow and LVDT, diaphragm capacitance and bridge Circuit.

Construction and Working of Speed Measurement by contacting and non-Contact Type- DC tachometer, photo- electric tachometer, toothed rotor tachometer Generator - magnetic pick-up and Stroboscope.

Construction and Working of Vibration measurement by accelerometer-LVDT accelerometer,

Piezo electric type.

Construction and Working of Flow measurement by electromagnetic and Turbine Flow meter.

Construction and Working of Liquid level measurement by resistive, inductive, Capacitive gamma rays and Ultrasonic methods.

Construction and Working of Thickness measurement by resistive, inductive, capacitive, ultrasonic and Nuclear methods.

Unit– IV Signal Conditioning

Basic Concept of signal conditioning System.

Draw pin configuration of IC 741.

Define Ideal OP-AMPand Electrical Characteristics of OP-AMP.

Different Parameters of op-amp:-Input offset voltage, Input offset current, Input bias current, Differential input resistance, CMMR, SVRR, voltage gain, output voltage, slew rate, gain bandwidth. Output, short circuit current.

Use of op-amp as inverting, non- inverting mode, adder, subtractor, and Working of Differential amplifier and instrumentation amplifier.

Filters: Types of RC filters and frequency response -no derivation.

Sample and hold circuits - operation and its application.

Unit– V Data Acquisition System

Generalized DAS- Block diagram and description of Transducer, signal conditioner, multiplexer, converter and recorder

Draw Single Channel and Multi-channel DAS- Block diagram only. Difference between Signal Channel and Multi-Channel DAS.

Data conversion- Construction and Working of Analog to digital conversion- successive approximation method, ramp type method.

Digital to Analog conversion- Construction and Working of binary weighted resistance method.

Concept and methods of data transmission of electrical and electronic transmission.

Construction and principle of telemetry system and its type - Electrical telemetering system-

Digital display device- operation and its application of seven segment display, dot matrix display and concept of 3½, 4½ digits, LED and LCD applications

Unit– VI Condition Monitoring and Diagnostic Analysis

Definition of condition monitoring

Insulation deterioration Mechanism- factors affecting occurrence and rate of deterioration, types of stresses responsible for deterioration

Different tests on transformer, their purpose, and the necessary condition of machine.

Tests on Circuit breaker, purpose and required condition of machine

Tests on CT, purpose, item to be tested and required condition of machine.

Power factor, capacitance /tan delta test

Insulation and Polarization index, DC winding resistance test, Turns Ratio test

Tools and equipment used in Condition monitoring

References:

1. Sawhney, A.K. Electric and Electronic Measurement and instrumentation, Dhanpat Rai and Co. Author, Nineteenth revised edition 2011 reprint, 2014, ISBN:10: 8177001000
2. Rangan, C.S. G.R.Sharma. andV.S.V.Mani, Instrumentation devices and system, Pen ram International *Publishing* India Pvt. Ltd. Fifth edition, ISBN:10: 0074633503
3. Mehta, V.K. Electronics and instrumentation, Third edition-S.Chand and company Pvt Ltd Reprint, 2010, ISBN:81-219-2729-3
4. Singh, S.K. Industrial instrumentation and control, Tata McGraw-Hill, 1987. ISBN: 007451914X, 9780074519141.
5. J.G. Joshi, Electronic Measurement and Instrumentation, Khanna Publishing House, New Delhi (ISBN: 978-93-86173-621)

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Select relevant instruments used for measuring electrical and non-electrical quantities.
b) Select relevant transducers/sensors for various applications.
c) Use relevant instruments for measuring non-electrical quantities.
d) Check the signal conditioning and telemetry system for their proper functioning.
e) Use data acquisition systems in various applications.
f) Undertake condition monitoring for diagnostic analysis of electrical equipment

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Course Code	:	EEPE***
Course Title	:	INDUSTRIAL INSTRUMENTATION AND CONDITION MONITORING LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites	:	NIL
Course Category	:	PE

Course objectives:

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

- Use instrumentation equipment for condition monitoring and control.

Practicals:

1. Identify different switches used in instrumentation system.
2. Measure linear displacement by L.V.D.T.
3. Measure the strain with the help of strain gauge
4. Measure temperature by PT-100, thermistor, thermocouple along with simple resistance bridge.
5. Use Thermocouple to control the temperature of a furnace/machine.

6. Measure pressure using pressure sensor kit.
7. Measure angular speed using stroboscope and tachometer.
8. Measure the flow using flow meter.
9. Use op-amp as inverter, non-inverting mode, adder, differentiator and integrator.
10. Convert digital data into analog data by using analog to digital converters and analog data into digital data by digital to analog converter.
11. Visit to testing center of electrical testing lab for tan delta and diagnostic tests and determine polarization index
12. Prepare a Report on various tools and equipment used for condition monitoring of electrical machines]I9KYI

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Select relevant instruments used for measuring electrical and non-electrical quantities.
b) Select relevant transducers/sensors for various applications.
c) Use relevant instruments for measuring non-electrical quantities.
d) Check the signal conditioning and telemetry system for their proper functioning.
e) Use data acquisition systems in various applications.
f) Undertake condition monitoring for diagnostic analysis of electrical equipment.

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Course Code	:	EEPE***
Course Title	:	INDUSTRIAL AUTOMATION AND CONTROL
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Prerequisites	:	NIL
Course Category	:	PE

Course objectives:

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

- Maintain Industrial Automation Systems.

Course contents:

Unit – I Introduction to Industrial Automation

Automation: Need and benefits.

Types of automation system: Fixed, Programmable, Flexible

Different systems used for Industrial automation: PLC, HMI, SCADA, DCS, Drives.

Evolution of PLC.

Unit – II PLC Fundamentals

Building blocks of PLC**:** CPU, Memory organization, Input- output modules (discrete and analog), Specialty I/O Modules, Power supply

Fixed and Modular PLC and their types, Redundancy in PLC module

I/O module selection criteria

Interfacing different I/O devices with appropriate I/O modules

Unit– III PLC Programming and Applications

PLC I/O addressing

PLC programming Instructions**:** Relay type instructions, Timer instructions: On delay, off delay, retentive, Counter instructions: Up, Down, High speed, Logical instructions, Comparison Instructions, Data handling Instructions, Arithmetic instructions.

PLC programming language**:** Functional Block Diagram (FBD), Instruction List. Structured text, Sequential Function Chart (SFC), Ladder Programming.

Simple Programming examples using ladder logic**:** Language based on relay, timer counter, logical, comparison, arithmetic and data handling instructions.

PLC Based Applications: Motor sequence control, Traffic light control, Elevator control, Tank Level control, Conveyor system, Stepper motor control, Reactor Control Gate trigger circuits – Resistance and Resistance-Capacitance circuits.

Unit– IV Electric Drives and special machines

Electric drives: Types, functions, characteristics, four quadrant operation.

DC and AC drive controls: V/F control, Parameters, direct torque control.

Drives: Specifications, Applications- Speed control of AC motor /DC Motor.

Unit– V Supervisory Control and Data Acquisition System (SCADA)

Introduction to SCADA: Typical SCADA architecture/block diagram, Benefits of SCADA

Various editors of SCADA

Interfacing SCADA system with PLC: Typical connection diagram, Object Linking & embedding for Process Control(OPC) architecture, Steps in Creating SCADA Screen for simple object, Steps for Linking SCADA object (defining Tags and Items) with PLC ladder program using OPC.

Applications of SCADA: Traffic light control, water distribution, pipeline control.

