

**GOVERNMENT OF RAJASTHAN**  
**BOARD OF TECHNICAL EDUCATION RAJASTHAN JODHPUR**

**SEMESTER SCHEME-2020-21**



**III SEMESTER**  
(SESSION 2021-2022 & ONWARDS)

### INTRODUCTION TO ELECTRIC GENERATION SYSTEMS

Course Code	EE 3001
Course Title	Introduction to Electric Generation Systems
Number of Credits	3 (L-3, T-0, P-0)
Prerequisites	None
Course Category	PC

#### **COURSE OBJECTIVES**

The aim of this course is to help the students to attain the following industry identified competency through various teaching learning experiences: Maintain the efficient operation of various electric power generating plants.

#### **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) Select the adequate mix of power generation based on economic operation.

#### **COURSE CONTENTS**

##### **1. THERMAL POWER PLANTS: COAL, GAS / DIESEL AND NUCLEAR-BASED**

- 1.1 Layout and working of a typical thermal power plant with steam turbines and electric generators.
- 1.2 Properties of conventional fuels used in the energy conversion.
- 1.3 Various fuels used in thermal power plants.
  - 1.3.1 Coal.
  - 1.3.2 Gas / Diesel.
  - 1.3.3 Nuclear fuels – fusion and fission action.
- 1.4 Safe Practices and working of various thermal power plants:
  - 1.4.1 Coal-based.
  - 1.4.2 Gas-based.
  - 1.4.3 Diesel-based.
  - 1.4.4 Nuclear-based.
- 1.5 Functions of the following types of thermal power plants and their major auxiliaries:
  - 1.5.1 Coal fired boilers: fire tube and water tube.
  - 1.5.2 Gas/Diesel based combustion engines.
- 1.6 Types of nuclear reactors.
- 1.7 Thermal power plants in India and Rajasthan.

##### **2. LARGE AND MICRO-HYDRO POWER PLANTS**

- 2.1 Energy conversion process of hydro power plant.
- 2.2 Classification of hydro power plant: High, medium and low head.
- 2.3 Construction and working of hydro turbines used in different types of hydro power plant::
  - 2.3.1 High head – Pelton turbine.
  - 2.3.2 Medium head – Francis turbine.
  - 2.3.3 Low head – Kaplan turbine.
- 2.4 Safe practices for hydro power plants.
- 2.5 Different types of micro-hydro turbines for different heads.
- 2.6 Locations of these different types of large and micro-hydro power plants in India and Rajasthan.

##### **3. ECONOMICS OF POWER GENERATION AND INTERCONNECTED POWER SYSTEM**

- 3.1 Related terms:
  - 3.1.1 Connected load.
  - 3.1.2 Firm power.
  - 3.1.3 Cold reserve.
  - 3.1.4 Hot reserve.

- 3.1.5 Spinning reserve.
- 3.1.6 Cost of generation.
- 3.1.7 Average demand.
- 3.1.8 Maximum demand.
- 3.1.9 Demand factor.
- 3.1.10 Plant capacity factor..
- 3.2 Base load and peak load plants.
- 3.3 Choice of size and number of generator units.
- 3.4 Causes and Impact and reasons of Grid system fault: State grid, national grid.

