West Bengal State Council of Technical & Vocational Education and Skill Development
(Technical Education Division)

Syllabus
of

Diploma in Electrical Engineering [EE]

Part-II (3rd Semester)

Revised 2022

3rd Semester

Sl. No	Category of course	Code No	Course Title	Credits	Marks	Total Contact Hours per Week	
						L	P
1	Program Core Course		Introduction to Electric Generation Systems	3	100	3	0
2	Program Core Course		Introduction to Electric Generation Systems Laboratory	1	100	0	2
3	Program Core Course		Electrical Circuits	3	100	3	0
4	Program Core Course		Electrical Circuits Laboratory	1	100	0	2
5	Program Core Course		Electrical and Electronic Measurement	3	100	3	0
6	Program Core Course		Electrical and Electronic Measurement Laboratory	1	100	0	2
7	Program Core Course		DC Machines and Transformers	3	100	3	0
8	Program Core Course		DC Machines and Transformers Laboratory	1	100	0	2
9	Program Core Course		Analog and Digital electronics	3	100	3	0
10	Program Core Course		Analog and Digital electronics Laboratory	1	100	0	2
11	Internship		Internship-I	1	100	0	
	TOTAL			**21**	**1100**	**15**	**10**

- Student **contact hrs./ week =25**
- Theory and practical periods of 60 minutes each
- Abbreviation: L: Lecture class; P: Practical class
- **For Theoretical subjects**: Internal Assessment (40 Marks): Mid semester class test: 20 Marks; Quizzes, viva-voce, Assignment: 10 Marks; Attendance: 10; External Assessment: 60 Marks.
- **For Practical/ Sessional Subjects**: Internal Assessment-60 Marks [Continuous Evaluation:50; Class Attendance:10]; End Semester Assessment-40 Marks [Assignment on the day of Viva-voce and Practical Report submission:20; Viva-voce:20]
- To make the students more familiar with software, effort should be made to prepare laboratory report (like graph; data table etc.) in soft format in addition with traditional hard copy wherever possible.

Course Code	:	
Course Title	:	INTRODUCTION TO ELECTRIC GENERATION SYSTEMS
Semester		Third
Number of Credits	:	3 (L: 3, P: 0)
Prerequisites	:	NIL
Course Category	:	PC
Full Marks		100 [Internal :40 Marks+ External: 60 Marks]

Course Objective

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 conventional electric power generating plants.

Contents (Theory):		Hrs./Unit
Unit : 1	**Coal Based Thermal Power Plant** 1.1 Selection of site 1.2 Layout and working with block diagram 1.3 Features and Function of the following equipments – (a) Boiler (b) Economiser (c) Super Heater & Reheater (d) Air Pre-Heater (e) F.D. Fan & I.D. Fan, Chimney (f) Steam Turbine (g) Condenser (h) Feed Water Heater and feed water pump (i) De-aerator (j) Spray pond & Cooling Tower (k) D.M. Water plant (l) Coal Handling Plant (m) Ash Handling (n) ESP (o) concept of zero discharge system. 1.4 Basic concept of Rankine Cycle 1.5 Fuel combustion: Stokers, Pulverisers, Fluidised Bed Combustion (concept only) 1.6 Basic concept of Super Critical Boiler 1.7 Classification of coal, Calorific Value, selection of coal for power generation 1.8 Merits & Demerits of coal power plant 1.9 Thermal, Electrical and Overall Efficiency, simple numerical problems. 1.10 List of important coal power plants in India with their capacities	**12**
Unit : 2	**Nuclear Power Plant** 2.1 Selection of site 2.2 Nuclear Fission & Fusion, Chain Reaction, Half-Life period 2.3 Layout and working with block diagram 2.4 Construction and Working of Nuclear Reactor. Features and Function of the following equipments – (a) Core (b) Fuel rod (c) Moderator (d) Control rod (e) Thermal shielding (f) Reflector 2.5 Nuclear fuels : Fissile & Fertile materials, Types of reactors 2.6 Disposal of nuclear waste 2.7 Merits & Demerits of nuclear power plant 2.8 List of important nuclear power plants in India with their capacities	**07**

Unit: 3	**Gas and Diesel Power Plant** **(A) Gas Turbine Power Plant** 3.1 Selection of site 3.2 Layout and working with block diagram 3.3 Fuels and different elements used in gas turbine power plant 3.4 Merits and Demerits of Gas Turbine Power Plant **(B) Diesel Electric Power Plant** 3.5 Layout and working with block diagram 3.6 Working of different elements used in diesel power plant 3.7 Merits & Demerits of Diesel Electric Power Plant 3.8 Field of application	**06**
Unit: 4	**Large Hydro Power Plants** 4.1 Selection of site 4.2 Layout and working with schematic diagram 4.3 Function of different components – Storage reservoir, Dam, Spillway,Penstock, Surge Tank etc. 4.4 Types of Water Turbines and their construction,basic operation of each type and their use(concept only) 4.5 Pumped Storage Plant 4.6 Merits & Demerits 4.7 Power calculation and plant related simple numerical problems 4.8 List of important Large Hydro Plants in India with their capacities	**08**
Unit: 5	**Economics of Power Generation and Interconnected Power Station** 5.1 Related Terms – Connected Load, Firm Power, Cold Reserve,Hot Reserve,Operating Reserve, Spinning Reserve, Average Demand, Maximum Demand 5.2 Base Load Plant & Peak Load Plant 5.3 Load Curve, Load Duration Curve, Integrated Duration Curve, Mass Curve, simple numerical problems 5.4 Factors affecting the cost of generation – Demand Factor, Load Factor, Diversity Factor, Plant Use Factor, Plant Capacity Factor. Simple numerical problems 5.5 Different types of Tariff system - Flat Rate, Block Rate, Two Part, Three Part, simple numerical problems 5.6 Significance of Interconnected Power System 5.7 Choice of size and number of units, combined operation of power stations 5.8 Reasons and impact of grid system faults, State Grid and National Grid 5.9 Brownout and Blackout	**12**
	Total	**45**