References:

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Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Identify different types of automation systems.

b) Interface I/O devices with the PLC modules.

c) Develop PLC ladder programs for various applications.

d) Select the suitable motor drives for different applications

e) Prepare simple SCADA applications.

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Course Code	:	EEPE***
Course Title	:	INDUSTRIAL AUTOMATION AND CONTROL LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites(Course code)	:	NIL
Course Category	:	PE

Course objectives:

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

- Maintain Industrial Automation Systems.

Practicals:

1. Identify various automation systems available in different appliances/ devices/ machines in day to day use.
2. Identify various parts of the given PLC and front panel status indicators.
3. Use PLC to test the START STOP logic using two inputs and one output.
4. Develop/Execute a ladder program for the given application using following: - timer, counter, comparison, logical, arithmetic instructions.
5. Use PLC to control the following devices like lamp, motor, push button switches, proximity sensor
6. Measure the temperature of the given liquid using RTD or Thermocouple and PLC.
7. Develop/test ladder program to blink the LED/lamp.
8. Develop / test the Ladder program for sequential control application of lamps/ DC motors.
9. Develop ladder program for Traffic light control system.
10. Develop and test ladder program for pulse counting using limit switch /Proximity sensor.
11. Develop /test ladder program for Automated car parking system.
12. Develop / test ladder program for Automated elevator control.
13. Develop / test ladder program for rotating stepper motor in forward and reverse direction at constant speed.
14. Develop /test ladder program for tank water level control.

15. Develop / test ladder program for control of speed of stepper motor with suitable drivers.
16. Identify various front panel controls of VFD (smart drive).
17. Control speed of AC/DC motor using VFD. (VFD-Variable Frequency Drive)
18. Use various functions of SCADA simulation editors to develop simple project.
19. Develop a SCADA mimic diagram for Tank level control.
20. Develop SCADA mimic diagram for Flow control in a given system.
21. Simulate Tank level control using available SCADA system.

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Identify different types of automation systems.
b) Interface I/O devices with the PLC modules.
c) Develop PLC ladder programs for various applications.
d) Select the suitable motor drives for different applications.
e) Prepare simple SCADA applications.

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Course Code	:	EEPE***
Course Title	:	INDUSTRIAL DRIVES
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Prerequisites (Course code)	:	NIL
Course Category	:	PE

Course Objectives:

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

- Maintain electric AC and DC Drives.

Course contents:

Unit – I Electric Drives

Need of Electric Drives, Functional Block diagrams of an electric drives.

DC Motors, Motor Rating

a. Series, Shunt and compound DC motors.
b. Universal motor
c. Permanent magnet motor
d. DC servo motor
e. Moving coil motor
f. Torque motor.

Starting and Braking of DC Motors

Brushless DC Motors for servo applications.

Maintenance procedure.

Unit – II AC Motors

Single phase AC Motors

a) Resistance split phase motors

b) Capacitor run motors

c) Capacitor start motors

d) Shaded pole motors

Three phase Induction Motors

a) Squirrel cage Induction motor

b) Slip ring Induction Motor

c) Starting methods of Induction Motor

d) Braking methods of Induction Motor

Determination of Motor Rating

Maintenance procedure.

Unit– III DC Drives

Single phase SCR Drives

a) Half wave converter

b) Full wave converter

c) Semi converter

d) Dual converter

Three Phase SCR Drives

a) Half wave converter

b) Full wave converter

c) Semi converter

d) Dual converter

Reversible SCR Drives.

Speed control methods of DC series Motor

Chopper Controlled DC Drives

Solar and battery powered vehicles

Maintenance procedure.

Unit– IV AC Drives

Starting and Braking of Induction motors.

Stator voltage control

Variable Frequency Control

Voltage Source Inverter Control

Current Source Inverter Control

Rotor Resistance Control

Slip Power Recovery

Solar powered pump drives

Maintenance procedure for AC drives

Sequences of stages & drives required in each stage for following applications:

a) Textile mills
b) Steel rolling mills
c) Paper mills
d) Sugar mills

Unit– V Advanced Techniques of Motor Control

Microcontroller/ Microprocessor based control for drives

Phase locked loop control of DC motor.

AC/DC motor drive using Microcomputer control

AC/DC motor drive using Microcontroller control.

Synchronous Motor drives.

Ratings & specifications of stepper motor.

Stepper motor drives employing microcontroller (No programming)

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Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Select relevant DC motor for various electric drive applications.

b) Select relevant AC motor for various electric drive applications.

c) Maintain DC Drives.

d) Maintain AC Drives.

e) Maintain microprocessor/micro controlled electric motors.

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Course Code	:	EEPE***
Course Title	:	INDUSTRIAL DRIVES LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites (Course code)	:	NIL
Course Category	:	PE

Course objectives:

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

- Maintain electric AC and DC Drives.

Practicals:

1. Dismantle the given DC motor and identify its different parts
2. Dismantle the given AC motor and identify its different parts
3. Control the speed of DC Motor using armature voltage control method
4. Control the speed of DC Motor using field current control method
5. Measure the output voltage of chopper for resistive load by varying the frequency and /or duty cycle of chopper.
6. Control the speed of three phase squirrel cage induction motor using stator voltage control method.
7. Effect on speed of given D.C. series motor by varying armature voltage using step down chopper.
8. Observe the effect on speed of the given D.C. separately excited motor by varying voltage using step down chopper.
9. Control the speed of the given separately excited motor by changing the firing angle of SCR using single phase semi converter and measure the speed.
10. Control the speed of the given separately exited motor by changing the firing angle of SCR using single phase full converter and measure the speed
11. Control the speed of the given three phase induction motor by using constant V/f method and plot the graph between speed and frequency.
12. Control the speed of the given three phase induction motor by varying frequency and plot the graph between speed and frequency
13. Control the speed of the given synchronous motor drives using microcontroller.
14. Demonstrate High power SCR/power device and Heat sink and write their specifications and rating.
15. Control the speed of single phase capacitor split phase induction motor using DIAC –TRIAC circuit.
16. Control the speed of DC motor drives using microcontroller.

17. Identify different parts and assemble the given DC motor.
18. Identify different parts and assemble the given AC motor.

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Select relevant DC motor for various electric drive applications.
b) Select relevant AC motor for various electric drive applications.
c) Maintain DC Drives.
d) Maintain AC Drives.
e) Maintain microprocessor/micro controlled electric motors.

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Course Code	:	EEPE***
Course Title	:	COMMUNICATION TECHNOLOGIES
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Prerequisites(Course code)	:	NIL
Course Category	:	PE

Course objectives:

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

- Use relevant data communication technique.

Course contents:

Unit – I Data Communication and Modulation

Block diagram of communication system

Types of communication system: synchronous and asynchronous, simplex, half-duplex, Full duplex, serial and parallel communication

Classification of communication technique: AM, FM, & PM on the basis of definition, wave-form, bandwidth, modulation index

Modulation and demodulation: Block diagram of AM, FM and PM

Pulse Modulation: Block diagram for waveform generation of PAM,PWM& PPM, working principle, advantages, disadvantages and applications.

Advantages of pulse modulation over AM and FM.

Unit – II Digital Modulation Techniques

Digital Communication: Block diagram and working principle, waveforms, strength and limitations

Sampling process Nyquist sampling theorem, quantization process, quantization error, quantization noise

PCM: Block diagram, working principle, waveforms, advantages, disadvantages, application of PCM.

Principle of ASK, PSK, FSK. Application of ASK, PSK, FSK

Unit– III Data Communication Media

Baud rate, Bit rate, types of errors in data communication and error correction techniques.

Types of communication media and frequency band of operation

Guided media: Types of cable-twisted pair cable, co-axial cable, fiber optic cable.

