Chhattisgarh Swami Vivekanand Technical University, Bhilai

Diploma in Electrical Engineering/Electrical & Electronics Engineering **Semester-III**

A) Course Code : 2024371(024)
B) Course Title : Electrical Circuits
C) Pre- requisite Course Code and Title : Applied Physics
D) Rationale :

Electrical Engineering as well as Electrical & Electronics Engineering diploma holders are expected to apply the basic laws and theorems governing electrical circuits to analyze and solve the complex electrical circuits. Also they should be capable of measuring various electrical quantities/parameters in single and three phase ac circuits. This is one of the most important core engineering course and also a prerequisite to learn the advanced electrical courses and develop skills to apply the principle of DC and AC circuits to trouble shoot electrical circuits. Therefore the diploma students should try to develop mastery over concepts of electrical circuits for effective working as an electrical engineer.

E) Course Outcomes:

CO-1 Apply basic laws and principles to analyze the electrical circuits.

CO-2 Apply various analysis and theorems to solve the electrical circuit problems.

CO-3 Measure electrical quantities in single phase AC circuits.

CO-4 Apply circuit theory to ascertain the resonance condition of electric circuits.

CO-5 Measure electrical quantities in three phase AC circuits.

F) Scheme of Studies:

S. No.	Board of Study	Course Code	Course Title	Scheme of Studies (Hours/Week)			
				L	P	T	Credits L+T+(P/2)
1.	Electrical Engineering	2024371(024)	Electrical Circuits	2	-	1	3
2.	Electrical Engineering	2025361(024)	Electrical Circuits (Lab)	-	2	-	1

Legend: **L**- Lecture, **T**- Tutorial, **P**- Practical,

Lecture (L): CL Classroom Instruction (Includes different instructional Strategies i.e. Lecture and others.)
Practical (P): LI Laboratory Instruction (Includes practical performances in Laboratory workshop, field or other locations using different instructional strategies).

Tutorial (T): Includes sessional work (SW) (assignment, seminar, mini project etc.), Self Learning (SL)

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

G) Scheme of Assessment:

S. No	Board of Study	Course Code	Course Titles	Scheme of Examinations					
				Theory			Practical (PRA+ PDA+ Viva)		Total Marks
				ESE	CT	TA	ESE	TA	
1.	Electrical Engineering	2024371 (024)	Electrical Circuits	70	20	30	-	-	120
2.	Electrical Engineering	2025361 (024)	Electrical Circuits (Lab)	-	-	-	30	50	80

Legend: ESE: End semester exam **CT:** Class Test **TA:** Teachers Assessment

PRA: Process Assessment, **PDA:** Product Assessment

Note:

i. TA in Theory includes Sessional work (SW) and Attendance (ATT), with weightage of 70% and 30 % weightage of total respectively.

ii. TA in Practical includes performance of PRA, PDA and Viva-Voce with weightage of 50%, 40% and 10 % weightage of total respectively.

iii. Minimum two experiments from each unit is mandatory.

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

CO-1 Apply basic laws and principles to analyze the electrical circuit.

(Approx. Hrs. CI+ LI= 15)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Classify the given components into active and passive. SO1.2 Quote examples of given type(s) of elements. SO1.3 Differentiate between the voltage-current characteristics of the given type of voltage source. SO1.4 Apply Ohm's, Kirchhoff's Current and Voltage Law to analyze given electric circuit(s).	LE 1.1 Identify the commonly used components and materials in an electrical circuit. LE 1.2 Observe voltage and current in an incandescent lamp and comment on your observation. LE 1.3 Measure voltage and current in a given linear electric circuit. LE 1.4 Measure current and voltage in a particular branch of the given electrical circuit using Kirchhoff's Current Law. LE 1.5 Measure voltage drop in a closed loop of the given electrical circuit using Kirchhoff's Voltage Law. LE 1.6 Determine the current and voltage in a given electrical circuit.	**Unit-1.0 Principles of Electric Circuit** 1.1 Classification of electrical elements: Active and passive, Unilateral and bilateral, Independent and dependent source 1.2 Passive Elements/ Components (R,L and C): Steady state behavior in DC circuit 1.3 Simple Series and parallel resistive circuits. 1.4 Ohm's law, Kirchhoff's voltage and current law. 1.5 Application of above laws to simple circuits 1.6 Source transformation (only concept, no numerical). 1.7 Mesh and nodal analysis (limited up to two loop/node problems)	• Compile the rating of the different types of components and materials used in a typical electric circuit.

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Solve simple numerical by applying various laws and principles mentioned in this unit above.
ii. Justify that a semiconductor diode is a unilateral element.
iii. Justify that the transmission line is a bilateral element.

b. Mini Project:

i. Connect two identical battery sources in parallel /series. Find the current flowing through and voltage across 100-ohm resistor connected as load and verifiy it theoretically.

c. Other Activities (Specify):

i. Prepare a chart illustrating the principle of transformation of sources.

CO-2 Apply various analysis and theorems to solve the electrical circuit problems

(Approx. Hrs: CI+ LI = 15)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO 2.1 Reduce the given passive network by applying star/delta and delta/star transformation and measure equivalent resistance. SO 2.2 Apply mesh analysis and nodal analysis to measure current and voltage of the given circuit. SO 2.3 Measure current in a branch of the given bilateral multiple source circuit using superposition theorem. SO 2.4 Determine the circuit parameters of the given network using The venin's theorem.	LE2.1 Connect star connected resistances to its equivalent delta connection and determine the equivalent resistance. LE2.2 Connect delta connected resistances to its equivalent Star connection and determine the equivalent resistance. LE2.3 Measure current through and voltage across a circuit element of a given electric circuit and verify applying mesh and nodal analysis. LE2.4 Measure current in a branch of the given electrical circuit having two or more input sources using Super position theorem. LE2.5 Measure load current	**Unit-2.0 Circuit analysis and network theorems Note: (No Proofs)** 2.1 Star/Delta transformation of passive network 2.2 Superposition theorem (only for two source network) 2.3 The venin's theorem 2.4 Concept Norton's theorem (no numerical) 2.5 Maximum power transfer theorem 2.6 Application of theorems to solve DC networks (only for simple Independent source network)	• Explore the practical application of maximum power transfer theorem.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
	in the load resistance using The venin's theorem in a given circuit. LE2.6 Measure load current in the load resistance using Norton's theorem in a given circuit LE2.7 Determine the maximum power and load resistance for which circuit has maximum power using maximum power transfer theorem.		

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Solve simple numerical by applying various theorems studied in this unit.

b. Mini Project:

i. Prepare a chart depicting various network theorems studied.
ii. Build and test an electrical circuit to verify maximum power transfer theorem.

c. Other Activities (Specify):

i. Search internet to compile dynamic animations on Network theorems studied and give seminar on it.

CO-3 Measure electrical quantities in single phase AC circuits.

(Approx. Hrs: CI+ LI = 15)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO 3.1 Differentiate the given AC circuit quantities. SO 3.2 Represent the given AC circuit quantities in complex form. SO 3.3 Convert the given AC quantity in rectangular to polar and vice	LE3.1 Measure peak value, RMS value, Period and frequency of a sinusoidal voltage using CRO. LE3.2 Observe the behavior of current and voltage wave form in CRO for Resistive load and comment on it. LE3.3 Observe the behavior of current and voltage wave	**Unit-3.0Single Phase AC circuits** 3.1. Generation of an alternating EMF 3.2. AC circuit quantities: Peak value, RMS and Average value of a Sinusoidal voltage waveform 3.3. J-operator 3.4. AC Series and	• Compare power factor of a resistive, inductive and capacitive circuit • Determine Power factor by different methods • Conversion

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
versa and other arithmetic operations. SO 3.4 Determine the current and voltage, impedance of the given series/parallel RL/RC/ RLC circuit SO 3.5 Determine the active, reactive, apparent power and power factor of the given AC circuit	form in CRO for R-L Load and comment on it. LE3.4 Measure voltage, current, power and power factor in a series RLC circuit and draw phasor diagram. LE3.5 Measure voltage, current, power and power factor in a RLC parallel circuit and draw phasor diagram. LE3.6 Determine the power and power factor in AC circuit using three ammeter methods.	parallel circuits, Phasor diagrams and impedance triangle 3.5. Active, reactive, apparent power and power factor in RLC circuit. 3.6. Vector representation of an alternating quantity, addition, subtraction, multiplication and division.	from rectangular to polar and vice versa and exponential form

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning

SW-3 Suggested Sessional Work (SW):

a. Assignments:

i. Collect information about the ratings of single phase electrical equipment in kVA and kW in machine lab.

ii. Measure power in a series RLC circuit using three voltmeter and one ammeter.

b. Mini Project:

i. Measure the energy consumed by a single-phase AC circuit by using wattmeter and energy meter and Compare the results measured.

c. Other Activities (Specify):

i. Prepare a chart depicting the different ac circuits, corresponding phasor diagram and expression for determining various parameters.

CO-4 Apply circuit theory to ascertain the resonance condition of electric circuits.

(Approx. Hrs: CI+ LI = 12)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Explain resonance in the given RLCseries circuit with sketches SO4.2 Determine the resonance frequency of the given series RLC circuit SO4.3 Explain the significance of quality factor of the	LE 4.1 Determine the current at series resonance. LE 4.2 Observe the variation of power factor for varying inductance for a series RLC circuit. LE 4.3 Determine the current at parallel	**Unit-4.0 Series and parallel resonance**: 4.1 Definition of resonance and its importance in electrical circuit 4.2 Series resonance: Derivation of Resonance frequency and simple numerical	• Analyze the causes and effects of resonance in a electrical network.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
given series RLC circuit. SO4.4 Determine the equivalent impedance and current magnitude of the given parallel RLC circuit under resonance condition.	resonance. LE 4.4 Determine the impedance of a circuit during parallel resonance.	4.3 Definition: Quality factor, bandwidth and selectivity in series RLC circuit.(No derivations) 4.4 Effect on current and power factor in series resonance circuit.	

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning

SW-4 Suggested Sessional Work (SW):

a. Assignments:

i. Explore the different functional modes available in an LCR meter and use it for measuring inductance and capacitance.

b. Mini Project:

i. Prepare an RC and RL series circuit with a toggle switch and DC source and also plot the voltage/current time response and calculate the time constant.

c. Other Activities (Specify):

i. Prepare a chart depicting the different types of series parallel RLC AC circuits, corresponding phasor diagram and expression for determining impedance.

CO-5 Measure electrical quantities for three phase AC circuits.

(Approx. Hrs: CI+ LI = 18)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO 5.1 determine the current drawn by the given three phase balanced load connected in star/delta. SO 5.2 Determine the current drawn by the given three phase loads connected in parallel. SO 5.3 Determine the power and power factor of the given three phase load using two wattmeter SO 5.4 Determine the power factor of the given type of three phase load connected in parallel using power triangle.	LE 5.1 Measure the line /phase current, line voltage/phase voltage for the given three phase load connected to a three phase source. LE 5.2 Measure neutral displacement voltage of the given three phase unbalanced load connected to a three phase source Measure three phase power for the given star connected load. LE 5.3 Measure three phase power for the given star /delta connected load.	**Unit-5.0 Three phase A C circuits** 5.1 Generation of three phase voltage 5.2 Three phase three wire source and three phase four wire source, Phase sequence and phasor diagram 5.3 Connection of three phase winding in Star/Delta 5.4 Line and phase electrical quantity relationship: Star/Delta 5.5 Three phase load: Balanced /Unbalanced 5.6 Measurement of power in three phase circuits	• Collect information about the earthling requirement for domestic wiring as per IS code.

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning

SW-5 Suggested Sessional Work (SW):

a. Assignments:

i. Enumerate on the uses of different measurement connections that are possible in three phase systems and their differences.

b. Mini Project:

i. Observe and comment on the single phase single wattmeter reading obtained for measuring power of a three phase balanced load.

c. Other Activities (Specify):

i. Collect information about the working of phase sequence indicator available in market

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

I) Suggested Specification Table (For ESA of Classroom Instruction CI+SW+SL):

Unit Number	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
1	Principles of Electric circuits	5	5	4	14
2	Circuit analysis and network theorems	5	5	4	14
3	Single phase AC circuits	3	5	6	14
4	Series and parallel resonance	5	5	4	14
5	Three phase AC circuits	3	5	6	14
Total		**21**	**25**	**24**	**70**

Legend: R: Remember**, U**: Understand, **A**: Apply and above

J) Suggested Specification Table (For Assessment of Laboratory Instruction*):

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (% Marks)		
		Performance		Viva-Voce
		PRA	PDA	
LE1.1	Identify the commonly used components and materials in an electrical circuit.	50	40	10
LE1.2	Observe the voltage current relation in an incandescent lamp.	50	40	10
LE1.3	Measure voltage and current in a given linear electric circuit.	50	40	10
LE1.4	Measure current and voltage in a particular branch of the given electrical circuit using Kirchhoff's Current Law.	50	40	10
LE1.5	Measure voltage drop in closed loop of the given electrical circuit using Kirchhoff's Voltage Law.	50	40	10
LE1.6	Determine the current and voltage in a given electrical circuit.	50	40	10
LE2.1	Connect star connected resistances to its equivalent delta connection and determine the equivalent resistance.	50	40	10
LE2.2	Connect delta connected resistances to its equivalent Star connection and determine the equivalent resistance.	50	40	10
LE2.3	Measure current through and voltage across a circuit element of a given electric circuit and verify applying mesh and nodal analysis.	50	40	10
LE2.4	Measure current in a branch of the given electrical circuit having two or more input sources using Super position theorem.	50	40	10
LE2.5	Measure load current in the load resistance using The venin's theorem in a given circuit.	50	40	10
LE2.6	Measure load current in the load resistance using Norton's theorem in a given circuit	50	40	10
LE2.7	Determine the maximum power and load resistance for which circuit has maximum power using maximum power transfer theorem.	50	40	10
LE3.1	Measure peak value, RMS value, Period and frequency of a sinusoidal voltage using CRO.	50	40	10
LE3.2	Observe the behavior of current and voltage wave form in CRO for resistive load and comment on it.	50	40	10
LE 3.3	Observe the behavior of current and voltage wave form in CRO for R-L Load and comment on it.	50	40	10
LE3.4	Measure voltage, current, power and power factor in aseries RLC circuit and draw phasordiagram.	50	40	10

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (% Marks)		
		Performance		Viva-Voce
		PRA	PDA	
LE3.5	Measure voltage, current, power and power factor in a RLC parallel circuit and draw phasordiagram.	50	40	10
LE3.6	Determine the power and power factor in AC circuit using three ammeter method.	50	40	10
LE4.1	Determine the current at series resonance.	50	40	10
LE4.2	Observe the variation of power factor for varying inductance for a series RLC circuit.	50	40	10
LE4.3	Determine the current at parallel resonance.	50	40	10
LE4.4	Determine the impedance of a circuit during parallel resonance.	50	40	10
LE5.1	Measure the line /phase current, line voltage/phase voltage for the given three phase load connected to a three phase source.	50	40	10
LE5.2	Measure neutral displacement voltage of the given three phase unbalanced load connected to a three phase source	50	40	10
LE5.3	Measure three phase power for a given star /delta connected load.	50	40	10

* Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practical's.