References:

1. P. K. Nag, Power Plant Engineering, McGraw Hill, New Delhi, ISBN: 978-9339204044
2. Tanmoy Deb, Electrical Power Generation, Khanna Publishing House, Delhi (Ed. 2018) ISBN-10- 9789386173379 ; ISBN: 13- 978-9386173379
3. B.R.Gupta, Generation of Electrical Energy, S. Chand & Co. New Delhi,
4. J.B. Gupta, A Course in Electrical Power- S. K Kataria and Sons, New Delhi. ISBN:13- 978-9350143742; ISBN:10-9350143747
5. Soni, Gupta, Bhatnagar, A Course in Electrical Power. – Dhanpat Rai and Sons
6. V K. Mehta, Principles of Power System – S. Chand & Company Ltd., New Delhi.ISBN-13- 978-8121924962; ISBN:10-9788121924962

Course Outcomes

After completion of this course, the students will be able to-

1. Explain the features, functioning, merits and demerits of Coal Based Thermal Power Plant.
2. Describe the construction, merits and demerits of Nuclear Power Plant.
3. Identify elements of gas turbine Power plant and Diesel Electric Power Plant through appropriate block diagram.
4. Select the merits and demerits of gas turbine Power Plant and Diesel Electric Power Plant for application in real field.
5. Explain the layout and functioning, merits and demerits of Large Hydro Power Plant with respect to it's various components.
6. Identify various factors associated in the economic use of Power generation and interconnected Power Station.

Internal Assessment (40 Marks)		
Mid Semester Class Test:20 Marks	Quizzes, viva-voce, Assignment: 10 Marks	Attendance: 10
External Assessment (End Semester Examination:60 Marks)		
GROUP	UNIT	
A	1	
B	2,3	
C	4,5	

Course Code	:	
Course Title	:	INTRODUCTION TO ELECTRIC GENERATION SYSTEMS LABORATORY
Semester		Three
Number of Credits	:	1 (L: 0, P: 2)
Prerequisites	:	NIL
Course Category	:	PC
Full marks		100 [Internal :60; External:40]

Course Objective

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 conventional electric power generating plants.

Practicals

At least EIGHT are to be done

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. Identify the routine maintenance parts of the diesel generator power plant after watching a video programme
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. Study on the different types of Boiler used in coal based thermal power plant
7. Study on different types of Nuclear Reactor used in nuclear power plant
8. Study on different types of Water Turbines used in large hydro power plant
9. Draw Load Curve, Load Duration Curve and Mass curve of your institute
10. Calculate the total energy cost in a (i) Residential (ii) Commercial and (iii) Industrial Bill.

Course Outcomes

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

a) Analyze the optimized working of the coal power plant.

b) Analyze the optimized working of the nuclear power plant.

c) Explain the optimized working of the gas power plant.

d) Explain the optimized working of the diesel power plant.

e) Analyze the optimized working of the large hydro power plant

f) Calculate the cost of electricity for different class of consumers.

E X A M I N A T I O N S C H E M E (SESSIONAL)

1. **Continuous Internal Assessment of 60 marks** is to be carried out by the teachers throughout the Third Semester. **Distribution of marks:** Continuous evaluation:50 Marks; Class Attendance: 10 Marks
2. **External Assessment (end Semester examination) of 40 marks** shall be held at the end of the Third Semester on the entire syllabus. Assignment on the day of Viva-voce and practical report submission:20; Viva-voce:20

Course Code	:	
Course Title	:	ELECTRIC CIRCUITS
Number of Credits	:	3 (L: 3, P: 0)
Semester		Third
Prerequisites	:	NIL
Course Category	:	PC
Full Marks		100 [Internal :40; External:60]

Course Objective

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.