Unguided media: Microwave communication, Infrared communication.

Unit– IV Fibre Optics

Introduction to Fiber optic communication.

Strength and limitations of fiber optic system

Light propagation : reflection, refraction, Snell's law

Light propagation through cable: Mode of propagation, index profile

Fibre optic cables: cable construction, fibre optics cable modes, single mode, step index fibre, multimode index fibre, multimode graded index fibre, fibre cable losses.

Light source and Detector: Light emitting diode (LED), Photo Transistor, Laser diode, opto-coupler.

Unit– V Data Communication Protocols and Interfacing Standard

OSI (Open Systems Interconnection) Reference model

Introduction to protocol, FTP, SMTP, TCP/IP, UDP

LAN standards.

Introduction to IEEE Standards for LAN and GPIB

RS-232 standard: Introduction, and working principle

Network topologies, introduction star, ring, tree, bus, mesh, hybrid

Basic functions of networking devices: modem, switches, routers, repeaters, hubs, bridges, gateway.

Unit– VI Advanced Data Communication

Introduction to Wi-Fi and Wi- Max

Bluetooth architecture and its layers,

Universal serial bus (USB) architecture.

Bluetooth and USB

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Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Identify the different types of data communication equipment and techniques.
b) Use relevant digital modulation techniques.
c) Interpret the specifications of the data communication media.
d) Maintain the fibre optics networks for data communication.
e) Use OSI model and relevant data communication protocols.
f) Maintain wireless network environment.

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Course Code	:	EEPE***
Course Title	:	COMMUNICATION TECHNOLOGIES LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites (Course code)	:	NIL
Course Category	:	PE

Course objectives:

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

- Use relevant data communication technique.

Practicals:

1. Measure the modulation index of amplitude modulated wave and observe the effect of modulating signal voltage on it.

2. Measure the modulation index of the frequency modulated wave and observe the effect of modulating and Carrier signal voltage on Frequency Modulation.
3. Test Pulse Amplitude Modulation (PAM)signal.
4. Test Pulse Width Modulation signal.
5. Test Pulse Position Modulation Signal.
6. Test Pulse Code Modulation Signal.
7. Test Amplitude Shift Keying Signal
8. Test Frequency Shift Keying Signal
9. Test Phase shift Keying Signal.
10. Plot the V-I Characteristics of given Infra-Red Light Source(IR-LED)
11. Test UTP/STP cable in straight and crossover mode and by line tester.
12. Plot the V-I Characteristics of given Light Source(LED) and detector(photo transistor)
13. Use OFT trainer Kit given 1mm. diameter Plastic optical fibre at 650 nm to determine the Numerical Aperture (NA).
14. Create the scenario and study the performance of token ring LAN protocol through simulation and using trainer kit.
15. Install and configure TCP/IP protocol.
16. Perform the transfer of files from PC to PC using Windows
17. Perform the transfer of a file from PC to another PC using Serial port RS-232
18. Establish star topology using transmission media and network control device.
19. Establish Wireless Communication between five computers using wireless LAN.
20. Establish Bluetooth communication using 4G mobile and laptop.

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Identify the different types of data communication equipment and techniques.
b) Use relevant digital modulation techniques.
c) Interpret data communication media.
d) Use fibre optics in data communication.
e) Use OSI model and relevant data communication protocols.
f) Maintain wireless network environment.

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Course Code	:	EEPE***
Course Title	:	ELECTRICAL TESTING AND COMMISIONING
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Prerequisites	:	NIL
Course Category	:	PC

Course objectives:

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

- Follow standard safety procedures in testing and commissioning of electrical equipment.

Course contents:

Unit – I Electrical Safety and Insulation

Do's and don'ts regarding safety in domestic electrical appliances as well for substation/ power station operators

Electrical safety in industry/power stations/ substations at the time of operation/ control/ maintenance. Fire detection alarm, fire-fighting equipments

Factors affecting life of insulating materials, classifications of insulating materials as per IS:1271-1958

Measuring insulation resistance by different methods such as i) Polarization, ii) Dielectric absorption, iii) Megger and to predict the condition of insulation

Reconditioning of insulation,

Insulating oil - properties of insulating oil, causes of deterioration of oil,

testing of transformer oil as per IS 1866-1961

Unit – II Installation and Erection

Concept of foundation for installation of machinery. Requirements of foundation for static and rotating electrical machinery.

Concept of leveling and aligning Procedure for leveling and aligning alignment of direct coupled drive, effects of mis-alignment

Installation of transformer as per I.S.-1886-1967 and procedure of installation of transformer, Requirements of installation of pole mounted transformer

Requirements of installation of rotating electrical machines as per I.S. 900 - 1965

Devices and tools required for loading, unloading, lifting, and carrying heavy equipment and precautions to be taken while handling them.

Unit– III Testing and Commissioning

Concept of testing, Objectives of testing. Roles of I.S.S. in testing of electrical equipment, Types of tests and concepts, Routine tests, type tests, supplementary test, special tests, Methods of testing - Direct/Indirect/Regenerative testing.

Tolerances for the various items for equipment –transformer, induction motor, dc motor, synchronous machines

Commissioning, Tests before Commissioning for transformer, induction motor, alternator

Testing of transformer as per I.S.1886- 1967 and I.S.2026- 1962

Testing of three-phase Induction motor as per I.S.325 - 1970.

Testing of single-phase induction motor as per I.S.990-1965.

Testing of synchronous machines as per ISS

Testing of D.C. machines

Unit– IV Troubleshooting Plans

Internal and external causes for failure / abnormal operation of equipment.

List of mechanical faults, electrical faults and magnetic faults in the electrical equipment remedies, applications

Use of tools like bearing puller filler gauges, dial indicator, spirit level, megger, earth tester, and growler. Common troubles in electrical equipments and machines.

Preparation of trouble shooting charts for D.C. Machines, AC Machines and transformers.

Unit– V Maintenance

Concept of maintenance, types of maintenance, Routine, preventive and breakdown maintenance.

Causes of failure of electrical machines

Preventive maintenance-procedure or developing maintenance schedules for electrical machines.

Factors affecting preventive maintenance schedules, Concept of TPM, Pillars of TPM

Identification of different types of faults developed such as mechanical/ electrical/ magnetic faults

Maintenance schedules of the following as per I.S.S.

a) Distribution transformer as per I.S.1886-1967
b) Single phase and three phase Induction motors as per I.S.900-1965.
c) Batteries

References:

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2. Rao, B V S Asia Club House, First Reprint, 2011, Operation and Maintenance of Electrical Equipment Vol-I, ISBN No 8185099022
3. Rosenberg. Mc GRAW-HILL, 1st Edition, May 2003, Maintenance and Repairs, ISBN No 9780071396035
4. Sharotri, S.K. Glencoe/ Mcgraw- Hill; 2ndEdition , June 1969; Preventive Maintenance of Electrical Apparatus, ISBN No 10: 007030839X 13: 978-0070308398

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Follow safety procedures with respect to earthing and insulation of electrical equipment
b) Select proper tools, equipment, for installation, testing, maintenance of electrical machines and transformers
c) Test and commission electrical equipment in accordance with IS codes
d) Make plans for troubleshooting electrical machines.
e) Undertake regular preventive and breakdown maintenance.

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Course Code	:	EEPE***
Course Title	:	ELECTRICAL TESTING AND COMMISIONING LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites	:	NIL
Course Category	:	PE

Course objectives:

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

- Follow standard safety procedures in testing and commissioning of electrical equipment.