**REFERENCES /SUGGESTED LEARNING RESOURCES:**

1. Nag, P. K., "Power Plant Engineering", McGraw Hill, New Delhi, ISBN: 978-9339204044
2. Tanmoy Deb, "Electrical Power Generation", Khanna Publishing House, Delhi (Ed. 2018)
3. Gupta, B.R., "Generation of Electrical Energy", S. Chand & Co. New Delhi,
4. Rachel, Sthuthi; Earnest, Joshua " Wind Power Technologies", PHI Learning, New Delhi, ISBN: 978-93-88028-49-3; E-book 978-93-88028-50-9
5. Solanki, Chetan Singh, " Solar Photovoltaics: Fundamentals, Technologies and Applications", PHI Learning, New Delhi, ISBN: 9788120351110
6. Hau, Erich, Wind Turbines, Springer-Verlag, Berlin Heidelberg, Germany, ISBN:978-3-642-27150-2
7. Gipe, Paul, "Wind Energy Basics", Chelsea Green Publishing Co; ISBN: 978-1603580304
8. Wizelius, Tore; Earnest, Joshua, " Wind Power Plants and Project Development", PHI
9. Gupta, J.B. "A Course in Electrical Power", S. K Kataria and Sons, New Delhi. 2014,
10. Soni, Gupta, Bhatnagar," A Course in Electrical Power. Lhanpatrai and Sons System, S.Chand & Co. New Delhi, 2005, ISBN: 9788121924962

(SEMESTER SCHEME 2020-21)

\*\*\*\*\*

**ELECTRICAL CIRCUITS**

Course Code	EE 3002
Course Title	Electrical Circuits
Number of Credits	4 (L-3, T-1, P-0)
Prerequisites	None
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 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:

- Troubleshoot problems related to single phase A.C series circuits.
- Troubleshoot problems related to single phase A.C parallel circuits.
- Troubleshoot problems related to three phase circuits.
- Use principles of circuit analysis to troubleshoot electric circuits.
- Apply network theorems to troubleshoot electric circuits.

**COURSE CONTENTS****1. SINGLE PHASE A.C. SERIES and PARALLEL CIRCUITS**

- Generations of alternating voltages.
- 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 and parallel circuit.
  - Impedance
  - Reactance
  - Impedance triangle
  - Power factor
  - Active power
  - Reactive power
  - Apparent power
  - Power triangle
  - Vector diagram
- Resonance, Bandwidth, Quality factor and voltage magnification in series R-L, R-C, R-L-C circuit.

**2. 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.
- Three phase power, active reactive and apparent power in star and delta system.

**3. NETWORK REDUCTION AND PRINCIPLES OF CIRCUIT ANALYSIS**

- Source transformation.
- Star / delta and delta/ star transformation.
- Mesh Analysis.
- Node Analysis.

**4. NETWORK THEOREMS (With numericals)**

- Superposition theorem.
- Thevenin's theorem.
- Norton's theorem.

- 4.4 Maximum power transfer theorem.
- 4.5 Reciprocity theorem.

**REFERENCES /SUGGESTED LEARNING RESOURCES:**

1. Ashfaq Husain, "Networks & Systems", Khanna Book Publishing, New Delhi.
2. Gupta, B.R; Singhal, Vandana;, " Fundamentals of Electrical Network", S.Chand and Co., New Delhi, ISBN : 978-81-219-2318-7
3. Saxena, S.B Lal; Dasgupta, K; "Fundamentals of Electrical Engineering", Cambridge University Press Pvt. Ltd., New Delhi, ISBN : 978-11-0746-435-3
4. Theraja, B. L. : Theraja, A. K;"A Text Book of Electrical Technology Vol-I", S. Chand & Co. Ramnagar, New Delhi, ISBN : 9788121924405
5. Sudhakar, A. ; Shyammohan, S. Palli; "Circuit and network", McGraw Hill Education, New Delhi, ISBN : 978-93-3921-960-4
6. Bell, David A., "Electric Circuits", Oxford University Press New Delhi, ISBN : 978-01-951-2524-6
7. Boylested, R.L., "Introductory circuit Analysis", Wheeler, New Delhi, ISBN: 978-00-731-3161-5
8. Mittle, V.N. ;Mittle, Arvind; "Basic Electrical Engineering", McGraw Hill Education, Noida, ISBN: 978-00-705-9357-2
9. Sivanandam, S.N, "Electric Circuit Analysis", Vikas Publishing House Pvt. Ltd, Noida, ISBN:978-81259-1364-1
10. Salivahanan, S.; Pravinkumar, S; "Circuit theory", Vikas Publishing House Pvt. Ltd, Noida; ISBN:978-93259-7418-0