Contents (Theory):		Hrs./Unit
Unit : 1	**Network Theorems (Statement, procedure, areas of applications and limitations of all theorems)** 1.1. Mesh Analysis and Node Analysis 1.2. Star/delta and delta/star transformation 1.3. Superposition theorem. 1.4. Thevenin's theorem. 1.5. Norton's theorem 1.6. Maximum power transfer theorem 1.7. Related Numerical problems.	**10**
Unit : 2	**Single Phase A.C Circuits** 2.1 Generation of alternating voltage. 2.2 Phasor representation of sinusoidal quantities 2.3 R, L, C circuit elements its voltage and current response. 2.4 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 and vector diagram. 2.5 Resonance, Bandwidth, Quality factor and voltage magnification in series and parallel R- L-C circuit. 2.6 Related Numerical problems.	**09**
Unit: 3	**Three Phase A.C Circuits** 3.1 Phasor and complex representation of three phase supply 3.2 Phase sequence and polarity 3.3 Types of three-phase connections, Relationship between Phase and line quantities in three phase star and delta system with derivation. 3.4 Concept of balanced and unbalanced load, neutral shift in unbalanced load 3.5 Three phase power, active, reactive and apparent power in star and delta system. 3.6 Related Numerical problems.	**08**

Unit: 4	**Transient Analysis** 4.1 Introduction 4.2 Simple R-L Circuit supplied from a DC voltage source 4.3 Simple R-C circuit supplied from a DC voltage source. 4.4 Time Constant. 4.5 Related Numerical problems.	**06**
Unit: 5	**Laplace Transform** 5.1 Definition & Properties. 5.2 Laplace Transform of Unit Step, Impulse, Ramp, Exponential, Sine, Cosine Function. Initial value and Final Value Theorem. 5.3 Applications of Laplace Transformations for solving differential equations describing simple electrical circuits 5.4 Related Numerical problems.	**08**
Unit: 6	**Two port network** 6.1 Open circuit Impedance and Short circuit Admittance parameters, 6.2 Transmission parameters and their Inter relations. (Simple Numerical)	**04**
	Total	**45**

References:

1. B.L. Theraja, Basic Electrical Engineering Volume – S. Chand; ISBN-13 : 978-8121924405
2. Mahmood Nahvi & JosephA Edminister, Schaum's outlines Electric circuits, McGrawhill Education (India)Pvt. Ltd., ISBN-13 : 978-9389538908
3. D Roy Choudhury, Networks and Systems, Publisher: NEW AGE, ISBN-13 : 978-8122427677; ISBN-10 : 9788122427677
4. A.Chakraborty, Circuit Theory Analysis and Synthesis. – Dhanpat Rai & Co.
5. S P Ghosh & A KChakraborty, Network Analysis & Synthesis – McGrawhill Education (India)Pvt. Ltd., ISBN-13- 9780070144781;ISBN-10- 9780070144781
6. S Salivahanan; Circuit theory Analysis and Synthesis; Pearson India Education Service Pvt Ltd; ISBN: 978- 93-539-4818-4
7. Gargi Basu; Introduction to circuit and Network; Platinum Publishers; ISBN: 978-8189874-46-9

Course Outcomes

After completion of this course, the students will be able to-

1. Explain the statement, procedure, areas of application and limitations of Network Theorems.
2. Describe the generation, phasor diagram of sinusoidal quantities, R, L, C series and parallel combination of Single-Phase AC Circuits.
3. Analyze circuits and systems by their standard parameters to identify their characteristics in Three Phase AC circuits
4. Explain Transient Analysis of R-L and R-C circuits supplied from DC Voltage Source and concept of time constant.
5. Apply Laplace Transformation to solve various real-life problem in Electrical Circuit Networks.

Internal Assessment (40 Marks)		
Mid Semester Class Test:20 Marks	Quizzes, viva-voce, Assignment: 10 Marks	Attendance: 10

External Assessment (End Semester Examination:60 Marks)	
GROUP	UNIT
A	1,6
B	2,3
C	4,5

Course Code	:	
Course Title	:	ELECTRIC CIRCUITS LABORATORY
Semester		Three
Number of Credits	:	1 (L: 0, P: 2)
Prerequisites	:	NIL
Course Category	:	PC
Full Marks		100 [Internal 60 Marks; External:40 Marks]

Course Objective

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

At least EIGHT are to be done

1) To verify Kirchhoff's Current Law and Kirchhoff's Voltage Law.
2) Use dual trace oscilloscope to determine A.C voltage and current response in given R, L, C circuit.
3) Use voltmeter, ammeter, wattmeter to determine active, reactive and apparent power consumed in given R-L / 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 and parallel 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-L / 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 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.
9) 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

10) Use voltmeter, ammeter to determine current through the given branch of an electric network by applying mesh analysis.
11) Use voltmeter, ammeter to determine current through the given branch of an electric network by applying node analysis.
12) Use voltmeter, ammeter to determine current through the given branch and voltage across the given element of circuit by applying superposition theorem.
13) Use voltmeter, ammeter to determine equivalent circuit parameter in a given circuit by applying Thevenin's theorem
14) Use voltmeter, ammeter to determine equivalent circuit parameter in a given circuit by applying Norton's theorem
15) 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 the course are to be taught and implementatecd 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.

E X A M I N A T I O N S C H E M E (SESSIONAL)

1. Continuous Internal Assessment of 60 marks is to be carried out by the teachers throughout the Third Semester. **Distribution of marks:** Continuous evaluation:50 Marks; Class Attendance: 10 Marks

2. External Assessment (end Semester examination) of 40 marks shall be held at the end of the Third Semester on the entire syllabus. Assignment on the day of Viva-voce and practical report submission:20; Viva-voce:20

Course Code	:	
Course Title	:	**ELECTRICAL AND ELECTRONIC MEASUREMENTS**
Semester		**Third**
Number of Credits	:	3 (L:3, P:0)
Prerequisites	:	NIL
Course Category	:	PC
Full Marks		100 Marks [Internal :40 Marks + External: 60 Marks]

Course Objective

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

1. Know relevant measuring instrument in different electrical & electronics applications.
2. Know working of relevant measuring instruments in analog & digital applications.