Legend: PRA: Process Assessment, PDA: Product Assessment

Note: Only one experiment has to be performed at the end semester examination of **30**Marks as per assessment scheme.

K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture Method
2. Industrial visits
3. Expert Lecture
4. Field Trips
5. Self Learning
6. Observation, Practice and Feedback
7. Classroom, Laboratory, Workshop, Field, Video, Live Demonstrations
8. Demonstration
9. ICT Based Teaching Learning (Video Demonstration, CBT, Blog, Face book, Mobile) can be integrated with many methods

L) Suggested Learning Resources:

(a) Books

S. No.	Titles	Author	Publisher	Edition & Year
1.	Fundamental of Electric Circuits	Charles K. Alexander , Matthew N.O. Sadiku	McGraw-Hill Education ISBN: 978-1259098598	5th edition, 2013
2.	Electronic Devices and Circuit	Boylestad , Robert L. ; Nashelsky, Louis	Pearson Education India; ISBN: 978-9332542600	11th edition, 2014

3.	Engineering Circuit Analysis	William H. Hayt; Jack Kemmerly; Steven M. Durbin	McGraw Hill Education; ISBN-13: 978-125909863	8th edition, 2013
4.	Circuits and Networks: Analysis and Synthesis	Sudhakar , A.; Palli , Shyammohan S.	McGraw Hill Education; ISBN: 978-9339219604	5thedition 2017
5.	Circuit Theory: Analysis and Synthesis	Chakrabarti, Abhijit	Dhanpat Rai & Co ISBN: 978-8177000009	7thRevised edition,2018
6.	A Text book of Electrical Technology ,Vol-I	Theraja, B.L.	S.Chand and Co. New Delhi	Latest edition
7.	Schaum's Outline of Electric Circuits (Schaum's Outline Series)	Nahvi, M; Edminister, Joseph	Tata McGraw Hill Education Private Ltd. ISBN: 978-1260011968	7th edition, 2017
8.	Electric Circuits and Network	Suresh Kumar, K S	Pearson Education ISBN: 978-8131713907	1st edition, 2008
9.	Network analysis	Van Valkenburg, M. E.	PHI Learning ISBN: 978-8131701584	3rd edition, 2005
10.	Experiments in Basic Electrical Engineering	S. K. Bhattacharya and K. M. Rastogi	New Age International	2007

(b) List of open source software/learning website :

1. Active and passive components : https://www.youtube.com/watch?v=DqVHKBQgO94
2. Unilateral and bilateral element : https://www.youtube.com/watch?v=cC34Nd0Bvyk
3. Independent and dependant sources: https://www.youtube.com/watch?v=SfKw8bHk7-o
4. Source transformation:https://www.youtube.com/watch?v=2COHvYKnfyU
5. Series and parallel circuits:https://www.youtube.com/watch?v=8lMO7VAyEkY
6. Kirchhoff's voltage and current law: https://www.youtube.com/watch?v=N8kBRVefQkA
7. Star/ Delta Transformation: https://www.youtube.com/watch?v=igvqOyJYAoA
8. Mesh and nodal analysis : https://www.youtube.com/watch?v=8f-2yXiYmRI
9. Superposition theorem : https://www.youtube.com/watch?v=S0GsrzjVkd4
10. The venin's theorem: https://www.youtube.com/watch?v=NP1z0Emo71Y
11. Norton's theorem : https://www.youtube.com/watch?v=FqcHtww1QWs
12. Maximum power transfer theorem : https://www.youtube.com/watch?v=Tsedxs8STQY
13. Conversion from rectangular to polar: https://www.youtube.com/watch?v=554qovAmSD8
14. Conversion from polar to rectangular : https://www.youtube.com/watch?v=UlkUFX0rk3Y
15. Conversion from rectangular to exponential form: https://www.youtube.com/watch?v=inNKD7-3qFM
16. Active, reactive, apparent power and power factor in an RLC circuit: https://www.youtube.com/watch?v=yFrLRIvnRRQ
17. Connection of three phase winding in Star/Delta: https://www.youtube.com/watch?v=o-bvRjlmqWY

(c) Others:

1. Learning Packages
2. Lab Manuals
3. Manufacturers' operating Manual

M) List of Major Laboratory Equipment and Tools:

S. No.	Equipment Name with Broad Specifications	Relevant Experiment Number
1	Passive components R,L & C of different values	LE1.4
2	Bread Board with hookup wires	LE1.1,LE 1.2
3	D. C. Ammeter range (0-5-10A), Portable analog PMMC type as per relevant BIS standard	LE2.1
4	D.C. Voltmeter Range (0-150/300V), Portable analog PMMC type as per relevant BIS standard	LE1.5, LE2.1, LE2.2, LE2.3, LE2.4, LE3.1, LE3.2,LE3.3, LE3.4, LE4.2, LE5.3,LE5.4
5	D.C. Voltmeter Range (0-15/30/75 V), Portable analog PMMC type as per relevant BIS standard	LE2.1, LE2.2, LE2.3, LE2.4
6	AC Ammeter range (0-2.5-5-10A), Portable analog MI type as per relevant BIS standard	LE 3.3
7	AC Voltmeter Range (0-75/150/300V), Portable analog MI type as per relevant BIS standard	LE 3.3,LE 3.4
8	Single phase electrodynamometer wattmeter (0,100,300V),(0,2.5,5Amp)	LE3.2, LE3.3, LE3.4, LE4.2, LE5.3, LE5.4
9	Single phase electrodynamometer wattmeter (0,100,300V),(0,5,10Amp)	LE3.2, LE 3.3, LE3.4, LE4.2 LE5.3,LE5.4
10	Digital portable LCR meter; Inductance : 0.1 mH to 9999 H, Resolution 0.1 mH ,Capacitance : 0.1 pF to 9999 mF, Resolution 0.1 pF ,Resistance : 0.001 Ω to 1 M Ω, Resolution 0.001 W	LE3.2
11	Single phase variable lamp load up to2kW	-
12	Clip on meter: Voltage : 0-750VAC,Current : up to 100 A	-
13	Three phase variable lamp load with provision for star/delta connection (0-6kW)	-
14	Rheostat (0-500 Ohm, 1.2 A), Nichrome wire wound rheostat on epoxy resin or class F insulating tube with two fixed and one sliding contact	-
15	Rheostat (0-100 Ohm, 5A), Nichrome wire wound rheostat on epoxy resin or class F insulating tube with two fixed and one sliding contact	-
16	Rheostat (0-50 Ohm, 10A), Nichrome wire wound rheostat on epoxy resin or class F insulating tube with two fixed and one sliding contact	-
17	Rheostat (0-350 Ohm, 1.5A), Nichrome wire wound rheostat on epoxy resin or class F insulating tube with two fixed and one sliding contact	-

N) Mapping of POs & PSOs with COs:

Course Outcomes (COs)	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)	
	PO-1 Basic knowledge	PO-2 Discipline knowledge	PO-3 Experiments and practice	PO-4 Engineering Tools	PO-5 The engineer and society	PO-6 Environment and sustainability	PO-7 Ethics	PO-8 Individual and team work	PO-9 Communication	PO-10 Life-long learning	PSO-1	PSO-2
CO-1 Apply basic laws and principles to analyze the electrical circuits.	3	3	3	2	1	1	1	2	2	2	3	3
CO-2 Apply various analysis and theorems to solve the electrical circuit problems.	3	3	3	2	1	1	1	2	2	2	2	3
CO-3 Measure electrical quantities in single phase AC circuits.	3	3	3	2	2	2	2	2	2	2	3	3
CO-4 Apply circuit theory to ascertain the resonance condition of electric circuits.	3	3	3	3	2	2	2	2	2	2	3	3
CO-5 Measure electrical quantities in three phase AC circuits.	3	3	3	3	2	2	2	2	2	2	3	3

Legend: 1 – Low, 2 – Medium, 3 – High

O) Course Curriculum Map:

POs & PSOs No.	COs No. & Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO-1,2,3, 4, 5,6,7,8,9,10 PSO-1,2	CO-1 Apply basic laws and principles to analyze the electrical circuits.	SO1.1 SO1.2 SO1.3 SO1.4	LE1.1, LE1.2 LE1.3, LE1.4 LE1.5, LE1.6	Unit-1. Principles of Electric Circuit 1.1,1.2,1.3,1.4,1.5,1.6, 1.7	As mentioned in relevant page numbers
PO-1,2,3, 4, 5,6,7,8,9,10 PSO-1,2	CO-2 Apply various analysis and theorems to solve the electrical circuit problems.	SO2.1 SO2.2 SO2.3 SO2.4	LE2.1, LE2.2 LE2.3, LE2.4 LE2.5, LE2.6 LE2.7	Unit-2.0: Circuit analysis and network theorems 2.1,2.2,2.3,2.4,2.5,2.6	
PO-1,2,3, 4, 5,6,7,8,9,10 PSO-1,2	CO-3 Measure electrical quantities in single phase AC circuits.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5	LE3.1, LE3.2 LE3.3, LE3.4 LE3.5, LE3.6	Unit-3.0 single phase A.C. Circuits 3.1,3.2,.3.3, 3.4,3.5,.3.6	
PO-1,2,3, 4, 5,6,7,8,9,10 PSO-1,2	CO-4 Apply circuit theory to ascertain the resonance condition of electric circuits.	SO4.1 SO4.2 SO4.3 SO4.4	LE4.1 LE4.2 LE4.3 LE4.4	Unit-4.0 Series and parallel resonance 4.1,4.2,4.3, 4.4	
PO-1,2,3, 4, 5,6,7,8,9,10 PSO-1,2	CO-5 Measure electrical quantities in three phase AC circuits.	SO5.1 SO5.2 SO5.3 SO5.4	LE5.1 LE5.2 LE5.3	Unit-5.0 Three phase AC circuits 5.1,5.2,5.3,5.4,5.5,5.6	

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A) Course Code : 2024372(024)
B) Course Title : Electrical and Electronic Measurements
C) Pre-requisite Course Code and Title : Applied Physics
D) Rationale :

The electrical/ Electrical & electronics diploma engineers are expected to measure precisely voltage, current, power, energy, etc. Therefore, they should be competent to use, calibrate and maintain different types of electrical and electronics measuring instruments used in the industry and electrical systems. This demands a better understanding of the construction, materialsusedandprincipleofoperationofvarioustypesofmeasuringinstruments.This course is therefore designed to meet these needs and hence it is a core course for any electrical and electronics engineer.

E) Course Outcomes:

CO-1 Select appropriate measuring instrument for a given application.

CO-2 Use electromechanical instruments for measurements.

CO-3 Measure circuit components using appropriate Bridge/ meter.

CO-4 Trouble shoots basic electronic instruments used for industrial applications.

CO-5 Use Cathode Ray Oscilloscope and Digital Storage Oscilloscope for measurements.

F) Scheme of Studies:

S.N	Board of Study	Course Code	Course Titles	Scheme of Studies (Hours/Week)			
				L	P	T	Credit L+T+(P/2)
1	Electrical Engineering	2024372(024)	Electrical and Electronic Measurements	2	-	1	3
2	Electrical Engineering	2025362(024)	Electrical and Electronic Measurements (Lab)	-	2	-	1

Legend : **L**- Lecture, **T**- Tutorial, **P**- Practical,

Lecture (L)→ CL Classroom Instruction (Includes different instructional Strategies i.e Lecture and others.)
Practical (P)→LI Laboratory Instruction (Includes practical performances in Laboratory workshop, field or other locations using different instructional strategies).
Tutorial (T)→ Includes sessional work (SW) (assignment, seminar, mini project etc), Self Learning (SL)

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

G) Scheme of Assessment:

S. N.	Board of Study	Course Code	Course Titles	Scheme of Examinations					
				Theory			Practical (PRA+PDA+Viva)		Total Marks
				ESE	CT	TA	ESE	TA	
1	Electrical Engineering	2024372(024)	Electrical and Electronic Measurements	70	20	30	-	-	120
2	Electrical Engineering	2025362(024)	Electrical and Electronic Measurements (Lab)	-	-	-	30	50	80

Legend: **ESE:** End semester exam **CT:** Class Test **TA:** Teachers Assessment

PRA: Process Assessment, **PDA:** Product Assessment

Note:

i. TA in Theory includes Sessional work (SW) and Attendance (ATT), with weightage of 70% and 30 % weightage of total respectively.

ii. TA in Practical includes performance of PRA, PDA and Viva-Voce with weightage of 50%, 40% and 10 % weightage of total respectively.

iii. minimum two experiments from each unit is mandatory.

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.
Convert unit of the given physical quantity from one-unit system to other.
Measure various electrical parameters with accuracy, precision, resolution.

CO-1 Select appropriate measuring instrument for a given application.