Practicals:

1. Determine breakdown strength of transformer oil.
2. Perform insulation resistance test on any one motor/transformer.
3. Prepare trouble shooting charts for electrical machines such as Transformer, D.C. machines, Induction motor, and Synchronous machines
4. Measure impedance voltage and load losses of three-phase transformer.
5. Find regulation and efficiency of single-phase transformer by direct loading and back-to-back connection method and compare the results.
6. Determine efficiency of D.C. machine by Swinburne's test.
7. Determine efficiency of D.C. machine by Hopkinson's test.
8. Perform reduced voltage running up test on three-phase Induction motor as per I.S.325 -1967.
9. Measure no load losses and no load current of a transformer as per IS.
10. Perform no load test on single phase Induction motor for the measurements of no load current, power input, and speed at rated voltage as per I.S.
11. Perform temperature rise test on single-phase transformer.
12. Find efficiency of M.G. set

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Follow safety procedures with respect to earthing and insulation of electrical equipment
b) Select proper tools, equipment, for installation, testing, maintenance of electrical machines and transformers
c) Test and commission electrical equipment in accordance with IS codes
d) Make plans for troubleshooting electrical machines
e) Undertake regular preventive and breakdown maintenance.

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Course Code	:	EEPE***
Course Title	:	ELECTRICAL ESTIMATION AND CONTRACTING
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Prerequisites	:	NIL
Course Category	:	PE

Course objectives:

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

- Design electrical installation with costing for tendering

Course contents:

Unit – I Electric Installation and Safety

Scope and features of National electric code 2011

Types of electrical installation

Fundamental principles for electrical installation

Permit to work, safety instructions and safety practices

Purpose of estimating and costing.

Unit – II Estimation and Costing

Meaning and purpose of- Rough estimate, detailed estimate, supplementary estimate, annual maintenance estimate and revised estimate

Factors to be considered while preparation of detailed estimate and economical execution of work

Contracts- Concepts of contracts, types of contracts, contractor, role of contractor

Tenders and Quotations- Type of tender, tender notice, preparation of tender document, and method of opening of tender

Quotation, quotation format, comparison between tender and quotation

Comparative statement, format comparative statement. Order format, placing of purchasing order.

Principles of execution of works, planning, organizing and completion of work, Billing of work

Unit– III Non-Industrial Installations

Types of Non-industrial installations-- Office buildings, shopping and commercial centre, residential installation, Electric service and supply

Design consideration of electrical installation in commercial buildings.

Design procedure of installation- steps involved in detail, Estimating and costing of unit

Earthing of commercial installation.

Design electrical installation scheme of commercial complex.

Erection, Inspection and testing of installation as per NEC

Unit– IV Industrial Installation

Classification of industrial buildings Classification based on power consumption,

Drawing of wiring diagram and singleline diagram for single phase and three phase

Motors.

Design consideration in industrial installations Design procedure of installation-detailed steps

Design electrical installation scheme of factory/ small industrial unit, Preparation of material schedule and detailed estimation

Installation and estimation of agricultural pump and flourmill

Unit– V Public Lighting Installation

Classification of outdoor installations streetlight/ public lighting installation

Street light pole structures. Selection of equipments, sources used in street light installations.

Cables, recommended types and sizes of cable. Control of street light installation.

Design, estimation and costing of streetlight

Preparation of tenders and abstracts.

Unit– VI Distribution Lines and LT Substation

Introduction to overhead and underground distribution line.

Materials used for distribution line HT and LV

Cables used for distribution line, factors determining selection of LT/ HT power Cables, cable laying and cable termination method according to IS

Design, estimation and costing of HT LT overhead line and underground cabling.

Types of 11 KV Distribution substations their line diagram, Estimation of load, Load factor, diversity factor and determination of rating of distribution.

Transformer. Design, estimation and costing of outdoor and indoor 11 KV substation.

References:

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5. Bureau of Indian Standard. IS: 732-1989, Code of Practice for Electrical Wiring Installation
6. Bureau of Indian Standard. SP-30:2011, National Electrical Code 2011

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Follow National Electrical Code 2011 in electrical installations.

b) Estimate the electrical installation works

c) Estimate the work of non-industrial electrical installations.

d) Estimate the work of industrial electrical installations.

e) Prepare abstract, tender, quotation of public lighting and other installations.

f) Prepare abstract, tender, quotation of low tension (LT) substations.

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Course Code	:	EEPE***
Course Title	:	ELECTRICAL ESTIMATION AND CONTRACTING LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites	:	NIL
Course Category	:	PE

Course objectives:

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

- Design electrical installation with costing for tendering.

Practicals:

1. Prepare a tender notice for purchasing a transformer of 200 KVA for commercial installation.
2. Prepare a quotation for purchasing different electrical material required.
3. Prepare a comparative statement for above material Prepare purchase order for the same.
4. Design drawing, estimating and costing of hall / cinema theater / commercial installation Prepare report and draw sheet.
5. Design electrical installation scheme for any one factory / small industrial unit. Draw detailed wiring diagram. Prepare material schedule and detailed estimate. Prepare report and draw sheet.
6. Estimate with a proposal of the electrical Installation of streetlight scheme for small premises after designing.
7. Estimate with a proposal of the L.T. line installation. Prepare report and draw sheet.
8. Estimate with a proposal of the 500 KVA, 11/0.433 KV outdoor substation and prepare a report

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Follow National Electrical Code 2011 in electrical installations.

b) Estimate the electrical installation works

c) Estimate the work of non-industrial electrical installations.

d) Estimate the work of industrial electrical installations.

e) Prepare abstract, tender, quotation of public lighting and other installations.

f) Prepare abstract, tender, quotation of low tension (LT) substations.

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Course Code	:	EEPE***
Course Title	:	ILLUMINATION PRACTICES
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Prerequisites	:	NIL
Course Category	:	PE

Course objectives:

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

- Design illumination schemes and associated electrification of buildings.

Course contents:

Unit – I Fundamentals of illumination

Basic illumination, Terminology, Laws of illumination

Polar curves, polar curve: its meaning and applications for designing the lamp.

Concept of Photometry, Measurement of illumination

Lighting calculation methods, Watt /m^2 method, Lumens or light flux method, Point to point method

Standards for illumination

Unit – II Types of lamps

Incandescent lamp, ARC lamps – AC and DC arc lamps, Fluorescent lamp

Types of other lamps: Mercury vapour lamp, HPMV lamp, Mercury iodide lamp, Sodium vapour lamp, Halogen Lamps, Ultraviolet Lamps, Neon Lamps. Neon Sign Tubes. Metal halides, HID and Arc lamps

LED lamps, CFL, Lasers

Selection Criteria for lamps

Unit– III Illumination Control and Control Circuits

Purpose of lighting control, and Dimmer, Resistance type Salt water Dimmer

Working principle and operation of Dimmer

Transformer and their types, Dimmer Transformer, Auto transformer dimmer, Two winding transformer dimmer

Electronic Dimmer: working principle and operation

a. Thyristor operated dimmer
b. Triac operated dimmer

Control of Enhance Lighting, Methods used for light control, Control circuits for lamps (refer): ON/OFF control

Control circuits for lamps: single lamp controlled by single switch, two switches.

Single Lamp control by two point method, three point method and four point method,

Unit– IV Illumination for Interior Applications

Standard for various locations of Interior Illumination

Design considerations for Interior location of residences (1/2/3/4 BHK), Commercial, Industrial premises

Illumination scheme for different Interior locations of Residential, Commercial, industrial unit

Unit– V Illumination for Interior Applications

Factory Lighting

Street Lighting (Latest Technology), Flood Lighting

Railway Lighting

Lighting for advertisement /Hoardings/sports lighting, Agriculture and Horticulture lighting, Health Care Centres / Hospitals, Decorating Purposes, Stage Lighting, Aquariums and Shipyards

Special purpose lamps used in photography video films.