Contents (Theory):		Hrs./Unit
Unit : 1	**Fundamentals of Measurements:** 1.1 Purpose of measurement and significance of measurement. 1.2 Definition & brief explanations of: - Range, sensitivity, true & indicated value, Errors (including limiting errors), Resolutions, Accuracy, Precision and instrument efficiency. 1.3 Classification of instrument systems: - 1.3.1 Null and deflection type instruments 1.3.2 Absolute and secondary instruments 1.3.3 Analog and digital instruments 1.3.4 Static and dynamic characteristics, types of errors 1.4 Calibration of instruments: Necessity and procedure 1.5 Classification of measuring instruments: - Indicating, Recording and Integrating instruments. 1.5.1 Essential requirements of indicating instruments	**05**
Unit : 2	**Measurement of voltage and current:** 2.1 Construction, working principle, salient features, merits and demerits of – i) Permanent Magnet Moving Coil (PMMC) type Instrument ii) Moving Iron (MI) type Instrument iii) Dynamometer type Instrument 2.2 AC voltmeter: Rectifier type (half wave and full wave) – their construction, working principle, salient features. 2.3 Different Methods of range extension of Ammeter and Voltmeter & related problems. 2.4 Calibration of Ammeter and Voltmeter. 2.5 CT: Construction, working principle, different errors and their reduction, Accuracy class, Burden on CT, Specifications, Precautions in the use of CT, application. 2.6 PT: Working principle, Errors (concept only), Accuracy class, Burdens, Specifications, Precautions in the use of PT, application. 2.7 Clamp-on meter: Construction, working principle, application.	**09**

Unit: 3	**Measurement of Electric Power:** 3.1 Dynamometer type wattmeter: Construction and working principle, Multiplying factor and extension of range, Different types of errors and their compensation. 3.2 Measurements of active power in three phase circuit for balanced load by one wattmeter method, two wattmeter method, three wattmeter method, related problems. 3.3 Measurement of active power in three phase circuit for unbalanced load. 3.4 Effect of power factor variation on wattmeter readings in two wattmeter method – Numerical problems. 3.5 Measurement of reactive power in three phase circuit. 3.6 Maximum Demand indicator - Construction and working principle.	**08**
Unit: 4	**Measurement of Electric Energy:** 4.1 Single phase and three phase electronic energy meter: Constructional features and working principle, Different types of errors and their compensation. 4.2 Constructional feature & working principle of single phase and three-phase induction type energy meter. Different types of errors and their compensation. 4.3 Calibration of single-phase electronic energy meter using direct loading.	**07**
Unit: 5	**Measurement of Circuit Parameter, CRO and Other Meters:** 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 5.1.4 Ohm meter: Series, Shunt type 5.2 Measurement of inductance using Anderson bridge. 5.3 Measurement of capacitance using Schering bridge. 5.4 Earth tester: Working and connection diagram, application. 5.5 Digital Multimeter: Working principle and basic block diagram, application. 5.6 L-C-R meter: Working and basic block diagram, application. 5.7 Digital Frequency meter: Working and basic block diagram, application. 5.8 Phase sequence indicator: Working and basic block diagram, application. 5.9 Power factor meter: Single phase and Three phase dynamometer type: Working principle and circuit diagram. 5.10 Synchroscope: Working principle and circuit diagram, application. 5.11 Tri-vector meter: Working principle, application. 5.12 Cathode Ray Oscilloscope (CRO): 5.12.1 Single beam/single trace, Dual trace CRO 5.12.2 Digital storage Oscilloscope**:** Basic block diagram, working. 5.12.3 Cathode ray tube, electrostatic deflection, vertical amplifier, horizontal amplifier, time base generator. 5.12.4 Measurement of voltage, amplitude, time period, frequency, phase angle using CRO. Lissajou figure. 5.12.5 Specifications of CRO. 5.13 Signal generator: Working and basic block diagram, Applications. 5.14 Function generator: Working and basic block diagram, function of symmetry, Applications.	**16**
	Total	**45**

References:

1. Sawhney A.K., Electrical and Electronics Measurements and Instrumentation.,DhanpaiRai and Sons, New Delhi, ISBN : 9780000279744
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. 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
6. Suryanarayna N.V., Electrical Measurements and Measuring Instruments, S.Chand and Co. New Delhi , ISBN :8121920116
7. Kalsi H S; Electronic Instrumentation; McGraw-Hill New Delhi; ISBN13:978-0-07-070206-6; ISBN10:0-07-070206-3

Course Outcomes:

After completion of this course, the students will be able to-

1. Explain the features, functioning and classification of Measuring instruments.
2. Describe the functioning and classification of different types of measuring instrument for measuring voltage and current.
3. Identify the construction, features and application of instrument for measurement of electric power.
4. Describe the features and application of Energy Meter.
5. Explain the functioning and application of different types of electrical instruments including CRO for measuring various electrical parameters.