(Approx.Hrs: CI+ LI =15)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Explain basic concept of measurements. SO1.2 Differentiate between deflecting, controlling and damping torque in an instrument. SO1.3 Explain terms related to	LE1.1 Select indicating, Recording and Integrating Instruments in your laboratory and write their specifications and features. LE1.2 Demonstrate the construction and working principle of	**Unit-1.0 Basics of Measurements and Measuring Instruments** 1.1 Block Diagram of measuring systems, requirements 1.2 Production of deflecting, controlling and damping torques 1.3 Accuracy, precision, Error,	• Differentiate between indicating, recording and integrating instruments with examples • Open a damaged meter to explore the constructional

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
measuring systems SO1.4 Differentiate between Indicating , Recording and Integrating Instrument SO1.5 Explain the construction and working principle of various types of electromechanical measuring instruments.	moving iron and moving coil type instruments. LE1.3 Demonstrate the construction and working principle of Induction type and dynamometer type instruments.	Resolution, Sensitivity and tolerance: Only Definition 1.4 Indicating , Recording and Integrating Instruments, Typical uses 1.5 Electromechanical measuring instruments: General description including working principle, construction applications, merits and demerits of-PMMC, Moving iron, Induction ,Dynamometers type instruments	details of PMMC, MI, induction, dynamometer type meters • Explore the working and applications of other electromechanical measuring instruments not discussed here.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Prepare a chart depicting symbols of various electrical measuring instruments.
ii. Prepare a chart showing the production of deflecting, controlling and damping torque in measuring instruments.
iii. prepare a chart showing the construction and working principle of a PMMC, MI, Induction and dynamometer type of instruments

b. Mini Project:

i. Search on internet for the information about latest trends in indicating, measuring and recording instruments in different field of applications

c. Other Activities (Specify):

i. Seminar on working of different types electrical measuring instruments
ii. Seminar on different torques produced in a electrical measuring instrument

CO-2 Use electromechanical instruments for measurements.

(Approx. Hrs: CI+ LI =18)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO 2.1. Explain the general principle of measuring current, voltage, power and energy in an electrical system SO 2.2. Extend the range of ammeter and voltmeter using	LE2.1 Measure DC, AC voltage and current using analogue meter. LE2.2 Convert a given galvanometer to DC/AC current- meter. LE2.3 Convert a given galvanometer to DC/AC Volt meter.	**Unit-2.0Electromechanical measuring Instruments** 2.1 Principle of current and voltage measurement 2.2 Galvanometer, Ammeter, Voltmeter 2.3 Range Extension of ammeter and	• Measure electrical entities in live Electrical circuit under supervision. • Open a damaged meter to explore the

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
shunt, multipliers and Current Transformer and Potential Transformer SO 2.3. Explain the general principle of measuring single and three phase power in an electrical system SO 2.4. Describe the calibration procedure of Ammeter, voltmeter, wattmeter and energy meter SO 2.5. Explain the Working of Digital energy meter with block diagram	LE2.4 Measure high value of current and voltages using shunt and multiplier. LE2.5 Measure high value of current and voltages using Current and Potential Transformer. LE2.6 Measure single and three phase power using wattmeter LE2.7 Measure 3 phase power using two and three wattmeter method LE2.8 Calibrate the given ammeter and voltmeter with a standard meter LE2.9 Calibrate the given wattmeter with a standard meter. LE2.10 Calibrate a given single phase energy meter with a standard meter LE2.11 Demonstrate the working of a digital energy meter	voltmeter using 2.3.1 Shunts and Multipliers 2.3.2 Current Transformer (CT) and Potential Transformer (PT) 2.4 Principle of Power and energy, Measurement, effect of power factor 2.5 Measurement of single and three phase power using wattmeter 2.6 Measurement of single phase energy using watt-hour meter 2.7 Calibration of ammeters, voltmeters, wattmeter's and energy meters 2.8 Working of Digital energy meter, Block diagram	constructional details of , shunts and multiplier • Compare the values of power measured using single, two and three wattmeter methods.

SW-2 Suggested Sessional Work (SW) :

a. Assignments:

i. Use an Analog Voltmeter to Measure the Voltage at a Point Referenced to Ground.
ii. List the specifications of various electromechanical meters available in market

b. Mini Project:

i. Measure active power in a 3 phase circuit using wattmeter's
ii. Measure reactive power in a 3 phase circuit using appropriate meters

c. Other Activities (Specify):

i. Identify the terminals of various types of meters and prepare a report on it
ii. Determine the power factor with resistive and inductive load using 2 wattmeter method and comment on the result.

CO-3 Measure circuit components using appropriate Bridges/meters

(Approx. Hrs: Cl+ Ll =17)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Explain the basic concept of bridge SO3.2 Use Kelvin's double bridge for low resistance measurement. SO3.3 Use Wheatstone Bridge to measure unknown medium resistance SO3.4 Use Megger to measure high value of resistance. SO3.5 Use Earth tester to measure earth resistance SO3.6 Describe the working and application of AC bridges	LE 3.1. Use Kelvin double bridge for low resistance measurement.. LE 3.2. Use Wheatstone bridge to measure medium resistance. LE 3.3. Use Megger for measure Insulation resistance. LE 3.4. Use Earth tester to measure earth resistance. LE 3.5. Measure inductance using Maxwell's Bridge LE 3.6. Measure capacitance using Schering's Bridge	**Unit-3.0 Measurements using Bridges/meters** 3.1 Classification of resistances-Low, Medium, High 3.2 Concept of bridge, balancing 3.3 Low resistance Measurement -Kelvin double bridge 3.4 Medium resistance measurement-Wheatstone bridge 3.5 High resistance measurement using Megger. 3.6 Earth resistance measurement using earth tester 3.7 Inductance Measurement using Maxwell's Bridge 3.8 Capacitance Measurement: Schering Bridge	• Explore the easiest and convenient method of determining various values of resistances. • Explore the easiest and convenient method of determining various values of inductance and capacitance.

SW-3 Suggested Sessional Work (SW) :

a. Assignments:

i. Prepare a chart depicting various DC and AC bridges, its uses and procedure to determine electrical parameter.

ii. Prepare a chart depicting precisely the working of megger and earth tester

b. Mini Project:

i. Make a meter bridge by soldering the components and prepare a report on it.

ii. Measure the Insulation Resistance values of a healthy and non healthy DC machine and Transformer using Megger and prepare a report on the results obtained.

c. Other Activities (Specify):

i. Seminar on Megger and its use

ii. Seminar on earth resistance and its measurement using earth tester

CO-4 Troubleshoot basic electronic instruments used for industrial applications.

(Approx. Hrs: CI+ LI =15)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Explain the significance of using electronic instruments SO4.2 Explain the working of true rms voltmeter with block diagram. SO4.3 Explain the working of DVM with block diagram. SO4.4 Describe working and advantage of digital multi meter with block diagram. SO4.5 Describe the working of LCR meter using block diagram.	LE4.1 Measure voltage, current, resistance using Digital Multi meter LE4.2 Perform continuity test using digital Multi meter. LE4.3 Measure resistance, Inductance and Capacitance using LCR meter. LE4.4 Measure quality Factor of given Inductor and Capacitor using LCR Q Meter LE4.5 Demonstrate the working of various analog/digital recorders.	**Unit-4.0 Electronic instruments** 4.1 Essentials and advantages of electronic instruments 4.2 True RMS reading voltmeter. 4.3 Digital Voltmeters(DVM) and its types 4.4 Digital multi meters 4.5 Digital LCR meter-Block diagram, Working principle 4.6 Analog/Digital recorders, Graphic recorder, Strip Chart recorder, XY recorder (Only block diagram)	• Measurement of electrical quantities by electronic measuring instruments • Explore the applications of various type Analog /Digital recorders.

SW-4 Suggested Sessional Work (SW) :

a. Assignments:

i. Use a DMM to Measure the Voltage of a Point Referenced to Ground.
ii. Use a DMM to Measure Voltage Drops in Series and Parallel Circuits.

b. Mini Project:

i. Prepare a report on use of various recorders for different applications
ii. Prepare a report on LCR meter

c. Other Activities (Specify):

i. Give a seminar on working of digital multi meter.
ii. Give a seminar on working of LCR meter.

CO-5 Use Cathode Ray Oscilloscope and Digital Storage Oscilloscope for measurement

(Approx. Hrs: CI+LI = 10)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Describe functions of basic building block of CRO SO5.2 Explain deflection systems of CRO SO5.3 Explain working of digital storage oscilloscope using block diagram.	LE5.1 Measurement of amplitude, Frequency, time period and Phase difference of different signals generated by function generator using CRO. LE5.2 Measure Unknown frequency, phase angle using Lissajous patterns. LE5.3 Demonstrate features of digital storage oscilloscope.	**Unit-5.0Cathode Ray Oscilloscope and Digital Storage Oscilloscope** 5.1 CRO-basic clock diagram, Cathode Ray Tube, Electrostatic and magnetic deflection, X & Y Amplifiers, Controls on CRO and their functions, Lissajous pattern 5.2 Digital Storage Oscilloscope- Basic block diagram and working	• Compare output of an electrical circuit with another signal using CRO. • Store a typical output waveform of a circuit, analyze and store the results using DSO.

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning

SW-5 Suggested Sessional Work (SW) :

a. Assignments:

i. Prepare a chart depicting the construction and various control of CRO.
ii. Observe the voltage waveform of a RC circuit switched on to DC supply using CRO and determine time constant.

b. Mini Project:

i. Observe supply current waveform in a tube light circuit using CRO and prepare a report on it.
ii. Prepare a report on the special features of DSO.

c. Other Activities (Specify):

i. Carry out a market survey to explore the specification of CRO
ii. Carry out a market survey to explore the specification of DSO

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

I) Suggested Specification Table (For ESA of Classroom Instruction):

Unit Number	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
I	Basics of Measurement & Measuring Instruments	5	3	4	12
II	Electromechanical Measuring Instruments	3	4	5	12
III	Measurements using Bridges/meters	4	4	6	14
IV	Electronic instruments	4	8	6	18
V	Cathode Ray Oscilloscope and Digital Storage Oscilloscope	4	5	5	14
Total		**20**	**24**	**26**	**70**

Legend: R: Remember, U: Understand, A: Apply and above

J) Suggested Specification Table (For Assessment of Laboratory Instruction*):

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (% Marks)		
		Performance		Viva-Voce
		PRA	PDA	
LE1.1	Selection of indicating, Recording and Integrating Instruments the laboratory and writing their specifications.	50	40	10
LE1.2	Demonstration of construction and working principle of moving iron and moving coil type instruments.	50	40	10
LE1.3	Demonstration of construction and working principle of Induction type and dynamometer type instruments.	50	40	10
LE2.1	Measurement of DC, AC voltage and current using analogue meter.	50	40	10
LE2.2	Conversion of a given galvanometer to DC/AC current- meter.	50	40	10
LE2.3	Conversion of a given galvanometer to DC/AC Voltmeter.	50	40	10
LE2.4	Measurement of high value of current and voltages using shunt resistance and multiplier.	50	40	10
LE2.5	Measurement of high value of current and voltages using Current and Potential Transformer.	50	40	10
LE2.6	Measurement of single and three phase power using wattmeter	50	40	10
LE2.7	Measurement of three phase power using two and three wattmeter method	50	40	10
LE2.8	Calibration of ammeter, voltmeter with a standard meter.	50	40	10
LE2.9	Calibration of wattmeter with a standard wattmeter.	50	40	10
LE2.10	Demonstration of working of a digital energy	50	40	10

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (% Marks)		
		Performance		Viva-Voce
		PRA	PDA	
	meter			
LE3.1	Measurement of low Resistance using Kelvin's double bridge	50	40	10
LE3.2	Measurement of medium Resistance using wheat stone bridge.	50	40	10
LE3.3	Measurement of insulation resistance using Megger	50	40	10
LE3.4	Measurement of earth resistance using Earth tester	50	40	10
LE3.5	Measurement of inductance using Maxwell's Bridge	50	40	10
LE3.6	Measurement of capacitance using Schering's Bridge	50	40	10
LE4.1	Measurement of voltage, current, resistance using Digital Multi meter	50	40	10
LE4.2	Continuity test using digital Multi meter	50	40	10
LE4.3	Measurement of resistance Inductance and Capacitance using LCR meters.	50	40	10
LE4.4	Measurement of Quality factor of a given Inductor and Capacitor using LCR Meter	50	40	10
LE4.5	Demonstration of various analog/digital recorders.	50	40	10
LE5.1	Measurement of amplitude, Frequency, time period and Phase difference of different signals generated by function generator using CRO.	50	40	10
LE5.2	Measurement of Unknown frequency, phase angle using Lissajous patterns.	50	40	10
LE5.3	Demonstration of Digital Storage Oscilloscope.	50	40	10

*Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practical.