\*\*\*\*\*

(SEMESTER SCHEME-2020-21)

**ELECTRICAL AND ELECTRONIC MEASUREMENTS**

Course Code	EE 3003
Course Title	Electrical and Electronic Measurements
Number of Credits	3 (L-2, T-1, P-0)
Prerequisites	None
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 OUTCOME**

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:

- Check the working of the electrical measuring instrument.
- Use different types of measuring instruments for measuring voltage and current.
- Use different types of measuring instruments for measuring electric power
- Use different types of measuring instruments for measuring electric energy.
- Use different types of electrical instruments for measuring various ranges of electrical parameters.

**COURSE CONTENTS****1. FUNDAMENTALS OF MEASUREMENTS**

- Measurements: Significance, units, fundamental quantities and standards.
- Classification of Instrument Systems:
  - Null and deflection type instruments.
  - Absolute and secondary instruments.
  - Analog and digital instruments.
- Types of errors.
- Calibration: need and procedure.
- Classification of measuring instruments:
  - Indicating.
  - Recording

**2. MEASUREMENT OF VOLTAGE AND CURRENT**

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

**3. MEASUREMENT OF ELECTRIC POWER**

- 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.

**4. MEASUREMENT OF ELECTRIC ENERGY**

- Single and three phase electronic energy meter: Constructional feature and working principle.
- Errors and their compensations.

**5. CIRCUIT PARAMETER MEASUREMENT, CRO AND OTHER METER**

- 5.1 Measurement of resistance:
  - 5.1.1 Low resistance: Kelvin's double bridge.
  - 5.1.2 Medium resistance: Voltmeter and ammeter method.
  - 5.1.3 High resistance: Megger and Ohm meter: Series and shunt.
- 5.2 Measurement of inductance using Anderson bridge ( no derivation and phasor diagram).
- 5.3 Measurement of capacitance using Schering bridge ( no derivation and phasor diagram).
- 5.4 Other meters:
  - 5.4.1 Earth tester.
  - 5.4.2 Digital Multimeter.
  - 5.4.3 L-C-R meter.
  - 5.4.4 Phase sequence indicator.
  - 5.4.5 Power factor meter ( single phase and three phase dynamometer type).

**REFERENCES /SUGGESTED LEARNING RESOURCES:**

1. Theraja B. L., Theraja A. K., "A Text Book of Electrical Technology Vol-I"(Basic Electrical Engg.), S.Chand and Co. New Delhi, ISBN: 9788121924405
2. Mittle V. N., "Basic Electrical Engineering", McGraw-Hill New Delhi, ISBN: 978-0-07-0088572-5,
3. Edward Hughes," Electrical Technology", Pearson Education, New Delhi, ISBN- 13:978-0582405196
4. Rajput R.K., "Electrical and Electronic Measurement and Instrumentation", S.Chand and Co. New Delhi, ISBN : 9789385676017
5. Sawhney A.K., "Electrical and Electronics Measurements and Instrumentation.", DhanpaiRai and Sons,New Delhi, ISBN : 9780000279744
6. Suryanarayana N.V., "Electrical Measurements and Measuring Instruments", S.Chand and Co. New Delhi , ISBN :8121920116

(SEMESTER SCHEME 2020-21)

**ELECTRIC MOTORS AND TRANSFORMERS**

Course Code	EE 3004
Course Title	Electric Motors and Transformers
Number of Credits	3 (L-2, T-1, P-0)
Prerequisites	None
Course Category	PC

**COURSE OBJECTIVES**

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

- Maintain electric motors and transformers.

**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:

- Maintain different types of DC generators.
- Maintain different types of DC motors.
- Maintain single phase transformer.
- Maintain three phase transformers.
- Maintain different types of special purpose transformers used in different applications.

**COURSE CONTENTS****1 DG GENERATORS**

- Construction, parts, materials and their functions.
- Principle of operation of DC generator: Fleming's right hand rule.
- Schematic diagrams.
- E.m.f. equation of generators.
- Armature reaction
- Commutation.
- Applications of DC generator.