Internal Assessment (40 Marks)		
Mid Semester Class Test:20 Marks	Quizzes, viva-voce, Assignment: 10 Marks	Attendance: 10 Marks

External Assessment (End Semester Examination:60 Marks)	
GROUP	UNIT
A	1,2
B	3,4
C	5

Course Code	:	
Course Title	:	**ELECTRICAL AND ELECTRONIC MEASUREMENTS LABORATORY**
Semester		Third
Number of credits	:	1 (L:0, P:2)
Prerequisites	:	NIL
Course Category	:	PC
Full marks		100 Marks [Internal :60 Marks; External:40 Marks]

Course Objective

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

1. Use relevant measuring instrument in different electrical & electronics applications.
2. Use working of relevant measuring instruments in analog & digital applications.
3. Know the troubleshooting of different electrical & electronic instruments.

List of Practicals: (At least EIGHT are to be performed)

1. Use Clamp-on meter / digital multi-meter for measurement of AC/DC current, AC/DC voltage.
2. Extend range of ammeter and voltmeter by using (i) shunt and multiplier (ii) CT and PT.
3. Use single wattmeter for measurement of active and reactive power of three phase balanced load.
4. Use two watt-meters for measuring active power of three-phase balanced load.
5. Calibrate single phase electronic energy meter by direct loading.
6. Troubleshoot single phase electronic energy meter.
7. Use Kelvin's double bridge for measurement of low resistance.
8. Use voltmeter and ammeter method / Wheatstone bridge for measurement of medium resistance.
9. Use Megger for measurement of insulation resistance.
10. Use earth tester for measurement of earth resistance.
11. Measure unknown inductance using Anderson bridge.
12. Measure unknown capacitance using Schering bridge.
13. Use CRO for the Measurement of voltage, frequency, phase angle.
14. 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 various ranges of electrical parameters.
f) Know the use of CRO, Signal generator, Function generator.

E X A M I N A T I O N S C H E M E (SESSIONAL)

1. Continuous Internal Assessment of 60 marks is to be carried out by the teachers throughout the Third Semester. **Distribution of marks:** Continuous evaluation:50 Marks; Class Attendance: 10 Marks

2. External Assessment (end Semester examination) of 40 marks shall be held at the end of the Third Semester on the entire syllabus. Assignment on the day of Viva-voce and practical report submission:20; Viva-voce:20

Course Code	:	
Course Title	:	DC Machines and Transformers
Semester		Third
Number of Credits	:	3 (L: 3, P: 0)
Prerequisites	:	NIL
Course Category	:	PC
Full Marks		100 [Internal :40+ External: 60]

Course Objective: The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences: Maintain dc motors and transformers.

	Contents (Theory):	Hrs/ unit
Unit:1	**GENERAL INTRODUCTION OF ROTATING MACHINE** 1.1. Mechanism of Electro-Mechanical energy conversion for generator & motor mode	01
Unit: 2	**D.C. Generator** 2.1 Working principles, Construction & Types of dc generator. 2.2 Armature winding types – Concept of Lap & Wave winding. 2.3 E.m.f equation 2.4 Generator characteristics: Open circuit characteristics; External Characteristics (Concept only); Methods of building up of e.m.f, Significance of Critical resistance and Critical speed (Numerical). 2.5 Concept of flux distribution in DC machine. 2.6 Armature reaction in DC machine and remedial measures. (Concept only). 2.7 Commutation method, Concept of reactance voltage. 2.8 Applications of different types of D.C. generator. 2.9 Parallel operation of dc generator.	08
Unit:3	**3. D.C. Motor** 3.1 Working principles, Back e.m.f., Speed and Torque equation. (Numerical) 3.2 Characteristics of Series, Shunt & Compound motors. 3.3 Methods of speed control of DC motors. (Numerical) 3.4 Starting methods of DC motor – 3-point & 4-point starter. 3.5 Losses and Efficiency (Numerical). 3.6 Braking methods of DC motor – Regenerative braking, Counter current braking, Dynamic braking. 3.7 Applications of different types of DC motor. 3.8 Brushless DC motors: Construction; working principle and applications.	09
Unit:4	**4.Single phase Transformer:** 4.1 Types of transformers: Shell type and Core type; construction; different parts of transformer and their function. Material used for different parts: CRGO, CRNGO, HRGO, amorphous core. 4.2 Principle of operation. 4.3 E.m.f. equation, Transformation ratio, rating of transformers. (Numerical) 4.4 Concept of ideal and practical transformer.	14