Legend: PRA: Process Assessment, PDA: Product Assessment

Note: Only one experiment has to performed at the end semester examination of **30** Marks per assessment scheme

K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Dynamic Animation
4. Case Method
5. Group Discussion
6. Industrial visits
7. Industrial Training
8. Field Trips
9. Portfolio Based Learning

10. Role Play
11. Demonstration
12. ICT Based Teaching Learning (Video Demonstration, CBT, Blog, Face book, Mobile)
13. Brainstorming
14. Others

L) Suggested Learning Resources:

(a) Books :

S. No.	Titles	Author	Publisher	Edition & Year
1	A course in electrical & electronic measurements and instrumentation	Sawhney, A.K.	Dhanpat rai & sons, Delhi: ISBN-13: 978-8177001006	Latest Edition, 2015
2	Electronic Instrumentation	Kalsi H.S	Tata McGraw-Hill Education ISBN-13:978-0-07-070206-6	3rd Edition, 2010.
3	Electronic instrumentation & measurement techniques	Cooper, W.D. & Helfrick, A.D.,	New Delhi: Prentice Hall of India ISBN-13:9780132507219	3rd Edition, 1989
4	Electrical measurements & measuring instruments	Suryanarayana	New Delhi, Tata McGraw Hill ISBN- 0-07-451751-1	1st Edition, 1994
5	Instrumentation for Engineering Measurements	Dally, J.W. et al;	John Wiley & Sons, New York ISBN - 9780471551928	1st Edition, 1984
6	Electronic Instrumentation Fundamentals	Albert Paul Malvino	Tata McGraw Hill, New Delhi ISBN-13: 978-0070398474	Latest Edition
7	Instruments Devices and System	Rangan C.S	Tata McGraw Hill Publications ISBN-9780074633502	2nd Edition, 2009.
8	Digital Instrumentation	Bouwens A. J	Tata McGraw Hill Publications ISBN-0070067120	16th reprint (2008).
9	Electrical and Electronics Measurement and Measuring Instruments (Hindi)	S. K. Gupta	Deepak Prakashan ISBN-978-81-7776-161-0	Latest Edition

(b) Open source software and website address:

1. Basics of Measurement & Measuring Instruments :https://www.youtube.com/watch?v=oV7TpfoiYNY
2. Electromechanical Measuring Instruments :https://www.youtube.com/watch?v=k5Nzkyb8u4Y
3. Ammeter, Voltmeter and wattmeter: https://www.youtube.com/watch?v=-tha5hKhC5Q
4. CT & PT: https://www.youtube.com/watch?v=D-ctyWhKTh0
5. Measurements using Bridges/meters: https://www.youtube.com/watch?v=nWWzKgEBqjA
6. Megger:https://www.youtube.com/watch?v=XV6QlTwobLo
7. Electronic instruments: https://www.youtube.com/watch?v=TdUK6RPdIrA
8. True RMS meter:https://www.youtube.com/watch?v=7ZzwlklBbKc
9. Cathode Ray Oscilloscope:https://www.youtube.com/watch?v=U1amW7S1fcI
10. Cathode Ray Oscilloscope: https://www.youtube.com/watch?v=JsoZZM2Vc5Y
11. Lissajous pattern on CRO:https://www.youtube.com/watch?v=pSyitNgy8hE
12. Digital Storage Oscilloscope:https://www.youtube.com/watch?v=FkWtPou_RGM

(c) Others:

1. Learning Packages.
2. Lab Manuals.
3. Manufacturers' Manual
4. Users' Guide

M) List of Major Laboratory Equipment and Tools:

S. No.	Name of Equipment	Broad Specifications	Relevant Experiment Number
1.	Moving iron Ammeter Moving Coil Ammeter	0-5/15/20Ampere 0-2 Ampere	LE1.1,LE1.2, LE2.1,LE2.6,LE2.8
2.	Moving Iron Voltmeter Moving Coil Voltmeter	0-75/150/300V 0-150/300/600V	LE1.1 LE1.2
3.	Wattmeter	0-2.5/5A, 75/150/300V 0-5/10A, 150/300/600V	LE1.3 LE2.6 LE2.7 LE2.9
4.	Energy meter	Single phase	LE1.3
5.	Electronic energy meter	230v, Single phase	LE2.10
6.	Shunt Multiplier	--	LE2.4
7.	Current Transformer Potential Transformer	--	LE2.5
8.	Megger	Mains/battery pack operated analog/digital insulation tester with selectable ranges of 50V, 250V, 500 V, 1000 V, 2500 V , 5000 V.	LE3.3
9.	Kelvin's double bridge	Range : 0.2 Micro - Ohms to 11 ohms, Accuracy : 0.1%(or ±1Slidewiredivisionwhicheverisgreater),Multiplier:	LE3.1

S. No.	Name of Equipment	Broad Specifications	Relevant Experiment Number
		5Ranges(0.01,0.1,1,10 and100)	
10.	Wheatstone bridge	MeasuringRange-1.000Ωto10.00MΩ,MeasuringArm-x 1mΩ,x10Ω+10Ωx10+100Ωx10+1000Ωx10(min.onestep:1Ω),**Ratio Arms-** x0.001x0.01,x0.01,x0.1,x1,x10,100,x1000(M10,M100,M1000 Murray and Varley loop testing), **Galvanometer Power Source** -Three1.5V batteries(built-in),Range,±0.1%ofreadingon100Ωto100kΩRange, **Accuracy-** ±0.3% of reading on 10Ω to 1MΩ Range, ±0.6% of reading on 1Ωto 10MΩ Range	LE3.2
11.	Maxwell bridge	Maxwell's inductance and Maxwells inductance-capacitance bridge on single board to determine unknown inductance and its Q factor by comparison with either variable standard self inductance or standard variable capacitance. by setting the null point	LE3.5
12.	Schering's Bridge	Four arms provided with suitable connectors, One 1 KHz oscillator of fixed amplitude to feed the input to the bridge. Measuring Range: 0.001uF - 2.0uF. Connector facility given to view the output of the bridge externally by CRO, Required patch Chords are provided. to measure unknown Capacitance ,Input Voltage : 15V DC, Output Frequency :1kHz Output Voltage :2V AC Output Current :0.5 Amps	LE3.6
13.	Digital multi meter	4 1/2 digit display, 9999 counts digital multi meter measuring: AC Voltage : 0-1000 V max DC Voltage : 0-24 V AC Current : 0-10/20 A Max DC Current : 0-10 A Max Resistance : 0 – 100 M ohm Capacitance measurement, component tester	LE4.1, LE4.2
14.	D.C. regulated power supply	230volt AC to 0-30volt DC,5Amp display for voltage and current.	As per requirement
15.	Cathode Ray Oscilloscope	30 MHz, Dual Trace	LE5.1,LE5.2
16.	Digital Storage Oscilloscope	2 Channel 70 MHz & 100 MHz	LE5.3
17.	LCR-Q meter	Hand held type 3 ½ digit, 7 segment, LCD display Ranges **:** Inductance : Upto 200 H, Capacitance : Upto 2000 µF, Resistance : Upto 20 MΩ Useful for measurement of inductances,	LE4.4

S. No.	Name of Equipment	Broad Specifications	Relevant Experiment Number
		capacitances and resistances of inductors, capacitors, resistors, motors, transformers, coils, chokes, cables, wires	
18.	Earth resistance Tester	Portable analog/digital To measure up to 10 ohm	LE3.4
19.	Soldering Iron	Soldering iron 230V, 30/50W, Flux for soldering and Solder filler material.	As per requirement
20.	Digital Voltmeter	Voltage DC Accuracy ±(0.09% + 2) Current AC Maximum 10 A Accuracy ±(0.09% + 1) Resistance, Max resolution 0.1 Ω	As per requirement
21.	Galvanometer	Current Sensitivity 0.9 μA/div ±10% Voltage sensitivity 270 μV/div ± 15% External Circuit resistance 200Ω	LE2.2, LE2.3
22.	Digital Volt-Ohm Meter	Power Requirements: 100 or 115, 200 or 230 V AC (must be specified), 50 or 60 Hz. Power Consumption: 20 VA max Operating Temperature Range: 5 to 40˚C (41 to 104˚F).	As per requirement
23.	Function generator	**Outputs:** Square wave, sine wave, triangle wave, TTL pulse, positive and negative ramp, pulse and skewed sine wave, AM, and sweep functions **Frequency ranges:**0.1 Hz to 11 MHz, up/down range switchable in eight decade steps **Dial accuracy:**±5% of full scale from 0.1 Hz to 10 MHz 11 MHz setting not less than 11 MHz (ambient temperature 20° C to 30° C)	LE4.3,LE4.4, LE5.1,LE5.2

N) Mapping of POs & PSOs with COs:

Course Outcomes (COs)	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)	
	PO-1 Basic knowledge	PO-2 Discipline knowledge	PO-3 Experiments and practice	PO-4 Engineering Tools	PO-5 The engineer and society	PO-6 Environment and sustainability	PO-7 Ethics	PO-8 Individual and team work	PO-9 Communication	PO-10 Life-long learning	PSO-1	PSO-2
CO-1 Select appropriate electrical measuring instrument for a given application.	2	3	3	3	1	1	2	3	2	3	2	2
CO-2 Use electromechanical instruments for measurements.	2	3	3	3	1	1	2	3	2	3	2	2
CO-3 Measure circuit components using appropriate Bridge/ meter.	3	3	3	3	1	1	3	3	2	3	2	2
CO-4 Troubleshoot basic electronic instruments used for industrial applications.	3	2	3	2	1	1	2	2	3	3	2	2
CO-5 Use Cathode Ray Oscilloscope and Digital Storage Oscilloscope for measurements.	2	2	2	3	1	1	2	2	2	3	3	2

Legend: 1 – Low, 2 – Medium, 3 – High

O) Course Curriculum Map:

POs & PSOs No.	COs No. & Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-1 Select appropriate electrical measuring instrument for a given application.	SO1.1, SO1.2 SO1.3, SO1.4 SO1.5	LE1.1 LE1.2 LE1.3	Unit-1.0 Basics of Measurement & Measuring Instruments 1.1 , 1.2, 1.3, 1.4,1.5	As mentioned in relevant page numbers
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-2 Use Electromechanical instruments for measurements.	SO2.1, SO2.2 SO2.3, SO2.4 SO2.5	LE2.1, LE2.2, LE2.3, LE2.4, LE2.5, LE2.6 LE2.7, LE2.8, LE2.9, LE2.10, LE2.11	Unit-2.0 Electromechanical Measuring Instruments 2.1, 2.2,2.3,2.4,2.5,2.6.2.7,2.8	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-3 Measure circuit components using appropriate Bridge/ meter.	SO3.1, SO3.2 SO3.3, SO3.4 SO3.5, SO3.6	LE3.1, LE3.2 LE3.3, LE3.4 LE3.5, LE3.6	Unit-3.0 Measurements using Bridges/Meters 3.1, 3.2, 3.3,3.4,3.5,3.6, 3.7,3.8	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-4 Troubleshoot basic electronic instruments used for industrial applications.	SO4.1, SO4.2 SO4.3, SO4.4 SO4.5	LE4.1, LE4.2 LE4.3, LE4.4 LE4.5	Unit-4.0 Electronic instruments 4.1, 4.2, 4.3, 4.4,4.5.4.6	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-5 Use Cathode Ray Oscilloscope and Digital Storage Oscilloscope for measurements.	SO5.1 SO5.2 SO5.3	LE5.1 LE5.2 LE5.3	Unit-5.0 Cathode Ray Oscilloscope and Digital Storage Oscilloscope 5.1, 5.2	

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning.

A) Course Code : 2024373(024)
B) Course Title : DC Machines and Transformers
C) Pre-requisite Course Code and Title : Applied Physics
D) Rationale :

Electrical and Electrical & Electronics engineering diploma holders are expected to apply the principle of electromechanical energy conversion in operating, testing and troubleshooting different types of DC machines, single and three phase transformers. This course will enable them to develop a set of knowledge, skills and attitude for maintaining various types of DC machines, single and three phase transformers taking appropriate safety measures. The laboratory course fundamentally aims at familiarizing the students with the fundamentals of various DC machines, single and three phase transformer and their applications.

E) Course Outcomes:

CO-1 Apply basic principle of electro-mechanical energy conversion to DC Machines.

CO-2 Test the performance of DC generators.

CO-3 Control the speed of DC motors as per requirements.

CO-4 Test the performance of single phase transformer.

CO-5 Operate two three phase transformers in parallel.

F) Scheme of Studies:

S. No.	Board of Study	Course Code	Course Title	Scheme of Studies (Hours/Week)			
				L	P	T	Credits L+T+(P/2)
1.	Electrical Engineering	2024373(024)	DC Machines and Transformers	2	-	1	3
2.	Electrical Engineering	2025363(024)	DC Machines and Transformers (Lab)	-	2	-	1

Legend : **L**- Lecture, **T**- Tutorial, **P**- Practical,
Lecture (L): CL Classroom Instruction (Includes different instructional Strategies i.e. Lecture and others.)
Practical (P):LI Laboratory Instruction (Includes practical performances in Laboratory workshop, field or other locations using different instructional strategies).

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

G) Scheme of Assessment:

S. N.	Board of Study	Course Code	Course Titles	Scheme of Examinations					
				Theory			Practical (PRA+PDA+Viva)		Total Marks
				ESE	CT	TA	ESE	TA	
1	Electrical Engineering	2024373 (024)	DC Machines and Transformers	70	20	30	-	-	120
2	Electrical Engineering	2025363 (024)	DC Machines and Transformers (Lab)	-	-	-	30	50	80

Legend: ESE: End semester exam **CT:** Class Test **TA:** Teachers Assessment

PRA: Process Assessment, **PDA:** Product Assessment

Note:

i. TA in Theory includes Sessional work (SW) and Attendance (ATT), with weightage of 70% and 30 % weightage of total respectively.

ii. TA in Practical includes performance of PRA, PDA and Viva-Voce with weightage of 50%, 40% and 10 % weightage of total respectively.

iii. Minimum two experiments from each unit are mandatory.

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

CO-1 Apply basic principle of electromechanical energy conversion to DC Machines.

(Approx. Hrs: CI + LI = 15)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Describe construction of a DC machine with the help of a neat labelled sketch. SO1.2 Apply Fleming's Right hand and left hand rule to analyze the working of DC generators and DC motors. SO1.3 Describe construction and working principle of the single loop DC machine with a neat sketch.	LE1.1 Illustrate the principle of Electro-mechanical energy conversion using BLV method. LE1.2 Identification of parts of a DC machine by dismantling the cut section model. LE1.3 Measure resistance of a series, shunt field winding and armature winding of a DC compound machine and comment on their relative resistances	**Unit-1.0 Basics of DC Machines** 1.1 Law of conservation of energy 1.2 Electromagnetic Induction, Faraday's laws of electromagnetic induction, Lenz's Law - concept and applications 1.3 Fleming's right and left hand rule 1.4 DC machines- construction, its parts 1.5 EMF equations : EMF, Back EMF	• Role of electrical energy and uses • Prepare a list of Equipment working on the principle of statically and mutually induced EMF • Type of windings and its use in DC machines

SW-1 Suggested Sessional Work (SW):

b. Assignments:

i. Prepare a chart to depict Flemings right hand rule as applicable to DC Generatorwith labeled sketches

ii. Prepare a chart to depict Flemings left hand rule as applicable to DC Motor with labeled sketches

i. Mini Project:

i. Fabricate single loop DC generator and observe the generated wave form on CRO.

c. Other Activities (Specify):

i. Note down the name plate description of different types of DC generators available in your Electrical machine laboratory.

ii. Note down the name plate description of different types of DC Motor available in your Electrical machine laboratory.

iii. Give seminar on constructional details of a DC Machine

CO-2 Test the performance of DC generators.