**2 D.C. MOTORS**

- Types of DC motors.
- Fleming's left hand rule.
- Principle of operation.
- Back e.m.f. and its significance.
- Voltage equation of DC motor.
- Torque
  - Armature torque.
  - Shaft torque.
  - BHP
- Losses.
- Efficiency.
- Speed control of DC shunt and series motor:
  - Flux
  - Armature control

**3 SINGLE PHASE TRANSFORMERS**

- Types of transformers: Shell type and core type.
- Construction: Parts and functions.
- Principle of operation.
- EMF equation of transformer.
- Voltage transformation ratio.
- Significance of transformer ratings.



- 3.7 Transformer No-load and on-load phasor diagram.
- 3.8 Equivalent circuit of transformers: Equivalent resistance and reactance.
- 3.9 Voltage regulation and Efficiency:
  - 3.9.1 OC/SC method.
- 3.10 All day efficiency.

#### 4. THREE PHASE TRANSFORMERS

- 4.1 Bank of three single phase transformers.
- 4.2 Single unit of three phase transformer.
- 4.3 Distribution and power transformers.
- 4.4 Construction.
- 4.5 Criteria for selection of distribution transformer and power transformer.
- 4.6 Amorphous core type Distribution Transformer.
- 4.7 Need of parallel operation of three phase transformer.
- 4.8 Polarity tests on mutually inductive coils and single phase transformers.
- 4.9 Polarity test, Phasing out test on Three-phase transformer.

#### 5. SPECIAL PURPOSE TRANSFORMERS

- 5.1 Concepts and working of
  - 5.1.1 Single phase auto transformers.
  - 5.1.2 Three phase auto transformers.
  - 5.1.3 Instruments Transformers: Current transformer and Potential transformer.
  - 5.1.4 Single phase welding transformer.
- 5.2 'K' factor of transformers.

#### REFERENCES /SUGGESTED LEARNING RESOURCES:

1. G.C. Garg & P.S. Bimbhra, "Electrical Machines Vol. II", Khanna Book Publishing House (ISBN: 978-9386173-447, 978-93-86173-607), New Delhi
2. Mittle, V.N. and Mittle, Arvind., "Basic Electrical Engineering", McGraw Hill Education, New Delhi, ISBN: 9780070593572
3. Kothari, D. P. and Nagrath, I. J., "Electrical Machines", McGraw Hill Education. New Delhi, ISBN: 9780070699670
4. Bhattacharya, S. K., "Electrical Machines", McGraw Hill Education, New Delhi, ISBN: 9789332902855
5. Mehta, V. K. and Mehta, Rohit, "Principles of Electrical Machines", S. Chand and Co. Ltd., New Delhi, ISBN: 9788121930888
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
8. Murugesh Kumar K., "DC Machines and Transformers", ISBN: 9788125916055.

\*\*\*\*\*

**RENEWABLE ENERGY POWER PLANTS**

Course Code	EE 3005
Course Title	Renewable Energy Power Plants
Number of Credits	3 (L-3, T-0, P-0)
Prerequisites	None
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 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:

- Maintain the optimised working of solar PV and CS power plants.
- Maintain the optimised working of large wind power plants
- Maintain the optimised working of small wind turbines.
- Maintain the optimised working of biomass-based power plants.

**COURSE CONTENTS****1 SOLAR PV AND CONCENTRATED SOLAR POWER PLANTS**

- Solar Map of India.
- Global solar power radiation.
- Concentrated Solar Power (CS) plants.
- Construction and working of:
  - Power Tower.
  - Parabolic Trough.
  - Parabolic Dish.
- Solar Photovoltaic (PV) power plant:
  - Component layout.
  - Construction.
  - Working.
- Rooftop solar PV power system

**2 LARGE WIND POWER PLANTS**

- Wind map of India.
- Wind power density in watts per square meter.
- Lift and drag principle.
- Components, layout and working of.
  - Geared type wind power plants
  - Direct drive type wind power plants.
- Constant speed Electric Generators:
  - Squirrel Cage Induction Generators (SCIG).
  - Wound Rotor induction Generators (WRIG).
- Variable speed Electric generators:
  - Doubly-fed induction generator (DFIG).
  - Wound rotor synchronous generator (WRSG).
  - Permanent magnet synchronous generator (PMSG).