	4.5 Performance under no-load condition with phasor diagram. (Numerical) 4.6 Performance under load condition with phasor diagram. (Numerical) 4.7 Equivalent circuit. (Numerical) 4.8 Per unit representation of impedance (Numerical). 4.9 Voltage Regulation at upf, lagging pf & leading pf. (Numerical) 4.10 Polarity test of transformer. 4.11 Open Circuit and Short Circuit tests – Estimation of losses & Equivalent circuit parameters. (Numerical) 4.12. Losses, Efficiency, Maximum efficiency, All-day efficiency. (Numerical) 4.13 Parallel operation of single phase transformers (Numerical). 4.14 Tap-changing methods, Tap changers – Off load & On-load type. 4.15 Single-phase Auto transformer: Construction, Working principles and application.	
Unit:5	**5. Three phase Transformer**: 5.1 Types of three phase transformer: Bank of three single phase transformers, single unit three phase transformers. 5.2 Construction of 3-phase transformer –different types of Winding. 5.3 Connections of 3-phase transformer – As per IS:2026 (part-IV)-1977 (Classification & necessity). 5.4 Practical application of zig-zag connection in earthing transformer. 5.5 Concept of Tertiary winding and its utility. 5.6 Different cooling methods of transformer. 5.7 Three-phase Auto transformer – Construction; working principle and application. 5.8 Scott-connected transformer – working principle, connection Diagram, practical application. 5.9 Open delta connection – working principle, connection diagram and practical application. 5.10 Criteria for selection of Power transformer and distribution transformer. Amorphous Core type distribution transformer; Specification of three phase distribution transformer as per IS: 1180(Part I)-1989 5.11 Need of parallel operation of three phase transformer, Conditions for parallel operation. 5.12 Phasing out test on Three-phase transformer.	09
Unit:6	**Special Purpose Transformers** 6.1 Isolation transformer: Construction, working principle and applications. 6.2 Single phase welding transformer: Construction, working principle and applications. 6.3 Pulse transformer: Construction, working principle and applications. 6.4 'K' factor of transformers: overheating due to non-linear loads and harmonics.	04
		45 hrs

References:

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2. Bhattacharya, S. K., Electrical Machines, McGraw Hill Education, New Delhi, ISBN:9789332902855

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5. Mittle, V.N. and Mittle, Arvind., Basic Electrical Engineering, McGraw Hill Education, New Delhi, ISBN: 9780070593572

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7. G.C. Garg & P.S. Bimbhra, Electrical Machines, Vol-I, II, Khanna Book Publishing House ISBN: 978-9386173-447, 978-93-86173-607, New Delhi

8. Mehta, V. K. and Mehta, Rohit, Principles of Electrical Machines, S. Chand and Co. Ltd., New Delhi, ISBN: 9788121930888

9. Bandyopadhyay, M. N., Electrical Machines Theory and Practice, PHI Learning Pvt. Ltd., New Delhi, ISBN: 9788120329973

10. S K Sen, Electrical Machinery, Khanna Book Publishing House, New Delhi; ISBN: 8174091521

Course Outcomes: After completion of this course, the students will be able to-

1. Describe the construction, classification and applications of DC Generator.
2. Identify features, classification and application of DC motors and staters.
3. Describe the working principle, construction, classification and application of single-phase transformer.
4. Explain the construction, classification, applications and different circuit connections of three phase transformer in real field.
5. Identify the construction, features and application of various Special Purpose Transformers.

Internal Assessment (40 Marks)		
Mid Semester Class Test:20 Marks	Quizzes, viva-voce, Assignment: 10 Marks	Attendance: 10

External Assessment (End Semester Examination:60 Marks)	
GROUP	UNIT
A	1,2,3
B	4
C	5,6

Course Code		
Course Title		DC Machines and Transformers Laboratory
Semester		Third
Number of credits		1 (L:0, T:0; P:2)
Prerequisites		NIL
Course Category		PC
Full Marks		100 [Internal :60; External:40]

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

- Use dc machines and transformers.

List of Practical: **At least eight Experiments to be performed (four from dc machines and four from transformers)**
1. Dismantle a DC machine.
2. Plot the O.C.C. of a D.C. generator & find the critical resistance.
3. Starting and reversing of DC motor.
3. Control the speed of DC shunt motor above & below rated speed & draw the speed characteristics.
4. Perform the brake test on DC series motor.
5. Compute the efficiency of a D.C. motor by Swinburne's test.
6. Determine equivalent circuit parameters of single-phase transformer by performing O.C. test and S.C. test.
7. Determine the regulation & efficiency of single-phase transformer by direct loading method
8. Compute the efficiency of a single-phase transformer by Back-to-Back test.
9. Perform parallel operation of two single phase transformers to determine the sharing of load current, apparent and real power.
10. Check the functioning and testing of the isolation transformer.
11. Check the functioning and testing of pulse transformer
12. Study and check the connections (vector grouping) of three phase 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:

1. Maintain DC generators and determine the performance characteristics.
2. Maintain different types of DC motors and determine their performance characteristics.
3. Maintain single phase transformer and determine the performance characteristics.
4. Check different types of connections of three phase transformers.
5. Maintain different types of special purpose transformers used in different applications.

E X A M I N A T I O N S C H E M E (SESSIONAL)

1. Continuous Internal Assessment of 60 marks is to be carried out by the teachers throughout the Third Semester. **Distribution of marks:** Continuous evaluation:50 Marks; Class Attendance: 10 Marks

2. External Assessment (end Semester examination) of 40 marks shall be held at the end of the Third Semester on the entire syllabus. Assignment on the day of Viva-voce and practical report submission:20; Viva-voce:20

Course Code	:	
Course Title	:	ANALOG AND DIGITAL ELECTRONICS
Semester		Third
Number of Credits	:	3 (L: 3, T: 0, P: 0)
Prerequisites	:	NIL
Course Category	:	PC
Full Marks		100 [Internal:40; External:60]

Course Objective

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 analog and digital electronic devices.