(Approx. Hrs: **CI + LI** = 15)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Explain the working of a DC Generator SO2.2 Classify DC generators SO2.3 Analyze the performance of a given DC Generator SO2.4 Select suitable Generator for a given application.	LE2.1 Perform load test on DC shunt generator. LE2.2 Perform a test to analyze the effect of speed and field flux on generated voltage of DC shunt generator. LE2.3 Perform load test on DC series generator	**Unit-2.0 DC Generators** 2.1 Working and applications of different types of DC generator (DC series, and DC shunt) 2.2 EMF equation 2.3 Performance of DC generators- -Efficiency, losses 2.4 Condition for building up EMF in self excited generator 2.5 Internal and external characteristics 2.6 Concept of Armature reaction and its effects 2.7 Concept of Commutation	• Construction of DC compound generator, types and applications • Explore the use of appropriate DC generator for arc welding purpose

SW-2 Suggested Sessional Work (SW) :

a. Assignments:

i. Prepare a chart of different types of DC Generators with suitable labeled sketches

ii. Prepare a chart of different types of DC Motors with suitable labeled sketches

b. Mini Project:

i. Prepare a report to use suitable DC generator for arc welding purpose.

c. Other Activities (Specify):

i. Collect information such as specification and use of various types of DC Generators from different manufactures and prepare a report based on information collected.

ii. Collect information such as specification and use of various types of DC Motors from different manufactures and prepare a report based on information collected.

CO-3 Control the speed of DC motors as per requirements.

(Approx. Hrs: CI + LI **= 15)**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Explain the working of a DC motor SO3.2 Classify DC Motors SO3.3 Analyze the performance of a given DC motor SO3.4 Use appropriate DC motor starter for a given DC motor. SO3.5 Control the speed of the given DC motor.	LE3.1 Start a D. C shunt motor and reverse its direction of rotation. LE3.2 Control the speed of D.C shunt motor by flux and armature control method. LE3.3 Perform load test on D. C shunt motor and plot its performance characteristics. LE3.4 Perform load test on DC series motor and plot its performance characteristics. LE3.5 Perform brake test on D. C shunt motor and plot its performance characteristics.	**Unit-3.0DC Motor** 3.1 Working and applications of different types of DC Motors (DC series and DC shunt motor) 3.2 EMF equation, Back EMF, Torque, speed, Output power, Losses and efficiency 3.3 Need of starters and types (two and three point only) 3.4 Compare the performance of Series and Shunt 3.5 Speed control methods of DC shunt and series motor	• Select DC motors for different industrial applications • Explore the use of DC series motor for traction • Select DC motor starter for different applications • Analyze the performance of DC compound motor

SW-3 Suggested Sessional Work (SW):

a. Assignments:

i. Prepare a chart depicting the working of 3 point DC shunt motor starter highlighting the inbuilt protective devices in the starter using a labeled sketch.

ii. Prepare a chart depicting the working of 4 point DC shunt motor starter highlighting the inbuilt protective devices in the starter using a labeled sketch.

iii. List the precautions to be taken while starting a DC series and shunt motor with reasons.

iv. Working and applications of different types of DC compound Motors.

b. Mini Project:

i. Propose strategy to start a given DC motor without conventional starters.

ii. Build a Bridge rectifier using diodes of appropriate rating to provide supply to a DC Machine

c. Other Activities (Specify):

Students may be encouraged to collect information and give seminar on:

i. DC generators and its applications
ii. DC motor and its applications
iii. DC motor starters
iv. Working and application of different DC compound motors and their characteristics.

CO-4 Test the performance of a single phase transformer.

(Approx. Hrs: **CI + LI** = 15)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Describe construction and working principle of transformer. SO4.2 Analyze the performance of a given single phase transformer by conducting various tests. SO4.3 Perform two single phase transformers in parallel SO4.4 Explain the working of single phase autotransformer as step up and step down transformer.	LE4.1 Perform test to determine voltage and current ratio of a given single phase transformer. LE4.2 Perform polarity test on a single phase transformer. LE4.3 Perform Open Circuit and Short Circuit test on a single phase transformer and determine the equivalent circuit parameters. LE4.4 Perform direct load test to determine efficiency and regulation of a single phase transformer. LE4.5 Perform parallel operation of two single phase transformers to determine the load sharing between transformers having equal and unequal kVA rating. LE4.6 Verify the use of single phase auto transformer as a step up and step down transformer. LE4.7 Test the Performance of an auto transformer and 1-ϕ two winding transformer of same rating.	**Unit-4.0.Single Phase Transformer** 4.1 Working Principle, construction, Types - Shell and Core 4.2 EMF equation, Voltage and Current Transformation ratio , Equivalent circuit parameters, Phasor diagram of practical transformer under no load and lagging load conditions in brief. 4.3 Losses: Iron loss- Hysteresis and eddy current , Copper loss 4.4 Efficiency, Condition for maximum efficiency and voltage regulation for lagging load only (No derivation) 4.5 OC & SC Test, 4.6 Concept of All Day Efficiency and its significance 4.7 Parallel operation of two single phase transformers, Essential and desirable conditions 4.8 Construction and Application of autotransformer.	• Explore the core material and its characteristics of a transformer • Differentiate between an ideal and a practical transformer • Efficiency , regulation measurement of single phase transformer r using direct Load test • Construction and Working of single phase autotransformer as step up and step down transformer.

SW-4 Suggested Sessional Work (SW) :

a. Assignments:

i. Prepare a chart depicting the various parts of a transformer drawing neat labeled sketch.

ii. Draw core and shell type of transformers highlighting the difference between them.

iii. List out the applications of single phase and three phase transformers, auto-transformer and wielding transformer.

b. Mini Project:

i. Investigate whether OC & SC test or direct load test is preferred for determining the performance of a transformer

ii. Fabricate a step-up or step-down transformer.

c. Other Activities (Specify):

Students may be encouraged to collect information and give seminar on:

i. Hysteresis and eddy current loss

ii. NO load current waveform and its causes.

CO-5 Operate two poly phase transformers in parallel

(Approx. Hrs: CI + LI **= 15)**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Describe the function of various additional accessories used in 3 phase power transformer SO5.2 Operate two three phase transformers in parallel. SO5.3 Maintain different types of 3 phase transformers	LE5.1 Perform parallel operation of two three phase transformers	**Unit-5.0 Poly phase Transformer** 5.1 Formulation of three phase transformer by three single phase transformers 5.2 3 phase Star-delta connection 5.3 Constructional details: Accessories of 3phasetransformer 5.4 Parallel operation of two three phase transformers 5.5 Cooling methods of Power transformers 5.6 Maintenance procedures of different types of 3 phase transformers	• Visit a nearby substation and prepare a survey report on Cooling methods of transformer used. • Download important Indian Standards related to Transformer i. IS2026 (Part I to IV) ii. IS 1180 Part(I & II)

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning

SW-5 Suggested Sessional Work (SW):

a. Assignments:

i. Collect the information (specification, and use) and prepare a report on three phase three winding transformers based on information collected from different manufacturers.

ii. Prepare a chart displaying the various routine tests performed on a three phase transformer as per IS.

iii. Compare a bank of 3 single phase transformers with that of 3 phase transformer.

b. Mini Project:

i. Visit nearby sub-station and list out the main cause of brake-down of distribution transformer and explain a strategy to reduce its failure.
ii. Develop a three phase transformer using three single phase transformer and compare its performance with a poly phase transformer.

c. Other Activities (Specify):

i. Carry out a market survey for availability of transformers in market and list down the complete specifications of at least five transformers.
ii. Visit nearby substation and collect the name -plate specifications of sub-station transformers.
iii. Search on internet to find out the types of insulation used between HV and LV winding and between winding and core for a HV, EHV and UHV transformer.
iv. Investigate what happens if a transformer is connected to a dc supply, a supply voltage of 5 HZ and 500 HZ and prepare a report.

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

I) Suggested Specification Table (For ESA of Classroom Instruction):

Unit Number	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
I	Basics of DC Machines	5	5	-	10
II	DC Generators	4	6	5	15
III	DC Motors	4	6	5	14
IV	Single Phase Transformer	4	6	5	14
V	Poly phase Transformer	5	5	7	17
Total		**22**	**28**	**22**	**70**

Legend: R: Remember, U: Understand, A: Apply and above

J) Suggested Specification Table (For Assessment of Laboratory Instruction*):

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (% Marks)		
		Performance		Viva-Voce
		PRA	PDA	
LE1.1#	Illustration of principle Electro-mechanical conversion using BLV method	-	-	-
LE1.2#	Identification of parts of a DC machine by dismantling the cut section model	-	-	-
LE 1.3	Measurement of resistance of a series, shunt field and armature winding of a DC compound machine and comment on their relative resistances.	50	40	10
LE2.1	Performance of Load test on a DC Shunt generator	50	40	10
LE2.2	Performance of a test to analyze the effect of speed and field flux on generated voltage of DC shunt generator.	50	40	10
LE2.3	Performance of load test on a DC series generator	50	40	10
LE3.1	Starting of a D. C shunt motor using DC 3 /4	50	40	10

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (% Marks)		
		Performance		Viva-Voce
		PRA	PDA	
	point starter and reverse its direction of rotation.			
LE3.2	Controlling the speed of a DC shunt motor by flux and armature control method.	50	40	10
LE3.3	Performance of load test on DC shunt motor	50	40	10
LE3.4	Performance ofLoad test on DC series motor	50	40	10
LE3.5	Performance ofBrake test of DC shunt motor	50	40	10
LE4.1	Performance of a test to Determine of Voltage and current ratio of a single phase transformer	50	40	10
LE4.2	Performance of polarity test on a single phase transformer.	50	40	10
LE4.3	Performance of Open Circuit and Short Circuit test on a single phase transformer and determine the equivalent circuit parameters.	50	40	10
LE4.4	Performance of direct load test on a single phase transformer	50	40	10
LE4.5	Performance of Parallel operation of two single phase transformers having equal and unequal kVA rating	50	40	10
LE4.6	Verification of single phase auto transformer as a step up and step down transformer.	50	40	10
LE4.7	Test the Performance of an auto transformer and 1-ϕ two winding transformer of same rating.	50	40	10
LE5.1	Perform parallel operation of two three phase transformers	50	40	10

*Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practical's.

Experiments marked with it may not be given for ESE. However viva-voce questions related to '#', may be integrated with other experiments during ESE.

Legend: PRA: Process Assessment PDA: Product Assessment

Note: Only one experiment has to be performed at the end semester examination of **30 Marks** as per assessment scheme.

K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Dynamic animations
4. Group Discussion
5. Industrial visits
6. Industrial Training
7. Field Trips
8. Portfolio Based Learning
9. Demonstration
10. ICT Based Teaching Learning (Video Demonstration, CBT, Blog, Face book, Mobile)

L) Suggested Learning Resources:

(a) Books :

S. No.	Titles	Author	Publisher	Edition & Year
1	Electrical Technology, Volume – II (AC & DC Machines)	Theraja B.L.	S. Chand and Co. Ltd., New Delhi ISBN:9788121924375	5th or latest Edition ,2014
2	Electrical Machinery	Dr. P.S. Bhimbra	Khanna Publications ISBN: 8174091734	7th Edition, 2011
3	Electrical Machines	Bhattacharya S. K.	Tata McGraw Hill Education Pvt. Ltd., New Delhi ISBN:9789332902855	2nd edition or latest,1998
4	Electrical Machines Machines(AC & DC)	Gupta J. B.	S. K. Kataria& Sons, New Delhi, ISBN:9788188458141	4thedition or latest
5	Basic Electrical Engineering (Hindi)	Mehta & Gupta	Dhanpat Rai Publishing Company(P) Ltd., ISBN: 978938437826	9th Edition, 2013
6	Electrical Machines	Kothari, D.P. &Nagrath, I.J.	Tata McGraw Hill Education Pvt. Ltd. New Delhi ISBN:9780070699670	4th edition or latest, 2010
7	Electric Machines	Ashfaq Husain	Dhanpat Rai & Company, ISBN: 6700000000432	Latest edition 2014
8	Basic Electrical Engineering	Mittle V.N. and Mittal Arvind	Tata McGraw Hill Education Pvt. Ltd. New Delhi ISBN:9780070593572	2nd edition, 2005
9	Electric Machinery	Arthur Eugene Fitzgerald and Charles Kingsley	Tata McGraw Hill Education Publications ISBN13: 9780070530393	, 6 th Edition, 2002
10	Electrical Machines-I	Ravikant Saini	Neelkanth Publisher Private Ltd.	2017

(b) Open source software and website address:

1. www.nptel.com/iitm/
2. www.vlab.com/
3. Electrical Machines:- http://www.eeeuniversity.com/2013/07/animation-of-electric-machines.html
4. Transformer:-https://www.youtube.com/watch?v=vh_aCAHThTQ
5. AC /DC Motor and Generator:-ttps://www.youtube.com/watch?v=4texz0Gn7cw
6. DC Motor &Generator :-https://www.youtube.com/watch?v=LAtPHANEfQo
7. AC DC motors: https://www.youtube.com/watch?v=unxTKC01CBQ

(c) Others:

1. Learning Packages
2. BIS standards
3. Manufacturers' Manual
4. Users' Guide

M) List of Major Laboratory Equipment and Tools:

S. No.	Name of Equipments	Broad Specifications	Relevant Experiment Number
1	DC Ammeter	Range (0-5-10A), Portable analog PMMC type as per relevant BIS standard	LE1.1, LE1.3 LE2.1, LE2.2, LE2.3, LE3.1, LE3.2, LE3.3, LE3.4, LE3.5
2	DC Voltmeter	Range (0-150/300V), (0-15/30/75 V), Portable analog PMMC type as per relevant BIS standard	LE1.1, LE1.3 LE2.1, LE2.2, LE2.3, LE3.1, LE3.2, LE3.3, LE3.4, LE3.5
3	AC Ammeter	Range (0-2.5-5-10A), Portable analog MI type as per relevant BIS standard	LE4.1, LE4.2, LE4.3, E4.4,LE4.5,LE4.6,LE4.7 LE5.1
4	AC Voltmeter	Range (0-75/150/300V), Portable analog MI type as per relevant BIS standard	LE4.3, LE4.3.E4.4,LE4.5,LE4.6,LE4.7 LE5.1
5	Lamp load	10-20 A	LE1.1, LE1.3 LE2.1, LE2.2, LE2.3, LE3.1, LE3.2, LE3.3, LE3.4, LE3.5
6	Rheostat	(0-500 Ohm, 1.2A); (0-100 Ohm, 5A); (0-50 Ohm, 10A); (0-350 Ohm,1.5A); Nichrome wire wound rheostat on epoxy resin or class F insulating tube with two fixed and one sliding contact	LE1.1 LE2.1, LE2.2, LE2.3, LE3.1, LE3.2, LE3.3, LE3.4, LE3.5
7	D. C. Supply	230V DC, 50A supply (with inbuilt rectifier to convert AC to DC)	LE1.1, LE1.3 LE2.1, LE2.2, LE2.3, LE3.1, LE3.2, LE3.3, LE3.4, LE3.5
8	Single phase transformer	Of suitable size (500 VA to 2kVA)	LE4.1, LE4.2, LE4.3, LE4.4,LE4.5, LE4.6,LE4.7
9	Single phase auto transformer	230V/0-270 V, 4/8/15 A	LE4.1, LE4.2, LE4.3, LE4.4,LE4.5, LE4.6,LE4.7
10	Wattmeter (LPF and UPF) Single phase 3 phase	0-150/300/600V, 2.5/5 A 0-300/600 V, 10/20 A	LE4.1, LE4.2, LE4.3, LE4.4,LE4.5, LE4.6,LE4.7, LE5.1,
11	DC Compound machine	3HP, 230V	LE1.2,LE1.3
12	DC Series Motor - Gen Set	Motor-5H.P Gen-3KW	LE2.2,LE3.3, LE3.4,LE3.5
13	DC Shunt Motor - Gen Set	Motor-5H.P Gen -3KW	LE2.3, LE3.1,LE3.2

N) Mapping of POs & PSOs with COs:

Course Outcomes (COs)	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)	
	PO-1 Basic knowledge	PO-2 Discipline knowledge	PO-3 Experiments and practice	PO-4 Engineering Tools	PO-5 The engineer and society	PO-6 Environment and sustainability	PO-7 Ethics	PO-8 Individual and team work	PO-9 Communication	PO-10 Life-long learning	PSO-1	PSO-2
CO-1 Apply the basic principle of electro-mechanical energy conversion in DC Machines..	3	2	1	1	-	-	1	1	2	3	3	2
CO-2 Test the performance of DC generators.	2	3	3	3	1	1	3	3	2	3	3	2
CO-3 Control the speed of DC motors as per requirements.	3	3	3	3	1	1	3	3	2	3	3	2
CO-4 Test the performance of single phase transformer.	3	3	3	3	1	1	3	3	2	3	3	2
CO-5 Operate two three phase transformers in parallel.	3	3	3	3	1	1	3	3	2	3	3	2

Legend: 1 – Low, 2 – Medium, 3 – High

O) Course Curriculum Map:

POs & PSOs No.	COs No. & Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO-1,2,3,4, 7,8,9,10 PSO-1,2	CO-1 Apply the basic principle of electro-mechanical energy conversion in DC Machines.	SO1.1 SO1.2 SO1.3	LE1.1 LE1.2 LE1.3	Unit-1.0 Basics of DC Machines 1.1 , 1.2, 1.3, 1.4,1.5	As mentioned in relevant page numbers
PO-1,2,3,4,5,6 7,8,9,10 PSO-1,2	CO-2 Test the performance of DC generators.	SO2.1 SO2.2 SO2.3 SO2.4	LE2.1 LE2.2 LE2.3	Unit-2.0 DC Generator 2.1, 2.2,2.3,2.4,2.5,2.6,2.7	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-3 Control the speed of DC motors as per requirements.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5	LE3.1 LE3.2 LE3.3 LE3.4 LE3.5	Unit-3.0 DC Motor 3.1, 3.2, 3.3, 3.4,3.5	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-4 Test the performance of single phase transformer.	SO4.1 SO4.2 SO4.3 SO4.4	LE4.1 LE4.2 LE4.3 LE4.4 LE4.5 LE4.6 LE4.7	Unit-4.0 Single Phase Transformer 4.1, 4.2, 4.3, 4.4, 4.5,4.6,4.7,4.8	
PO-1,2,3,4,5,6, 7,8,9,10 PSO-1,2	CO-5 Operate two three phase transformers in parallel..	SO5.1 SO5.2 SO5.3	LE5.1	Unit-5.0 Poly Phase Transformer 5.1, 5.2 ,5.3, 5.4,5.5,5.6	

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning.

A) Course Code : 2024374(024)

B) Course Title : Electrical Drawing and CAD

C) Pre- requisite Course Code and Title :

D) Rationale :

All equipment, installations, circuits and other electrical and electronic systems in commercial, power and industrial sector need drawings for their manufacturing, installation, operation and maintenance. A technician working in design and shop floor must possess the skill of reading, interpreting different drawings and for most of the activities. With the evolution of various computer software's the role of earlier draftsman is now taken over by Computer software. The AutoCAD software will be used to perform various practical exercises in this course. This will enable the students to become competent for working in the fast growing information technology environment by enhancing their computer aided drawing and designing in the field of electrical and electronics engineering.

E) Course Outcomes:

CO-1 Use standard symbols and codes for representing electrical and electronic components.

CO-2 Draw installation, mounting and layout details of power and safety equipment.

CO-3 Draw sectional views- plan, front elevation and end elevation for static and dynamic electrical machines.

CO-4 Interpret layout of an illumination system.

CO-5 Use Auto CAD software for 2D view of an electrical component.

F) Scheme of Studies:

S.No.	Board of Study	Course Code	Course Title	Scheme of Studies (Hours/Week)			
				L	P	T	Credit L+T+(P/2)
1.	Electrical Engineering	2024374(024)	Electrical Drawing and CAD	3		0	3

Legend : **L**- Lecture, **T**- Tutorial, **P-** Practical,

Lecture (L)→CL Classroom Instruction (Includes different instructional Strategies i.e Lecture and others.)
Practical (P)→LI Laboratory Instruction (Includes practical performances in Laboratory workshop, field or other locations using different instructional strategies).
Tutorial (T)→ Includes sessional work (SW) (assignment, seminar, mini project etc), Self Learning (SL)

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

#LI should be included in the Classroom Instructions or should be taken in lab classes as per the requirement of the topic.

G) Scheme of Assessment:

S.No.	Board of Study	Course Code	Course Title	Scheme of Examination					
				Theory			Practical		Total Marks
				ESE	CT	TA	ESE	TA	
1	Electrical Engineering	2024374(024)	Electrical Drawing and CAD	70	20	30	-	-	120

Legend: **ESE:** End semester exam **CT:** Class Test **TA:** Teachers Assessment

PRA: Process Assessment, **PDA:** Product Assessment

Note: i. TA in Theory includes Sessional work (SW) and Attendance (ATT), with weightage of 70% and 30 % weightage of total respectively.

ii. TA in Practical includes performance of PRA, PDA and Viva-Voce with weightage of 50%, 40% and 10 % weightage of total respectively.

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

CO -1 Use standard symbols and codes for representing electrical and electronics components.

(Approx. Hrs: CI+ LI = 6)

Session Outcomes (SOs)	Laboratory Instruction (LI)#	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Identify the given types of electrical and electronic components using symbols. SO1.2 Draw the layout of the installation of electrical appliance and their wiring diagram for the given residential house. SO1.3 Describe with sketch the layout of the metering	LE1.1 Draw the symbols and notation of electrical equipment and measuring instruments commonly used in lab. LE1.2 Draw the symbol of the common hand tools used by electrician for maintenance of electrical network. LE1.3 Draw the layout of a typical classroom showing the location of fans, light fixtures, switch boards, distribution boards. LE1.4 Draw the Electrical power distribution	**Unit-1.0 Symbols and Codes** 1.1 ISI Symbols in electrical engineering 1.2 Conventions for circuit and schematic representation of electrical and electronic components, instruments and equipment	• Identify and draw the symbols of the different protective devices used for electrical fault prevention.

Session Outcomes (SOs)	Laboratory Instruction (LI)#	Class room Instruction (CI)	Self Learning (SL)
device with incoming supply, protection gear for the given house/shop.	circuit diagram for a residential house.		

#LI should be included in the Classroom Instructions or should be taken in lab classes as per the requirement of the topic.

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Draw the symbols of the different semiconductor devices used as switch.
ii. Draw the diagram of electric series board for testing electrical equipment.

b. Mini Project:

i. Draw and demonstrate in lab the wiring diagram of a three phase energy meter with fuse connection feeding a three phase load from a three phase supply.

c. Other Activities (Specify):

i. Draw and display the different types of cable joints in your lab.

CO-2 Draw installation, mounting and layout details of power and safety equipment.

(Approx. Hrs:CI+ LI+ = 10)

Session Outcomes (SOs)	Laboratory Instruction (LI)#	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Determine the dimension requirement for installation of the given type of transformer. SO2.2 Draw the 11/0.415kV Electrical substation earthing layout as per IS standards. SO2.3 Describe the function of the given equipment used in a typical 11/0.415kV substation	LE2.1 Draw the foundation plan as per dimensions for installation of an 11/0.415kV distribution transformer for rating above 500 kVA. LE2.2 Demonstrate the working of Buchholz relay. LE2.3 Draw the orthographic projection of pin type/suspension type insulator.	**Unit-2.0Installation, mounting and layout of power and safety equipment** 2.1 Different types of mountings for static(transformers): pole and ground mounted 2.2 Mountings for dynamic equipment (electrical rotating machines) 2.3 Substation layout with circuit breaker, on-load and off-load isolators, Buchholz's relay and other protective devices	• Collect information about the foundation and mounting details of three phase motors used for fans for ventilation and air conditioning.

Session Outcomes (SOs)	Laboratory Instruction (LI)#	Class room Instruction (CI)	Self Learning (SL)
SO2.4 Draw the free hand sketch of the given type of substation SO2.5 Describe with sketch the given types of mounting arrangement for rotating machines.	LE2.4 Draw the plate earthing installation confirming to IS standards. LE2.5 Draw the pipe earthing installation confirming to IS standards.	of transformers up to 2MVA 2.4 Plate and Pipe earthing 2.5 Extension of range using shunt, multiplier, CT, PT	

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SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Draw the front view and plan of a three phase core type distribution transformer.
ii. Draw the guard wire arrangement for road and rail line crossings.

b. Mini Project:

i. Draw the free hand sketch of the CT/PT metering equipment installed at the college electrical switch yard.

c. Other Activities (Specify):

i. Seminar on the types of earthing and their importance.

CO-3 Draw sectional views- plan, front elevation and end elevation for static and dynamic electrical machines.

(Approx. Hrs: CI+ LI = 6)

Session Outcomes (SOs)	Laboratory Instruction (LI)#	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Describe with sketch as per the given dimension the pole with pole shoe of a DC machine. SO3.2 Determine with sketch the winding dimension for the given machine rating SO3.3 Identify and sketch the	LE3.1 Draw the control circuit wiring diagram for a 3 point motor starter. LE3.2 Draw the power and control circuit wiring diagram for DOL starter of a three phase I.M. LE3.3 Draw the excitation control circuit wiring diagram for an alternator. LE3.4 Draw the power and	**Unit-3.0Constructional Features of Electrical Machines** 3.1 Parts of a transformer up to 2 MVA 3.2 DC Machines: pole, pole shoe, simplex lap and wave winding 3.3 Alternators: salient and cylindrical rotor 3.4 Induction motors: squirrel cage and slip ring 3.5 AC Machine winding:	• Collect information about the constructional features of single phase Induction motor.

Session Outcomes (SOs)	Laboratory Instruction (LI)#	Class room Instruction (CI)	Self Learning (SL)
different parts of an alternator as per the given dimensions. SO3.4 Describe with sketch various parts of the given type of three phase I.M.	control circuit wiring diagram for rotor resistance starter of slip ring I.M.	full pitch winding and short pitch winding	

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Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self LearningSW-3Suggested Sessional Work (SW):

SW-3 Suggested Sessional Work (SW):

a. Assignments:

i. Draw the control circuit wiring diagram for changing the direction of rotation of a 1-phase I.M

b. Mini Project:

i. Draw the power and control circuit wiring diagram for autotransformer starting of 3- phase I.M and demonstrate the circuit implementation in lab.

c. Other Activities (Specify):

i. List the advantage and disadvantage of full pitch and short pitch AC winding coils used in AC machines.

CO-4 Interpret layout of an illumination system.

(Approx. Hrs: CI+ LI =10)

Session Outcomes (SOs)	Laboratory Instruction (LI)#	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Determine with sketch the illumination system requirement of the given room. SO4.2 Determine the wiring material and other electrical item required for go downof the given size and draw the god own wiring layout. SO4.3 Determine the wiring	LE4.1 Draw the power wiring of a 6 way distribution board. LE4.2 Draw the wiring diagram for corridor lighting having four LED lamps using two way switches. LE4.3 Draw the wiring diagram of a 4- lane highway road with fixture load of 15kW. LE4.4 Draw the wiring diagram from main	**Unit-4.0Domestic and Commercial wiring for LV Equipment** 4.1 Illumination fixtures: types and Internal circuit diagram 4.2 Control wiring of go down, staircase, street light and for houses 4.3 Wiring of energy meters for domestic and commercial loads. 4.4 Internal Wiring of Refrigerators and Air	• Collect information about the power and control circuit diagram for compressor pump in an air filling station.