**3 SMALL WIND TURBINES**

- Components and working of
  - Horizontal axis small wind turbine:
    - Direct drive type.
    - Geared type.

- 3.1.2 Vertical axis small wind turbine.
  - 3.1.2.1 Direct drive
  - 3.1.2.2 Geared drive
- 3.1.3 Types of towers
- 3.1.4 Installation of small wind turbines on
  - 3.1.4.1 Roof tops.
  - 3.1.4.2 Open fields.
- 3.1.5 Electric generators used in small wind power plants.

#### 4 BIOMASS-BASED POWER PLANTS

- 4.1 Properties of solid fuel for biomass power plants:
  - 4.1.1 Bagasse.
  - 4.1.2 Wood chips.
  - 4.1.3 Rice husk.
  - 4.1.4 Municipal waste.
- 4.2 Properties of liquid and gaseous fuel for biomass power plants:
  - 4.2.1 Jatropha
  - 4.2.2 Bio-diesel
  - 4.2.3 Gobar gas.
- 4.3 Layout of a Bio-chemical based (e.g. biogas) power plant.
- 4.4 Layout of a Thermo-chemical based (e.g. Municipal waste) power plant.
- 4.5 Layout of a Agro-Chemical based (e.g. bio-diesel) power plant.

#### 5 Ocean Energy :

- 5.1 Introduction to ocean energy
- 5.2 Types of ocean energy
  - 5.2.1 Open cycle
  - 5.2.2 Closed cycle

#### REFERENCES /SUGGESTED LEARNING RESOURCES:

1. Deambi, Suneel: "From Sunlight to Electricity: a practical handbook on solar photovoltaic application"; TERI, New Delhi ISBN:9788179935736
2. David M. Buchla, Thomas E. Kissell, Thomas L. Floyd - Renewable Energy Systems, Pearson Education New Delhi , ISBN: 9789332586826,
3. Rachel, Sthuthi; Earnest, Joshua "Wind Power Technologies", PHI Learning, New Delhi, ISBN: 978-93-88028-49- 3; E-book 978-93-88028-50-9
4. Khoiyangbam, R S Navindu, Gupta and Sushil Kumar; "Biogas Technology: Towards Sustainable Development"; TERI, New Delhi; ISBN: 9788179934043
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)

\*\*\*\*\*

**INTRODUCTION TO ELECTRIC GENERATION SYSTEMS LAB.**

Course Code	EE 3006
Course Title	Introduction to Electric Generation Systems Lab.
Number of Credits	1(L-0, T-0, P-2)
Prerequisites	None
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 OUTCOME**

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:

1. Maintain the optimised working of the thermal power plant.
2. Maintain the optimised working of large and micro hydro power plants.
3. Select the adequate mix of power generation based on economic operation.

**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.

\*\*\*\*\*

(SEMESTER SCHEME-2020-21)

**ELECTRICAL CIRCUITS LAB.**

Course Code	EE 3007
Course Title	Electrical Circuits Lab.
Number of Credits	1(L-0, T-0, P-2)
Prerequisites	None
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 systems applying AC and DC circuits fundamentals.

**COURSE OUTCOME**

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:

- Troubleshoot problems related to single phase A.C series circuits.
- Troubleshoot problems related to single phase A.C parallel circuits.
- Troubleshoot problems related to three phase circuits.
- Use principles of circuit analysis to troubleshoot electric circuits.
- Apply network theorems to troubleshoot electric circuits.