References:

1. Lindsey, Jack L., Applied Illumination Engineering, The Fairmont Press Inc.
2. Simons, R. H., Bean, Robert; Lighting Engineering: Applied Calculations, Architectural Press. ISBN: 0750650516.
3. Casimer M Decusatis, Handbook of Applied Photometry, Springer, ISBN 1563964163.
4. Butterworths, Lyons Stanley, Handbook of Industrial Lighting, Butterworths
5. Simpson Robert S, Lighting Control Technology and Applications, Focal Press
6. Kao Chen, Energy Management in Illuminating Systems, CRC Press

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Select relevant lamps for various applications considering illumination levels
b) Select the lighting accessories required for selected wiring scheme.
c) Design relevant illumination schemes for interior applications.
d) Design Illumination schemes for various applications
e) Design Illumination schemes for various outdoor applications.

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Course Code	:	EEPE***
Course Title	:	ILLUMINATION PRACTICES LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites	:	NIL
Course Category	:	PE

Course objectives:

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

- Design illumination schemes and associated electrification of buildings.

Practicals:

1. Conduct illumination level assessment in workplace using lux meter.
2. Fit the given lamp in the selected mounting
3. Interpret the polar curves of the given type of lamp and verify it using the lux meter
4. Measure the illumination output of different lamps (Incandescent, Fluorescent, CFL, LED, HPSV, HPMV) and compare it with their wattage.
6. Measure illumination level with and without reflectors used in the various Luminaries.
7. Estimate and compare luminous efficiency of incandescent and compact fluorescent lamp.
8. Prepare light dimmer arrangement using the relevant dimmer type of transformer
9. Identify the given types of dimmer transformer and their parts
10. Build an electronic dimmer – Part I
11. Build another type of electronic dimmer – Part II
12. Build a single lamp control by single switch
13. Build a single lamp control by two switches
14. Build a single lamp control circuit for two-point method
15. Build a lamp control circuit for three-point method
16. Build a lamp control circuit for four-point method.

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Select the relevant Illumination levels for various applications
b) Select relevant lamps for various applications
c) Select the lighting accessories required for selected wiring scheme.
d) Design relevant illumination schemes for interior applications.
e) Design Illumination schemes for various applications
f) Design Illumination schemes for various outdoor applications.

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Course Code	:	EEPE***
Course Title	:	SWITCHGEAR AND PROTECTION
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Prerequisites	:	NIL
Course Category	:	PE

Course objectives:

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

- Maintain switchgear and protection schemes used in electrical power systems.

Course contents:

Unit – I Basics of Protection

Necessity, functions of protective system.

Normal and abnormal conditions.

Types of faults and their causes.

Protection zones and backup protection

Short circuit fault calculations in lines fed by generators through transformers

Need of current limiting reactors and their arrangements.

Unit – II Circuit Interruption Devices

Isolators- Vertical break, Horizontal break and Pantograph type.

HRC fuses – Construction, working, characteristics and applications.

Arc formation process, methods of arc extinction (High resistance and Low resistance), Arc voltage, Recovery voltage, Re-striking voltage, RRRV.

HT circuit breakers (Sulphur-hexa Fluoride (SF6), Vacuum circuit breaker) - Working, construction, specifications and applications.

L.T. circuit breaker (Air circuit breakers (ACB), Miniature circuit breakers (MCB), Moulded case circuit breakers (MCCB) and Earth leakage circuit breaker (ELCB)) - Working and applications.

Selection of LT and HT circuit breakers (ratings), Selection of MCCB for motors.

Gas insulated switchgear.

Unit– III Protective Relays

Fundamental quality requirements: Selectivity, Speed, Sensitivity, Reliability, Simplicity, Economy.

Basic relay terminology- Protective relay, Relay time, Pick up, Reset current, current setting, Plug setting multiplier, Time setting multiplier.

Protective relays: Classification, principle of working, construction and operation of – Electromagnetic (Attracted armature type, Solenoid type, Watt-hour meter type) relay, Thermal relay. Block diagram and working of Static relay.

Overcurrent relay-Time current characteristics.

Microprocessor based over current relays: Block diagram, working.

Distance relaying- Principle, operation of Definite distance relays.

Directional relay: Need and operation.

Operation of current and voltage differential relay.

Unit– IV Protection of Alternator and Transformer

Alternator Protection

Faults, Differential protection Over current, earth fault, overheating and field failure, protection.

Reverse power protection.

Transformer Protection

Faults, Differential, over current, earth fault, over heating protection, Limitations of differential protection.

Buchholz relay: Construction, operation, merits and demerits.

Unit– V Protection of Motors, Bus-bar and Transmission Line Motor

Faults. Short circuit protection, Overload protection, Single phase preventer.

Bus bar and Transmission line

Faults on Bus bar and Transmission Lines.

Bus bar protection: Differential and Fault bus protection.

Transmission line: Over current, Distance and Pilot wire protection.

References:

1. Mehta V. K ;Rohit Mehta, Principles of Power System, S .Chand and Co., New Delhi., ISBN: 978-81-2192-496-2.
1. Rao.Sunil S., Switchgear and Protection, Khanna Publishers, New Delhi, ISBN: 978-81-7409-232-3.
2. Singh, R. P., Switchgear and Power System Protection, PHI Learning, New Delhi, ISBN: 978-81-203-3660-5.
3. Gupta. J. B.. Switchgear and Protection, S. K. Kataria and Sons, New Delhi, ISBN: 978-93-5014-372-8.
4. Veerapan, N.,Krishnamurty, S. R., Switchgear and Protection, S .Chand and Co., New Delhi. ISBN: 978-81-2193-212-7.
5. Ram, Badri; Vishwakarma D. N., Power System Protection and Switchgear, McGraw-Hill, New Delhi. ISBN : 978-07-107774-X

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Identify various types of faults in power system.
b) Select suitable switchgears for different applications.
c) Test the performance of different protective relays.
d) Maintain protection systems of alternators and transformers.
e) Maintain protection schemes for motors and transmission lines.
f) Maintain protection schemes for power system against overvoltages.

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Course Code	:	EEPE***
Course Title	:	SWITCHGEAR AND PROTECTION LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites	:	NIL
Course Category	:	PE

Course objectives:

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

- Maintain switchgear and protection schemes used in electrical power systems.

Course contents:

1. Identify various switchgears in the laboratory and write their specifications.
2. Test HRC fuse by performing the load test.
3. Test MCB by performing the load test
4. Dismantle MCCB/ELCB and identify various parts.
5. Dismantle ACB/VCB and identify different parts.
6. Set the plug and time (with PSM, TSM) of induction type electromagnetic relay.
7. Test electromagnetic over-current relay by performing load test.
8. Simulate differential protection scheme for transformer with power system simulation kit.
9. Test the working of the single phasing preventer using a three phase induction motor.
10. Simulate transmission line protection by using the impedance relay/over current relay for various faults. (On transmission line protection simulation Kit).
11. Dismantle Thyrite type arrester and identify different parts.
12. Perform neutral earthing at different substations / locations.

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Identify various types of faults in power system.
b) Select suitable switchgears for different applications.
c) Test the performance of different protective relays.
d) Maintain protection systems of alternators and transformers.

e) Maintain protection schemes for motors and transmission lines.

f) Maintain protection schemes for power system against overvoltages.