Course Contents:

Contents (Theory):		Hrs./Unit
Unit : 1	**1. Diode** **1.1 Zener Diode** 1.1.1 Construction, Symbol, Circuit diagram for characteristics of Zener diode (Forward & Reverse), Zener & Avalanche Breakdown 1.1.2 Zener diode specifications – Zener voltage, power dissipation, break over current, dynamic resistance & maximum reverse current. **1.2 Rectifiers and Filters:** 1.2.1 Need of rectifier, Types of single-phase rectifiers - Half wave & full wave rectifier (Bridge & Centre tapped). 1.2.2 Circuit operation of the rectifiers, Input & output waveforms for voltage & current, Average and rms value of voltage & current (expression only), Ripple, Ripple factor, Ripple frequency, form factor, PIV of diode used, Rectifier efficiency. 1.2.3 Need of filters, Types of filters – a) Series inductor, b) Shunt capacitor, c) LC filter, d) π filter. 1.2.4 Circuit operation of the filters, limitations & advantages	**6**
Unit : 2	**2. Transistors:** **2.1 Bipolar Junction Transistor (BJT):** 2.1.1 Transistor configurations – CB, CE, CC, circuit diagram for input & output characteristics of each configuration, Input & output characteristics. Comparison between three configurations. 2.1.2 Transistor parameters – input & output resistance, α, β and relation between them, Related numerical problems. 2.1.3 Transistor specification – $V_{CE\ Sat}$, $I_{C\ Max}$, V_{CEO}, I_{CEO}, $V_{CE\ Breakdown}$, α, β, Power dissipation. 2.1.4 Basic Common Emitter Amplifier and D.C Load Line : Importance of DC load line and AC load line, Operating point, selection of Q point and stabilization, Related numerical problems.	**14**

	2.1.5 Need of biasing, Name of different biasing methods of transistor. 2.1.6 Voltage Divider biasing method 2.1.7 Power Amplifier: Classification of power amplifier – Class A, Class -B, Class AB and class C, Operation of Push – pull amplifier. **2.2 Field effect transistor (JFET):** 2.2.1 Symbol, Construction of JFET, working principle and V-I characteristics of JFET, pinch-off voltage, drain resistance, transconductance, amplification factor and their relationship. **2.2.2** Introduction to MOSFET-Types of MOSFET, construction, working principle and applications. **2.3 Unijunction transistor (UJT):** Symbol, Construction, Working principle and characteristics of UJT, Equivalent circuit, UJT as relaxation oscillator, Applications.	
Unit: 3	**3. Feedback Amplifiers and Oscillators** 3.1 Concept of Positive and Negative feedback, Voltage gain of amplifier for negative and positive feedback. **3.2** Introduction to oscillator, Block diagram of sine wave oscillator, requirement of oscillation, Barkhausen criterion. Wien bridge oscillator, Colpitt oscillator – operating principle, frequency of oscillation.	**05**
Unit: 4	**4. Combinational Logic Circuits:** **4.1** Half adder, Full adder, Half subtractor, Full subtractor, N bit parallel adder, Parity Generator and checker, Digital comparator **4.2** Code converter, Encoder, Decoder, Multiplexer, Demultiplexer.	**06**
Unit: 5	**5 Sequential Logic Circuits:** 5.1 Flip-flops – RS, D, T, JK, JK Master Slave Flip Flops using basic gates, preset and clear signals. 5.2 Counters - Asynchronous & Synchronous Counter, Mod-N counter, Up Down Counter, Ring counter 5.3 Registers - Shift register, Serial in Serial out, Serial in Parallel out, Parallel in serial out, Parallel in Parallel out.	**09**
Unit: 6	**6 Data Converters & Memory Devices:** 6.1 D/A Converter: Basic concepts, Weighted Resistor D/A converter, R-2R Ladder D/A converter. 6.2 A/D Converter: Successive approximation method, Dual slope method. 6.3 Concept of - Static Memory & Dynamic Memory, SDRAM, DDR RAM, PROM, EEROM, EPROM. 6.4 Comparison of Logic families – DTL, TTL and ECL Gates	**05**
	Total	**45**

References:

1. Electronic Principles, Albert Malvino & D.J.Bates , McGraw Hill Publisher; ISBN:13- 978-9354602399
2. David A. Bell; Electronic Device and Circuit; Oxford University Press, India; ISBN: 13-9780-0-19-569340-9
3. Electronics Engineering, J.B.Gupta, S.K.Kataria & Sons; ISBN:13-978-9350144374
4. V K Mehta & Rohit Mehta; Principles of Electronics, S. Chand Publishing; ISBN: 13- 978-9352838363
5. S Salivahanan, N Suresh Kumar, Electronic Devices and Circuits, McGraw Hill Education; ISBN:13- 978-9339219505
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8. Digital Circuits and Design: S. Salivahanan; Oxford University Press, India ISBN: 13-9780-0-19-948868-1

Course Outcomes

After completion of this course, the students will be able to-

1. Describe the features and applications of diode and rectifiers.
2. Explain construction, different types of circuit configurations and applications of Transistors.
3. Describe the concept, features and different application of Feedback Amplifiers and Oscillators through block diagram.
4. Describe and explain different combinational circuits and the practical applications in digital electronics.
5. Describe and explain different sequential circuits in digital electronics.
6. Describe and explain different data converter and memory devices.