**PRACTICALS:**

- Use dual trace oscilloscope to determine A.C voltage and current response in given R, L, C circuit.
- Use voltmeter, ammeter, wattmeter to determine active, reactive and apparent power consumed in given R-L series circuit. Draw phasor diagram.
- Use voltmeter, ammeter to determine active, reactive and apparent power consumed in given R-C series circuit. Draw phasor diagram.
- Use voltmeter, ammeter, wattmeter to determine active, reactive and apparent power consumed in given R-L-C series circuit. Draw phasor diagram.
- Use variable frequency supply to create resonance in given series R-L-C circuit or by using variable inductor or variable capacitor.
- Use voltmeter, ammeter, wattmeter to determine current, p.f., active, reactive and apparent power in R-C parallel A.C. circuit.
- 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.
- Use variable frequency supply create resonance in given parallel R-L-C circuit or by using variable inductor or capacitor.
- 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.
- 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.
- Use voltmeter, ammeter to determine current through the given branch of a electric network by applying mesh analysis.
- Use voltmeter, ammeter to determine current through the given branch of a electric network by applying node analysis.
- Use voltmeter, ammeter to determine current through the given branch and voltage across the given element of circuit by applying superposition theorem.
- Use voltmeter, ammeter to determine equivalent circuit parameter in a given circuit by applying Thevenin's theorem
- Use voltmeter, ammeter to determine equivalent circuit parameter in a given circuit by applying Norton's theorem
- Use voltmeter, ammeter to determine load resistance for maximum power transfer for a given circuit by applying maximum power transfer theorem.

\*\*\*\*\*

**ELECTRICAL AND ELECTRONIC MEASUREMENTS LAB.**

Course Code	EE 3008
Course Title	Electrical and Electronic Measurement Lab.
Number of Credits	1(L-0, T-0, P-2)
Prerequisites	None
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 OUTCOME**

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:

- Check the working of the electrical measuring instrument.
- Use different types of measuring instruments for measuring voltage and current.
- Use different types of measuring instruments for measuring electric power
- Use different types of measuring instruments for measuring electric energy.
- Use different types of electrical instruments for measuring electrical parameters of various ranges.

**PRACTICALS:**

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

\*\*\*\*\*

**ELECTRIC MOTORS AND TRANSFORMERS LAB.**

Course Code	EE 3009
Course Title	Electric Motors and Transformers Lab.
Number of Credits	1(L-0, T-0, P-2)
Prerequisites	None
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.

**COURSE OUTCOME**

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:

- Maintain different types of DC generators.
- Maintain different types of DC motors.
- Maintain single phase transformer.
- Maintain three phase transformers.
- Maintain different types of special purpose transformers used in different applications.

**PRACTICALS:**

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

\*\*\*\*\*

**RENEWABLE ENERGY POWER PLANTS LAB.**

Course Code	EE 3010
Course Title	Renewable Energy Power Plants Lab.
Number of Credits	1(L-0, T-0, P-2)
Prerequisites	None
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.

**COURSE OUTCOME**

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:

- Maintain the optimised working of solar PV and CS power plants.
- Maintain the optimised working of large wind power plants
- Maintain the optimised working of small wind turbines.
- Maintain the optimised working of biomass-based power plants.

**PRACTICALS:**

- Dismantle the parabolic trough CSP plant.
- Assemble the parabolic trough Concentrated Solar Power (CSP) plant.
- Assemble the parabolic dish CSP plant.
- Dismantle the parabolic dish CSP plant.
- Assemble the solar PV plant to produce electric power
- Dismantle the solar PV plant.
- Identify the routine maintenance parts of the large wind power plant after watching a video programme.
- Assemble a horizontal axis small wind turbine to produce electric power
- Dismantle a horizontal axis small wind turbine.
- Assemble a vertical axis small wind turbine to produce electric power
- Dismantle a vertical axis small wind turbine.
- Assemble a small biogas plant to generate electric power
- Dismantle the biogas plant.

\*\*\*\*\*