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Course Code	:	EEPE
Semester	:	---
Course Title	:	SOLAR POWER TECHNOLOGIES
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Prerequisites	:	NIL
Course Category	:	PC

Course objectives:

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

- Maintain the efficient operation of various types of solar power technologies

Course contents:

Unit – I Solar Energy

Solar Map of India: Global solar power radiation

Different types of Solar water heaters: Construction, working, specifications and installation

Solar Heating systems

Solar drying and different types of Solar cookers

Solar lighting.

Preventive maintenance of all of the above.

Unit – II Concentrated Solar Power (CSP)

Concentrated Solar Power (CSP) plants or solar thermal electric systems

Parabolic Trough: Construction, working and specifications

Parabolic Dish: Construction, working and specifications

Power Tower, Fresnel Reflectors: Construction, working and specifications

Solar Stirling engines

Preventive maintenance of all of the above

Unit– III Solar PV Systems

Solar PV cell: Types construction, working, Typical specifications of solar cells

Solar PV working principle: Series and parallel connections of solar modules

Solar Photovoltaic (PV) system: components layout and working.

Solar modules, arrays and their standard specifications

Roof top and streetlight solar PV systems and typical specifications

Maintenance of these systems

Unit– IV Solar PV Electronics

Solar Charge controllers: working and specifications, switchgear and cables

Batteries: Different types for solar PV systems, maintenance and specifications

Solar Inverters: working and specifications

Signal conditioning systems: working and specifications

Solar Power tracking: construction, working, tilt angle, solar radiation, I-V, P-V characteristics, maximum power point tracking (MPPT)

Maintenance of these systems.

Unit– V Solar PV Off-grid and Grid Tied Systems

Solar off grid systems: layout and specifications

Solar Grid tied (on grid) systems: Working principle of grid-tied dc-ac inverter, grid synchronization and active power export

Net metering: main features and working

Solar-wind Hybrid systems: Layout and specifications.

References:

1. Solanki, Chetan Singh, - Solar Photovoltaics: Fundamentals, Technologies and Applications, PHI Learning, New Delhi, ISBN: 9788120351110
1. Solanki, Chetan Singh, - Solar Photovoltaic Technology and Systems - A Manual For Technicians, Trainers and Engineers, PHI Learning, New Delhi, ISBN: 9788120347113
2. Kothari, D.P. et aL:Renewable Energy Sources and Emerging Technologies, PHI
3. David M. Buchla, Thomas E. Kissell, Thomas L. Floyd, - Renewable Energy Systems, Pearson Education New Delhi ,ISBN: 9789332586826
4. Rachel, Sthuthi, Earnest, Joshua; -Wind Power Technologies, PHI Learning
5. O.P. Gupta, Energy Technology, Khanna Publishing House, ISBN: 978-93-86173-683

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Maintain the solar non-electric equipment.
b) Maintain CSP plants
c) Maintain solar PV systems.
d) Maintain solar PV electronics and MPPT systems
e) Maintain off-grid and on-grid solar power plants.

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Course Code	:	EEPE
Course Title	:	SOLAR POWER TECHNOLOGIES LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites (Course code)	:	NIL
Course Category	:	PC

Course objectives:

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

- Maintain the efficient operation of various types of solar power technologies

Practicals:

1. Dismantle solar power heaters
2. Assemble solar power heaters
3. Assemble the parabolic dish CSP plant.
4. Dismantle the parabolic dish CSP plant.
5. Troubleshoot a CSP plant
6. Assemble the solar PV system.
7. Dismantle the solar PV system
8. Troubleshoot a solar PV system
9. Troubleshoot a solar PV panels and arrays
10. Troubleshoot solar inverters
11. Troubleshoot solar signal conditioners
12. Troubleshoot solar PV MPPT systems
13. Troubleshoot solar off-grid systems
14. Troubleshoot solar net metering systems
15. Troubleshoot solar-wind hybrid systems.

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Maintain the solar non-electric equipment.
b) Maintain CSP plants
c) Maintain solar PV systems.
d) Maintain solar PV electronics and MPPT systems
e) Maintain off-grid and on-grid solar power plants.

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Course Code	:	EEPE***
Course Title	:	WIND POWER TECHNOLOGIES
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Prerequisites (Course code)	:	NIL
Course Category	:	PE

Course objectives:

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

- Maintain large wind power plants and small wind turbines.

Course contents:

Unit – I Wind Energy and Wind Power Plants

Wind power scenario in the world and India

Characteristics of Wind Energy: Wind movement, wind profile, roughness, effects of obstacles in wind path.

Types of Wind Power Plants (WPPs): Small and large wind turbines; Horizontal and Vertical axis; Upwind and Downwind, One, Two and Three blades; constant and variable Speed; Geared, Direct-Drive and Semi-Geared (Hybrid) WPPs; WECS, WEGs, WTs, WPPs,

WPP Tower Types: Lattice; tubular: steel, concrete, hybrid, ladders, cables.

WPP substation: Switchgear, transformers, inside layouts of Electric electronic panels at block level.

Unit – II Construction and Working of Large Wind Power Plants.

Wind Turbine Terminologies: Cut-in, cut-out and survival wind speeds, Threshold wind speeds, rated power, nominal power, Wind Power Curve,

Major parts and Functions of WPP: Rotor blades, hub, nacelle, tower, electric sub-station, nacelle layouts of Geared, Direct-Drive and Semi-Geared WPPs, Main shaft, gearbox, electric generator, electronic control panels

Rotation principles: Drag and Lift principle, thrust and torque of wind turbine rotor.

Different types of Sensors: Anemometer, wind vane, rpm sensors of main shaft and generator, temperature sensors of nacelle, gearbox and generator; cable untwisting and vibration sensors.

Different types of Actuators: Electric and hydraulic pitching and yawing mechanisms, cable untwisting and braking mechanisms

Unit– III Aerodynamic Control, Electric Generators and Grid Connection

Aerodynamic Control of WPPs: Stall Pitch and Active Stall.

Braking mechanisms of large WPPs.

Electric Generator Types: Working of Squirrel-Cage rotor Induction Generator

(SCIG), Wound-Rotor Induction Generator (WRIG), Doubly-Fed Induction Generator

(DFIG), wound rotor and permanent magnet synchronous generators.

Electric grid connection of WPPs: Local Impacts and system wide impact

Unit– IV Maintenance of Large Wind Power Plants

General maintenance of WPPs: preventive maintenance schedule of actuators such as yaw control, pitch control, braking mechanisms and sensors; oiling and greasing; electric and electronic equipment related; tower related; minor repairs, some tips,

Scheduled Maintenance: of Stall and Pitch and Active Pitch controlled WPPs

Unscheduled maintenance: operational factors, design faults, wear and tear of components, spurious trip, Major repairs.

Software related, warranty and insurance related issues

Unit– V Construction and Working Small Wind Turbines

Types and working of different type of small wind turbines (SWT): Classification: Horizontal and Vertical axis, Upwind and Downwind, One, Two and Three blades; Constant and Variable Speed; Direct-Drive and Geared; braking of SWTs

Parts of SWTs: Rotor, generator, gearbox, tower, electric control panel, tale vane, anemometer, wind vane, temperature and rpm sensors.

Working SWTs: Direct-drive and Geared.

Electrical generators in SWTs: permanent magnet synchronous generators, induction generators

SWT towers: Lattice tubular type, hydraulic towers, ladders, cables,

Unit– VI Maintenance of Small Wind Turbines

Small wind turbine assembly.

Installation of different types of small wind turbines (SWT): tubular and lattice types.