Session Outcomes (SOs)	Laboratory Instruction (LI)#	Class room Instruction (CI)	Self Learning (SL)
size and other electrical item required for concealed wiring of a residential house for the given floor area and connected load.	supply board to a commercial shop having six AC of 1.5 Ton capacity each.	conditioners 4.5 Starter,4-point starter 4.6 Wiring diagram of submersible and centrifugal pumps	

 # LI should be included in the Classroom Instructions or should be taken in lab classes as per the requirement of the topic.

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SW-4 Suggested Sessional Work (SW):

a. Assignments:

i. Collect information about the dimension of cable tunnel for underground laying of LT/HT cables and draw the cable trench diagram.

b. Mini Project:

i. Draw the wiring diagram for energizing a lamp of given wattage and demonstrate it in lab.

c. Other Activities (Specify):

i. Prepare a chart showing the cross sectional view of different types of LT/HT power cables.

CO-5 Use AutoCAD software for 2D view of an electrical component.

(Approx. Hrs: CI+ LI+SW+SL=13)

Session Outcomes (SOs)	Laboratory Instruction (LI)#	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Use Auto CAD for the given electrical Drawing. SO5.2 Draw the sectional view of a DC motor armature for the given dimensions. SO5.3 Draw the sectional view of the stator of the given type of 3-phase IM. SO5.4 Draw the orthogonal projection of the given type of insulators.	LE5.1 Draw the Electrical and Electronic symbols in AutoCAD. LE5.2 Draw the electrical feeder layout of the college in AutoCAD. LE5.3 Draw the foundation details of a distribution transformer of rating between 500-1000 kVA in AutoCAD. LE5.4 Draw the street lighting layout of the college campus. LE5.5 Draw the typical LT and HT cable trench	**Unit-5.0Computer Aided Electrical Drawing(CAD)** 5.1 Computer Aided Drawing: Draw command, edit command, Coordinate entry, Osnap, Layers, Dimensioning, Text in a drawing, Ortho command, Zoom command and plot command 5.2 General electrical and electronic symbols, Layouts of domestic, commercial and industrial	• Collect information about using Auto CAD for 3D view.

Session Outcomes (SOs)	Laboratory Instruction (LI)#	Class room Instruction (CI)	Self Learning (SL)
	details.	wiring (2D only) 5.3 Cross Sectional view of: i. Fuse and cables (2D) ii. D.C. Motor and their parts iii. Single phase Transformer, Power transformer iv. Induction Motor v. Insulators, Circuit Breakers, Lightning Arresters vi. 11 kV Pole Mounted Substation 5.4 Single line diagrams of 11kV/33 kV Substation.	

#LI should be included in the Classroom Instructions or should be taken in lab classes as per the requirement of the topic.

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning

SW-5 Suggested Sessional Work (SW):

a. Assignments:

i. Draw sectional view for the different types of lighting arrestor used in HV, EHV and UHV S/S yard.

b. Mini Project:

i. Draw the earthing layout for a 33/11kV switchyard showing the equipment and neutral equipment if any.

c. Other Activities (Specify):

i. Draw free hand sketch of the different types of circuit breakers used in electrical switch yard.

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

I) Suggested Specification Table (For ESA of Classroom Instruction CI+SW+SL):

Unit Number	UnitTitles	Marks Distribution			Total Marks
		R	U	A	
1	Symbols and Codes	5	5	4	14
2	Installation, Mounting andLayout of Power and Safety Equipment	5	5	4	14
3	Constructional Features of Electrical Machines	3	5	6	14
4	Domesticand Commercial wiring for LV Equipment	3	5	6	14
5	Computer Aided Electrical Drawing(CAD)	3	5	6	14
Total		**19**	**25**	**26**	**70**

Legend: R: Remember, U: Understand, A: Apply and above

J) Suggested Specification Table (Laboratory Instruction*):

Laboratory Instruction Number	Short Laboratory Experiment Titles
LE1.1	Draw the symbols and notation of electrical equipment and measuring instruments commonly used in lab.
LE1.2	Draw the symbol of the common hand tools used by electrician for maintenance of electrical network.
LE1.3	Draw the layout of a typical classroom showing the location of fans, light fixtures, switch boards, distribution boards.
LE1.4	Draw the Electrical power distribution circuit diagram for a residential house.
LE2.1	Draw the foundation plan as per dimensions for installation of an 11/0.415kV distribution transformer for rating above 500 kVA.
LE2.2	Demonstrate the working of Buchholz relay.
LE2.3	Draw the orthographic projection of pin type/suspension type insulator.
LE2.4	Draw the plate earthing installation confirming to IS standards.
LE 2.5	Draw the pipe earthing installation confirming to IS standards.
LE3.1	Draw the control circuit wiring diagram for a 3 point motor starter.
LE3.2	Draw the power and control circuit wiring diagram for DOL starter of a three phase I.M.
LE 3.3	Draw the excitation control circuit wiring diagram for an alternator.
LE3.4	Draw the power and control circuit wiring diagram for rotor resistance starter of slip ringI.M.
LE4.1	Draw the power wiring of a 6 way distribution board
LE4.2	Draw the wiring diagram for corridor lighting having four LED lamps using two way switches.
LE4.3	Draw the wiring diagram of a 4- lane highway road with fixture load of 15 kW.
LE4.4	Draw the wiring diagram from main supply board to a commercial shop having six AC of 1.5 Ton capacity each.
LE5.1	Draw the Electrical and Electronic symbols in AutoCAD.
LE5.2	Draw the electrical feeder layout of the college in AutoCAD.

Laboratory Instruction Number	Short Laboratory Experiment Titles
LE5.3	Draw the foundation details of a distribution transformer of rating between 500-1000 kVA in AutoCAD.
LE5.4	Draw the street lighting layout of the college campus.
LE 5.5	Draw the typical LT and HT cable trench details.

* Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practicals

Legend : PRA: Process Assessment, PDA : Product Assessment

Note : Only one experiment has to performed at the end semester examination of 30 Marksas per assessment scheme.

Marks are not allotted for LI as it has to be included in CI (Classroom Instructions).

K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture Method
2. Industrial visits
3. Field Trips
4. Self Learning
5. Observation, Practice and Feedback
6. Classroom, Laboratory, Workshop, Field, Video, Live Demonstrations
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration, CBT, Blog, Face book, Mobile) can be integrated with many methods.

L) Suggested Learning Resources:

(a) Books :

S. No.	Titles	Author	Publisher	Edition & Year
1.	Electrical Engineering Drawing	Bhattacharya, S.K.	New Age International Publisher 978-8122408553	Second Edition, 2009
2.	Electrical Engineering Drawing, Part-1	Singh, Surjit	SK Kataria and Sons, New Delhi, ISBN:978-9350143056	Second Edition
3.	Electrical Engineering Drawing	Narang, K. L.	Satyaprakashan, New Delhi, ISBN:9788176841504	Latest edition, 2016
4.	Basic engineering Drawing	Anwani, M.L. &Anwani, I.	Dhanpat Rai & Sons ISBN:978-8177000191	Twenty Third Revised edition 2017
5.	Computer Aided Electrical Drawing	Yogesh, M., Nagaraja, B. S., Nandan, N.	PHI Learning Pvt. Ltd., Delhi ISBN:978-812034953	First edition 2014
6.	AutoCAD Electrical 2018 Black book	Verma, Gaurav	Cadcamcae Works 978-1988722085	Fourth edition 2017

7.	AutoCAD Electrical 2018 for Electrical Control Designers	Tickoo, Sham	BPB Publications 978-9386551627	Eighth edition 2018
8.	Electrical Drawing and Estimating and costing	Dr. M. F. Qureshi	Deepak Publication 978-81-7776-169-2	First Edition, 2018

(b) List of open source software/learning website :

1. https://grabcad.com/tutorials
2. http://help.autodesk.com/view/INVNTOR/2014/ENU/
3. https://www.cadlearning.com/lesson/140270?courseId=100274&productId=100055&versionId=46
4. http://www.cadtutor.net/tutorials/autocad/
5. http://www.cad-notes.com/contents/autocad-articles/
6. https://www.youtube.com/watch?v=dKDgfdPcHTI
7. www.youtube.com/watch?v=Nv8skZZcUlw
8. www.youtube.com/watch?v=Lz6piHlBn7g
9. https://www.youtube.com/watch?v=yruPUj_61bw

(c) Others:

1. Learning Packages
2. Lab Manuals
3. Manufacturers' operating Manual

M) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment	Broad Specifications
1.	Computer	Personal computer(Intel core i3/ i7/ RAM 16 GB/ HDD) with internet facility and peripheral devices.
2.	AutoCAD Electrical	2017 or latest version
3.	Printer	Laser Printer
4.	MS Back Office	2016 or latest
5.	Open Office Suit	2016 or latest

N) Mapping of POs & PSOs with COs:

Course Outcomes (COs)	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)	
	PO-1 Basic knowledge	PO-2 Discipline knowledge	PO-3 Experiments and practice	PO-4 Engineering Tools	PO-5 The engineer and society	PO-6 Environment and sustainability	PO-7 Ethics	PO-8 Individual and team work	PO-9 Communication	PO-10 Life-long learning	PSO-1	PSO-2
CO-1 Use standard symbols and codes for representing electrical and electronic components.	2	3	3	1	1	1	3	3	2	2	3	3
CO-2 Draw installation, mounting and layout details of power and safety equipment.	2	3	3	2	1	1	1	2	3	2	3	3
CO-3 Draw sectional views-plan, front elevation and end elevation for static and dynamic electrical machines.	1	3	3	3	2	1	2	2	2	2	2	2
Co-4 Interpret layout of an illumination system.	1	3	2	2	1	1	2	2	3	3	3	2
Co-5 Use AutoCAD software for 2D view of an electrical component.	2	3	3	3	2	2	2	2	2	2	2	2

Legend: 1 – Low, 2 – Medium, 3 – High

O) Course Curriculum Map:

POs & PSOs No.	COs No. & Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO-1,2,3, 4, 5,6,7,8,9,10 PSO-1,2	CO-1 Use standard symbols and codes for representing electrical and electronic components	SO1.1 SO1.2 SO1.3	LE1.1 LE1.2 LE1.3 LE1.4	Unit-1. Symbols and Codes 1.1,1.2	As mentioned in relevant page numbers
PO-1,2,3, 4, 5,6,7,8,9,10 PSO-1,2	CO-2 Draw installation, mounting and layout details of power and safety equipment.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5	LE2.1 LE2.2 LE2.3 LE2.4 LE2.5	Unit-2.0: Installation and layout of power and safety equipment's 2.1,2.2,2.3,2.4, 2.5	
PO-1,2,3, 4, 5,6,7,8,9,10 PSO-1,2	CO-3 Draw sectional views- plan, front elevation and end elevation for static and dynamic electrical machines	SO3.1 SO3.2 SO3.3 SO3.4	LE3.1 LE3.2 LE3.3 LE3.4	Unit-3.0 Constructional Features of Electrical Machines 3.1,3.2,.3.3,3.4,3.5	
PO-1,2,3, 4, 5,6,7,8,9,10 PSO-1,2	CO-4 Interpret layout of an illumination system.	SO4.1 SO4.2 SO4.3	LE4.1 LE4.2 LE4.3 LE4.4	Unit-4.0 Domestic and Commercial wiring for LV equipment's 4.1,4.2,4.3,4.4,4.5, 4.5,4.6	
PO-1,2,3, 4, 5,6,7,8,9,10 PSO-1,2	CO-5 Use AutoCAD software for 2D view of an electrical component.	SO5.1 SO5.2 SO5.3 SO5.4	LE5.1 LE5.2 LE5.3 LE5.4 LE5.5	Unit-5.0 Computer aided Electrical drawing 5.1,5.2,5.3,5.4	

#LI should be included in the Classroom Instructions or should be taken in lab classes as per the requirement of the topic.

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A) Course Code : 2025375(025)

B) Course Title : Basic Electronics

C) Pre-requisite Course Code and Title : Applied Physics

D) Rationale :

Electronic circuits are integral part of most of the instrument, consumer gadgets, automobile and Industrial control/automation system. This course is classified under basic technology group and is intended to enable the students to test the working of basic electronics circuits like: rectifiers, filters, amplifiers oscillators and their applications in the various electronic circuits. This course will also help the student in acquiring investigation skill when he/she will be working as technician.

E) Course Outcomes:

CO-1 Use semiconductor diodes in various electronics circuits.

CO-2 Test the performance of different types of rectifiers and filters.

CO-3 Test function of Zener diode, clipper and clamper circuit.

CO-4 Test the working of Bipolar Junction Transistor(BJT) and FET.

CO-5 Use OP-AMP for various applications.

F) Scheme of Studies:

S.N	Board of Study	Course Code	Course Titles	Scheme of Studies (Hours/Week)			
				L	P	T	Credit L+T+(P/2)
1	Electrical & Electronics Engineering	2025375(025)	Basic Electronics	2	-	1	3
2	Electrical & Electronics Engineering	2025364(025)	Basic Electronics (Lab)	-	2	-	1

Legend: **L**- Lecture, **T**- Tutorial, **P**- Practical

Lecture (L)→ CL Classroom Instruction (Includes different instructional Strategies i.e Lecture and others.)

Practical (P)→ LI Laboratory Instruction (Includes practical performances in Laboratory workshop, field or other locations using different instructional strategies).

Tutorial (T)→ Includes sessional work (SW) (assignment, seminar, mini project etc), Self Learning (SL)

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

G) Scheme of Assessment:

S. N.	Board of Study	Course Code	Course Titles	Scheme of Examinations					
				Theory			Practical (PRA+PDA+Viva)		Total Marks
				ESE	CT	TA	ESE	TA	
1	Electrical & Electronics Engineering	2025375 (025)	Basic Electronics	70	20	30	-	-	120
2	Electrical & Electronics Engineering	2025364 (025)	Basic Electronics (Lab)	-	-	-	30	50	80

Legend: **ESE:** End semester exam **CT:** Class Test **TA:** Teachers Assessment

PRA: Process Assessment, **PDA:** Product Assessment

Note: i. TA in Theory includes Sessional work (SW) and Attendance (ATT), with weightage of 70% and 30 % weightage of total respectively.

ii. TA in Practical includes performance of PRA, PDA and Viva-Voce with weightage of 50%, 40% and 10 % weightage of total respectively.

iii. Minimum two experiments from each unit are mandatory

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.
Convert unit of the given physical quantity from one unit system to other.
Measure various electrical parameters with accuracy, precision, resolution.