Internal Assessment (40 Marks)		
Mid Semester Class Test:20 Marks	Quizzes, viva-voce, Assignment: 10 Marks	Attendance: 10

External Assessment (End Semester Examination:60 Marks)	
GROUP	UNIT
A	1,3,4
B	2
C	5,6

Course Code	:	
Course Title	:	ANALOG AND DIGITAL ELECTRONICS LABORATORY
Number of Credits	:	1 (L: 0, T: 0, P: 2)
Semester		Three
Prerequisites	:	NIL
Course Category	:	PC
Full Marks		100 [Internal:60; External:40]

Course Objective

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 analog and digital electronic devices.

Practicals

1. Analog Electronics: (At least Four Experiments are to be performed) :

1.1 Construct full-wave rectifier circuit & draw input, output waveforms – with filters and without filters.

1.2 Plot the characteristics of Zener diode and find the breakdown voltage.

1.3 Plot the input & output characteristics of a BJT in CE or CB mode.

1.4 Plot the characteristics of JFET / MOSFET.

1.5 Construct a single stage CE amplifier circuit on a bread board to find out the gain and observe the input and output waveforms.

1.6 Construct Relaxation Oscillator using UJT and observe output waveform by CRO.

1.7 Construct a ±12V power supply on bread board and observe the output waveform by CRO with and without filter circuit. Also observe the output voltage using IC regulator 78XX & 79XX.

2. **Digital Electronics: (At least Four Experiments are to be performed) :**

2.1 Realization of Half Adder, Full Adder, Half Subtractor and Full Subtractor.

2.2 Verification of the function of SR, D, JK and T Flip-flops.

2.3 Realization of Encoder and Decoder circuit.

2.4 Realization of Multiplexer and Demultiplexer circuit.

2.5 Construction of binary Asynchronous or Synchronous counter.

2.6 Construction controlled shift register & verify SISO, SIPO, PISO, PIPO operation.

2.7 Implementation of D/A converter and A/D converter using trainer kit.

Course Outcomes

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

a) Analyze and describe the performance of Full wave rectifier, Zener Diode, BJT, JFET, MOSFET, UJT, Single stage Amplifier.
b) Construct and analyze the performance of dc power supply (± 12 V).
c) Explain and describe the performance of combinational circuits.
d) Explain and describe the performance of sequential circuits.

E X A M I N A T I O N S C H E M E (SESSIONAL)

1. Continuous Internal Assessment of 60 marks is to be carried out by the teachers throughout the Third Semester. **Distribution of marks:** Continuous evaluation:50 Marks; Class Attendance: 10 Marks

2. External Assessment (end Semester examination) of 40 marks shall be held at the end of the Third Semester on the entire syllabus. Assignment on the day of Viva-voce and practical report submission:20; Viva-voce:20

Internship-I

Course Objectives: Following are the objectives of this course:

- To understand industrial environment and Electrical Engineering activities.
- To get exposure to field level works.
- To get brief idea on drawings/ auto CAD for electrical etc.

After **2nd semester, for Internship I,** students are required to be involved in Inter/Intra Institutional activities viz; Training and simulation programmed with different Institute like workshop of ITI, Other Polytechnics and Technical Institutes Institutions; Soft skill training organized by Training and Placement Cell of the respective institutions; contribution at innovation/entrepreneurship cell of the institute; participation in workshops/ competitions etc; Learning at Departmental lab/ Institutional workshops.

After completion of Internship, the student should prepare a comprehensive report to indicate what he/she has observed and learnt in training period. The student may contact Industrial Supervisor/Faculty Mentor/ TPO for assigning topics and problems and should prepare the final report on the assigned topics. The training report should be signed by the Industrial Supervisor/ Internship Faculty Mentor, TPO and HOD.

Institute may follow

- Basic and applied Science in Inter/ Intra Institution.

OR

- Technical Drawings/ auto CAD for electrical in Inter/ Intra Institution.

OR

- Computer application like module course on "C Programming language "etc in Inter/ Intra Institution.

OR

- Mini project as beginner in Sci Lab/Tinkercad / any other simulation software in Inter/ Intra Institution.

OR

- Workshop practice in Inter/ Intra Institution.

OR

- Industrial Visit

OR

- Free online technical courses

OR

- Different combination of the above.
- **Activities may be conducted continuously for stipulated period of time or may be arranged in a staggered fashion.**

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:

- To learn new skills and supplement knowledge.
- To practice communication and teamwork skills.
- To learn strategies like time management, multi-tasking etc. in an industrial setup.
- To meet new people and learn networking skills

The Internship Report will be evaluated on the basis of following criteria (as applicable)

Sl. No.	Criteria for evaluation of Internship Report
1	Originality
2	Adequacy and purposeful write up
3	Organizations, format, drawing, sketches, style, language
4	Practical applications and relationships with basic theory
5	Concept taught in the course outcome
6	Practical applications, relationships with basic theory and concept taught in the course
7	Attendance record, daily diary, quality of Internship Report.

Seminars must be arranged for the student based on his/her training report, before an Internal Committee constituted by the concerned department of the Institute. The evaluation will be based on the following criteria:

Sl. No.	Criteria for evaluation of Internship Seminar
1	Quality of content presented
2	Proper Planning for presentation
3	Effectiveness of presentation
4	Depth of knowledge and skills
5	Viva voce