SWT Routine maintenance: Tips; Preventive maintenance schedule of: braking mechanisms, sensors; oiling and greasing related; electric and electronic equipment related; tower related; software related, minor repairs

Power electronic devices and converters in different types of SWTs: thyristors, power transistors

Common electrical and mechanical faults in SWTs

References:

1. Hau, Erich: Wind TurbinesSpringer-Verlag, Berlin Heidelberg, Germany, ISBN: 978-3-642-27150-2
2. Rachel, Sthuthi, Earnest, Joshua; -Wind Power Technologies, PHI Learning, New Delhi, ISBN: 978-93-88028-49- 3; E-book 978-93-88028-50-9
3. Gipe, Paul: Wind Energy Basics, Chelsea Green Publishing Co; ISBN: 978-1603580304
4. Wizelius, Tore, Earnest, Joshua - Wind Power Plants and Project Development, PHI Learning, New Delhi, ISBN:978-8120351660
5. Bhadra, S.N., Kastha, D., Banerjee, S, Wind Electrical Systems installation; Oxford University Press, New Delhi, ISBN: 9780195670936
6. O.P. Gupta, Energy Technology, Khanna Publishing House, New Delhi (ISBN: 978-93-86173-683)

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Identify the various types of wind power plants and their auxiliaries.
b) Maintain the normal working of large wind turbines.
c) Optimize the aerodynamic and electric control of large wind power plants.
d) Troubleshoot the common faults of large wind power plants.

e) Maintain the normal working of small wind turbines.

f) Troubleshoot small wind turbines.

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Course Code	:	EEPE***
Course Title	:	WIND POWER TECHNOLOGIES LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites (Course code)	:	NIL
Course Category	:	PE

Course objectives:

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

- Maintain large wind power plants and small wind turbines.

Practicals:

1. Identify the specified items of a wind farm after watching the video clip.
2. Identify the specified parts inside the nacelle of a large wind power plant after watching the video clips.
3. Check the performance of the temperature and vibration sensor used in 125/150 kW WPPs.
4. Check the performance of the SCIG
5. Check the performance of the PMSG
6. Check the performance of the hydraulic and electric pitch actuator and yaw actuator used in 125/150 kW WPPs.
7. Check the performance of the contactless RPM sensors used in WPPs
8. Troubleshoot the anemometer and wind vane
9. Check the generator performance of SWTs.
10. Identify the parts of a direct-drive SWT
11. Identify the parts of a geared SWT
12. Assemble/Dismantle a direct-drive SWT
13. Assemble/Dismantle a geared SWT
14. Check the performance of direct-drive SWT
15. Check the performance of geared SWT
16. Simulate faults in the small wind turbine trainer
17. Troubleshoot direct-drive SWT
18. Troubleshoot geared SWT
19. Interpret the wiring of a SWT electric-electronic control panel

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Identify the various types of wind power plants and their auxiliaries.
b) Maintain the normal working of large wind turbines.
c) Optimize the aerodynamic and electric control of large wind power plants.
d) Troubleshoot the common faults of large wind power plants.
e) Maintain the normal working of small wind turbines.
f) Troubleshoot small wind turbines.

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Course Code	:	EEPE***
Course Title	:	BIOMASS AND MICRO-HYDRO POWER PLANTS
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Prerequisites	:	NIL
Course Category	:	PE

Course objectives:

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

- Maintain the efficient operation of various types of Biomass and Microhydro power plants.

Course contents:

Unit– I Basics of Biomass-based Power Plants

Properties of solid fuel for biomass power plants: bagasse, wood chips, rice husk, municipal waste

Properties of liquid and gaseous fuel for biomass power plants: Jatropha, bio-diesel gobar gas

Layout of a Bio-chemical based (e.g. biogas) power plant:

Layout of a Thermo-chemical based (e.g. Municipal waste) power plant

Layout of a Agro-chemical based (e.g. bio-diesel) power plant

Selection of biomass power plants.

Unit– II Biomass Gasification Power Plants

The basic principle to convert Agriculture and forestry products and wood processing remains (including rick husks, wood powder, branches, offcuts, corn straws, rice straws, wheat straws, cotton straws, fruit shells, coconut shells, palm shells, bagasse, corncobs) into combustible gas

General Construction and working of a typical gasifier

Power generating in gas engine:

Strengths and limitations of Agriculture and forestry products gasifier

Preventive maintenance steps different types of biomass gasifiers.

Unit– III Different Types of Gasifiers

Construction and working of the following types of gasifiers:

Rice Husk Gasification Power Plant and their specifications

Straw Gasification Power Plant and their specifications

Bamboo Waste, Bamboo Chips Gasification Power Plantand their specifications
Coconut shell, coconut peat, coconut husk, Gasification Power Plantand their specifications
Bagasse/Sugar Cane Trash Gasification Power Plantand their specifications
Gobar gas plant and its specifications
Breakdown maintenance of biomass power plant at the module level.

Unit– IV Micro-hydro Power Plants

Locations of microhydro power plant
Energy conversion process of hydro power plant.
Classification of hydro power plant: High, medium and low head.
General Layouts of typical micro-hydro power plant.
Strengths and limitations of microhydro power plants

Unit– V Different types of Microhydopower plants

Construction and working of High head – Pelton turbineand their specifications
Construction and working of Medium head – Francis turbineand their specifications
Construction and working of Low head – Kaplan turbineand their specifications
Preventive and breakdown maintenance of microhydro power plants
Safe Practices for microhydro power plants.

References:

1. Khoiyangbam, R S Navindu; Gupta and Sushil Kumar; Biogas Technology :Towards Sustainable Development; TERI, New Delhi; ISBN: 9788179934043
2. David M. Buchla; Thomas E. Kissell; Thomas L. Floyd - Renewable Energy Systems, Pearson Education New Delhi , ISBN: 9789332586826,
3. Kothari, D.P. et aL: Renewable Energy Sources and Emerging Technologies, PHI
4. Rachel, Sthuthi, Earnest, Joshua; -Wind Power Technologies, PHI Learning
5. O.P. Gupta, Energy Technology, Khanna Publishing House, ISBN: 978-93-86173-683

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Select the relevant biomass power plant
b) Undertake the preventive maintenance of different types of biomass gasifiers
c) Undertake the breakdown maintenance of different types of biomass gasifiers
d) Maintain the optimised working of large wind power plants
e) Maintain the optimised working of small wind turbines.
f) Maintain the optimised working of micro hydro power plants.

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Course Code	:	EEPE***
Course Title	:	BIOMASS AND MICRO-HYDRO POWER PLANTS LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites (Course code)	:	NIL
Course Category	:	PE

Course objectives:

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

- Maintain the efficient operation of various types of Biomass and Microhydro power plants.

Practicals:

1. Identify different components of a typical Biomass power plant.
2. Identify different biomass resources and evaluate their energy potential.
3. Determine the carbon content of solid biomass.
4. Assemble the Biogas power plant.
5. Dismantle the Biogas power plant
6. Identify the components of the high head micro hydro power plant
7. Identify the components of the medium head micro hydro power plant
8. Identify the components of the low head micro hydro power plant
9. Assemble a high head micro hydro power plant
10. Assemble a medium head micro hydro power plant
11. Assemble a low head micro hydro power plant
12. Undertake preventive maintenance of the high head micro hydro power plant
13. Undertake preventive maintenance of the medium head micro hydro power plant
14. Undertake preventive maintenance of the low head micro hydro power plant
15. Check the performance of Pelton wheel micro hydro power plant

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Select the relevant biomass power plant
b) Undertake the preventive maintenance of different types of biomass gasifiers
c) Undertake the breakdown maintenance of different types of biomass gasifiers
d) Maintain the optimised working of large wind power plants
e) Maintain the optimised working of small wind turbines.
f) Maintain the optimised working of micro hydro power plants.

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Course Code	:	EEPE ***
Course Title	:	ELECTRIC VEHICLES
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Prerequisites	:	NIL
Course Category	:	PE

Course objectives:

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

- Maintain electric vehicles

Course contents:

Unit – I Introduction to Hybrid Electric Vehicles

Evolution of Electric vehicles

Advanced Electric drive vehicle technology Vehicles-Electric vehicles (EV), Hybrid Electric drive (HEV), Plug in Electric vehicle (PIEV),

Components used Hybrid Electric Vehicle

Economic and environmental impacts of Electric hybrid vehicle

Parameters affecting Environmental and economic analysis

Comparative study of vehicles for economic, environmental aspects

Unit – II Dynamics of hybrid and Electric vehicles

General description of vehicle movement

Factors affecting vehicle motion- Vehicle resistance, tyre ground adhesion, rolling resistance, aerodynamic drag, equation of grading resistance, dynamic equation

Drive train configuration, Automobile power train, classification of vehicle power plant

Performance characteristics of IC engine, electric motor, need of gear box

Classification of motors used in Electric vehicles

Basic architecture of hybrid drive trains, types of HEVs

Energy saving potential of hybrid drive trains

HEV Configurations-Series, parallel, Series-parallel, complex.

Unit– III DC-DC Converters for EV and HEV Applications

EV and HEV configuration based on power converters

Classification of converters –unidirectional and bidirectional

Principle of step down operation

Boost and Buck- Boost converters

Principle of Step-Up operation

Two quadrant converters; multi quadrant converters

Unit– IV DC-AC Inverter & Motors for EV and HEVs

DC-AC Converters

Principle of operation of half bridge DC-AC inverter (R load, R-L load)

Single phase Bridge DC-AC inverter with R load, R-L load

Electric Machines used in EVs and HEVs, principle of operation, working & control

Permanent magnet motors, their drives, switched reluctance motor

Characteristics and applications of above motors

Unit– V Batteries

Overview of batteries

Battery Parameters, types of batteries

Battery Charging, alternative novel energy sources-solar photovoltaic cells, fuel cells, super capacitors, flywheels

Control system for EVs and HEVs, overview, Electronic control unit ECU

Schematics of hybrid drive train, control architecture

Regenerative braking in EVs

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Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Interpret the salient features of Hybrid electric vehicles.

b) Interpret the Dynamics of hybrid and Electric vehicles

c) Maintain the DC-DC converters in EV applications.

d) Maintain the DC-AC converters in EV applications

e) Select the batteries for EV applications.

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Course Code	:	EEPE***
Course Title	:	ELECTRIC VEHICLES LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites (Course code)	:	NIL
Course Category	:	PE

Course objectives:

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

- Maintain electric vehicles

Practicals:

1. Develop block diagram of Electric vehicle and identify parts
2. Case study- Compare minimum four vehicles for economic and environmental analysis
3. Develop schematic diagram of hybrid electric vehicle and identify the components fluorescent lamp.
4. Prepare report on Plug in Electric vehicle by visiting a charging station
5. Inspect and install inverter of given lead acid battery
6. Prepare a report on batteries used from market survey
7. Collect specifications of converters and inverters used for Electric vehicles a single lamp control by two switches
8. Diagnose, repair and maintain battery used in electric vehicle
9. Prepare test procedure for equipment used in Electric vehicle
10. List safety procedures and schedule for handling HEVs and EVs.

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Interpret the salient features of Hybrid electric vehicles.

b) Interpret the Dynamics of hybrid and Electric vehicles

c) Maintain the DC-DC converters in EV applications.

d) Maintain the DC-AC converters in EV applications

e) Select the batteries for EV applications.

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Course Code	:	EEPE
Course Title	:	ELECTRIC TRACTION
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Prerequisites	:	NIL
Course Category	:	PE

Course objectives:

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

- Maintain electric traction systems.

Course contents:

Unit – I Basics of Traction

General description of Electrical Traction system in India.

Advantages and Disadvantages of Electric Drive, Diesel Electric Drive, Battery Drive

Problems associated with AC traction System and remedies for it.

Voltage balance, current balance, production of harmonics, induction effects.

Metro rail system, features

Unit – II Power Supply Arrangements

Constituents of supply system:-

- Substation: layout, list of equipment and their functions
- Feeding post: list of equipment and their functions
- Feeding and sectioning Arrangements
- Sectioning and paralleling post
- Sub sectioning and Paralleling post
- Sub sectioning post
- Elementary section

Major equipment at substation, Miscellaneous equipment at control post or Switching station

Protection system for traction transformer and 25 kV centenary construction

Unit– III Overhead Equipment

Different types of overhead equipments

Pentagonal OHE Centenary Construction

Different Types of Centenary according to speed Limit

OHE Supporting Structure, Cantilever assembly diagram

Overhead system- Trolley collector, Bow collector, Pantograph Collector

Types and construction of pantograph

Unit– IV Electric Locomotive

Classification and Nomenclature of Electric Locomotive

Block diagram of AC locomotive

Power Circuit of AC Locomotive

Equipment (List and Function only) used in auxiliary circuit of AC Locomotive

Loco bogie classification according to wheel arrangements

Maintenance of AC systems

Unit– V Traction Motors and Train Lighting

Desirable characteristics of traction motor.

Types of motors used for traction with their characteristics and features

Control of motors used for traction and methods to control

Requirements of braking, types of braking

Electric braking, Regenerative braking

Systems of train lighting, Single battery, double battery parallel block system

SG, HOG, End on generation

Unit VI. Signalling and Supervisory Control

Requirements of signaling systems

Types of signals, track circuits

Advantages of remote control

Systems of remote control, equipment and network

Metro rail-supply systems, advantages, schemes in India

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3. Partab H., Dhanpat Rai and Co,' Art and Science of Utilization of Electrical Energy
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6. Open Shaw Taylor, Orient Longman ltd., Utilisation of electrical energy.

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Interpret the traction layout and its systems
b) Maintain the power supply arrangements.
c) Maintain the function of the overhead equipment for electric traction
d) Maintain the different components of the electric locomotive.
e) Maintain the traction motor and train lighting system
f) Maintain the signalling and supervisory control systems.

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Course Code	:	EEPE***
Course Title	:	ELECTRIC TRACTION LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Prerequisites (Course code)	:	NIL
Course Category	:	PE

Course objectives:

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

- Maintain electric traction systems

Practicals:

1. Dismantle a traction motor
2. Assemble a traction motor
3. Troubleshoot a traction motor
4. Visit electric-traction train lighting system installation, identify components of system and prepare report
5. Visit electric-traction loco shed, investigate working of each section & prepare report
6. Visit to Traction Substation or feeding post (for layout and OHE) and write a report
7. Visit to Railway Station (for signalling and train lighting) and writing a report on visit
8. Draw traction substation Layout on drawing sheet and prepare report
9. Draw Pentagonal OHE Catenary, different Catenaries according to speed limit, OHE supporting structure on drawing sheet and prepare report
10. Draw Power Circuit of AC Locomotive on drawing sheet and prepare report.

Course outcomes:

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a) Interpret the traction layout and its systems
b) Maintain the power supply arrangements.
c) Maintain the function of the overhead equipment for electric traction
d) Maintain the different components of the electric locomotive.
e) Maintain the traction motor and train lighting system
f) Maintain the signalling and supervisory control systems.

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