CO-1 Use semiconductor diodes in various electronics circuits.

(Approx. Hrs: CI+ LI = 17)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO1.1 Describe the construction of pn-Junction diode. SO1.2 Explain formation of depletion layer in pn-Junction. SO1.3 Sketch V-I characteristics of pn-junction diode and LED. SO1.4 Describe working of LED,	LE1.1 Test the performance of pn-Junction diode in the forward and reverse biased condition. LE1.2 Test the performance of the given LED Diode. LE1.3 Test the performance of the given Photo Diode.	**Unit 1.0 Semiconductor Diode** 1.1 pn- Junction diode: working, formation of depletion layer, cconstruction, symbol and equivalent circuits of pn- Junction diode 1.2 Barrier potential voltage, forward and reverse biasing, V-I characteristics of diode 1.3 Diode current equation, Static and Dynamic resistance, Diode	• Sketch Symbols of different types of diode. • Compare characteristics of Tunnel diode and pn- Junction diode.

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
photo diode and varactor diode.		capacitance 1.4 Symbol, working and characteristic of other diodes like: LED, Photodiode, Varactor diode	

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Compare the construction of LED and PN-Junction diode.
ii. Describe the working of Varactor diode.
iii. List applications of various types of diode.

b. Mini Project:

i. Prepare a chart showing symbol and V-I characteristic of various types of diode.
ii. Build a circuit using LED and switch.

c. Other Activities (Specify):

i. Arrange a seminar on applications of diode.

CO-2 Test the performance of different types of rectifiers and filters.

(Approx. Hrs: CI+ LI = 13)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1 Illustrate need of rectification. SO2.2 Calculate PIV, Ripple factor, and efficiency of half wave and full wave center taped rectifier. SO2.3 Explain the need of filter circuit used with rectifier.	LE2.1 Test the input and output waveform of Half Wave Rectifier a) without filter b) with filter LE2.2 Test the input and output waveform of full Wave center tapped Rectifier a) without filter b) with filter LE2.3 Test the input and output waveform of full Wave Bridge Rectifier a) without filter b) with filter	**Unit 2.0 Rectifiers and Filters** 2.1 Need for rectification, rectifier Parameters, PIV, Ripple factor, Efficiency, Peak Inverse Voltage(PIV), Transformer utilization actor(TUF) of rectifiers 2.2 Types of rectifier: Half Wave Rectifier, Full Wave rectifier, Center taped and Bridge type full wave rectifier 2.3 Filter Circuits: L –filter, C –filter, LC- filter, CLC-filter	• Compare parameters of various types of rectifiers. • Analysis functions of different types of filters.

SW-2 Suggested Sessional Work (SW) :

a. Assignments:

i. Explain the need of filter with regulator.

ii. Compare the working of various types of filters used with rectifiers.

b. Mini Project:

i. Develop a rectifier with filter to get 10v DC output.

c. Other Activities (Specify):

i. Seminar on the application of various types of rectifiers.

CO-3 Test function of Zener diode, clipper and clamper circuit.

(Approx. Hrs: CI+ LI = 14)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Describe the working principle of Zener diode with the help of VI characteristic. SO3.2 Analyze the Positive and negative Clipper circuit. SO3.3 Analyze the Positive and negative clamper circuit.	LE3.1 Test the performance of Zener diode. LE3.2 Test the output of the given Zener voltage regulator. LE3.3 Test the output waveform of a) Positive Clipper b) Negative Clipper LE3.4 Test the output waveform of a) Positive Clamper b) Negative Clamper	**Unit 3.0 Diode Circuits** 3.1 Zener diode: working, construction and equivalent circuits of Zener diode 3.2 Zener and avalanche breakdown phenomenon, Zener diode as voltage regulator 3.3 Clipper: Function of clipper circuit, types of clipper :positive and negative clipper circuits 3.4 Clamper: Function of clamper, types of clamper, positive and negative clamper circuits	• Compare different types of Clipper and Clamper circuits.

SW-3 Suggested Sessional Work (SW) :

a. Assignments:

i. Develop a positive Clamper circuit which clamp the given input to 5VDC .

ii. Differentiate between clipper and clamper circuit.

b. Mini Project:

i. Design a voltage regulator using Zener diode.

ii. Build and test a series diode Clipper circuit.

iii. Design a clamper circuit using diode

CO-4 Test the working of Bipolar Junction Transistor(BJT) and FET.

(Approx. Hrs: CI+ LI = 16)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Describe construction and operation of NPN and PNP transistor. SO4.2 Compare CB,CE and CC configurations of BJT. SO4.3 Define the term: current gain, amplification factor, thermal runaway. SO4.4 Explain need of biasing for the proper operation of the given transistor. SO4.5 Describe the working of FET.	LE4.1 Determine the current gain of CE configuration with the help of input output characteristics of CE configuration. LE4.2 Determine the current gain of CB configuration with the help of input output characteristics. LE4.3 Determine the current gain of CC configuration with the help of input output characteristics. LE4.4 Build and test the operation of BJT as a switch. LE4.5 Bias the given NPN transistor in the active region by voltage divider biasing method. LE4.6 Test the performance of the given FET.	**Unit 4.0 Bipolar Junction Transistor (BJT) and Field effect transistor (FET)** 4.1 BJT: Working, types of BJT ; NPN and PNP, construction and operation of NPN and PNP transistor. 4.2 Modes of operation : active, saturation and cutoff, current amplification factor β and α 4.3 Transistor biasing: need for biasing, types of biasing, thermal runaway 4.4 Transistor configurations: Common Emitter(CE), Common Base(CB) and Common collector configuration circuit , working and input and output characteristics. 4.5 Field Effect Transistor(FET): Working, construction, input and output characteristics, drain current, pinch-off voltage	• Compare different type of biasing circuits.

SW-4 Suggested Sessional Work (SW) :

a. Assignments:

i. Prepare a chart to describe the working principle of FET.
ii. Enlist the technical specifications of FET.

b. Mini Project:

i. Prepare a report on the comparison of technical parameters of NPN and PNP transistor.
ii. Build and test the transistor switch circuit.

CO-5 Use OP-AMP for various applications.

(Approx. Hrs: CI+LI = 15)

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO5.1 Describe the working principle of differential amplifier. SO5.2 Sketch the block diagram of Op-Amp IC and describe the functions of each block. SO5.3 Define the following terms: Virtual ground, Slew rate, gain , Input and output resistance, frequency of operation. SO5.4 Analyze working of OP-Amp as inverting and non-inverting amplifier. SO5.5 Analysis the input and output waveform of Op-Amp based integrator and differentiator circuit.	LE5.1 Test the performance of the given Op-Amp IC in inverting mode. LE5.2 Build and test Op-Amp based summing amplifier. LE5.3 Test the output of non inverting amplifier. LE5.4 Test the performance of Op-Amp based integrator and differentiator circuit. LE5.5 Build and test the performance of Instrumentation amplifier.	**Unit 5.0 Introduction to Operational Amplifier(Op-Amp)** 5.1 Basics of differential amplifier, Working principle, input and output characteristics. 5.2 Basics of Op-Amp: OP-AMPIC-741, functional block diagram, virtual ground, configurations of working :inverting and non inverting, parameters : I/O resistance, gain, slew rate, bandwidth, power. 5.3 Applications op-amp : Summing, multiplier, and divider amplifier, integrator and differentiator, Log and Anti-Log amplifier.	• Analyze working of Op-Amp as adder, sub tractor, multiplier and divider circuit.

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning

SW-5 Suggested Sessional Work (SW) :

a. Assignments:

i. Describe the working of Op-Amp based Instrumentation amplifier.
ii. List the applications of Op-Amp based circuits.

b. Mini Project:

i. Design an oscillator circuit using OP-amp.
ii. Design a adder/subtractor circuit using OP-amp.

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

I) Suggested Specification Table (For ESA of Classroom Instruction):

Unit Number	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
I	Semiconductor Diode	2	4	6	12
II	Rectifiers and Filters	2	4	8	14
III	Diode Circuits	2	6	8	16
IV	Bipolar Junction Transistor (BJT) and Field effect transistor (FET)	2	4	8	14
V	Introduction to Operational Amplifier(Op-Amp)	2	4	8	14
Total		**10**	**22**	**38**	**70**

Legend: R: Remember, U: Understand, A: Apply and above

J) Suggested Specification Table (For Assessment of Laboratory Instruction*):

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (% Marks)		
		Performance		Viva-Voce
		PRA	PDA	
LE1.1	Test the performance of pn-Junction diode in the forward and reverse biased condition.	50	40	10
LE1.2	Test the performance of the given LED Diode.	50	40	10
LE1.3	Test the performance of the given Photo Diode.	50	40	10
LE2.1	Test the input and output waveform of Half Wave Rectifier a) without filter b) with filter	50	40	10
LE2.2	Test the input and output waveform of full Wave center tapped rectifier a) without filter b) with filter	50	40	10
LE2.3	Test the input and output waveform of full Wave Bridge Rectifier a) without filter b) with filter	50	40	10
LE3.1	Test the performance of Zener diode.	50	40	10
LE3.2	Test the output of the given Zener voltage regulator.	50	40	10
LE3.3	Test the output waveform of a) Positive Clipper b) Negative Clipper	50	40	10
LE3.4	Test the output waveform of a) Positive Clamper b) Negative Clamper	50	40	10
LE4.1	Determine the current gain of CE	50	40	10

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (% Marks)		
		Performance		Viva-Voce
		PRA	PDA	
	configuration with the help of input output characteristics of CE configuration.			
LE4.2	Determine the current gain of CB configuration with the help of input output characteristics.	50	40	10
LE4.3	Determine the current gain of CC configuration with the help of input output characteristics.	50	40	10
LE4.4	Build and test the operation of BJT as a switch.	50	40	10
LE4.5	Bias the given NPN transistor in the active region by voltage divider biasing method.	50	40	10
LE4.6	Test the performance of the given FET.	50	40	10
LE5.1	Test the performance of the given Op-Amp IC in inverting mode.	50	40	10
LE5.2	Build and test Op-Amp based summing amplifier.	50	40	10
LE5.3	Test the output of non inverting amplifier.	50	40	10
LE5.4	Test the performance of Op-Amp based integrator and differentiator circuit.	50	40	10
LE5.5	Build and test the performance of Instrumentation amplifier.	50	40	10

*Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practicals.

Legend: PRA: Process Assessment, PDA: Product Assessment

Note: Only one experiment has to performed at the end semester examination of .Marks as per assessment scheme.

K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Industrial visits
6. Industrial Training
7. Field Trips
8. Portfolio Based Learning
9. Role Play
10. Demonstration
11. ICT Based Teaching Learning (Video Demonstration, CBT, Blog, Face book, Mobile)
12. Brainstorming
13. Others

L) Suggested Learning Resources:

(a) Books :

S. No.	Titles	Author	Publisher	Edition & Year
1	Basic Electronics & Linear Circuits	Bhargava N.N.; Kulshreshtha D.C.; Gupta S. C.	Tata McGraw Hill; New Delhi	IInd edition,2013, ISBN 13:9789383286607
2	Integrated Electronics	Millman Jacob; Halkias Christo; Parikh Chetan D	Mcgraw Hill Education,India	IInd edition,2011ISBN: 9780070151420, 0070151423
3	Op-amps and linear Integrated circuits	Gayakwad Ramakant A.	PRENTICE HALL,India	4th edition,2002, **ISBN-13:** 978-8120320581
4	Linear Integrated circuits and Applications	Bakhshi U.A.; Godse A.P. and Bakshi A. V.	Technical Publications, Pune, India	SECOND edition, January 1, 2011, **ISBN-13:** 978-9350380055
5	Electronic Devices and Circuit Theory	Boylestead Robert; Neshelsky Louis	Pearson Education, New Delhi	10th edition, 2009 ISBN: 978-8131727003
6	Basic Electrical & Electronics (Hindi)	Dr. M F Qureshi	Deepak Prakashan	ISBN: 978-81-7776-200-6
7	Principles of Electronics	Mehta, V.K.; Mehta, Rohit	S. Chand and Company, Ram Nagar, New Delhi-110 055, 504	2014, ISBN: 9788121924
8	Basic Electronic Engineering	Baru V.; Kaduskar R.; Gaikwad S.T.	Dream tech Press, New Delhi,	2015, ISBN: 9789350040126

(b) Open source software and website address:

i. http://www.learnerstv.com/video/Free-video-Lecture-5079-Engineering.htm
ii. https://www.allaboutcircuits.com/textbook/semiconductors/chpt-2/bipolar-junction-transistors
iii. http://nptel.ac.in/courses/117103063/
iv. https://www.youtube.com/watch?v=clTA0pONnMs
v. Clipper and Clamper:- https://www.youtube.com/watch?v=rkP3xmDF1oA
vi. Clamper:- http://ee.eng.usm.my/eeacad/arjuna/Electronic%20device%20lecture4.pdf

(c) Others:

1. Learning Packages.
2. Lab Manuals.
3. Manufacturers' Manual
4. Users' Guide

M) List of Major Laboratory Equipment and Tools:

S. No.	Name of Equipment	Broad Specifications	Relevant Experiment Number
1	Variable D.C. power supply	Variable DC power supply 0- 30V, 2A, SC protection, display for voltage and current.	All
2	Cathode Ray Oscilloscope CRO	Cathode Ray Oscilloscope Duel Trace 20Mhz, 1MegaΩ Input Impedance	All
3	Function Generator	0-2 MHz with Sine , square and triangular output with variable frequency and amplitude.	All
4	Multimeter	Digital Multimeter : 3 1/2 digit display, 9999 counts digital multimeter measures: V_{ac}, V_{dc} (1000V max) , A_{dc}, A_{ac} (10 amp max), Resistance (0 - 100 MΩ) , Capacitance and Temperature measurement	All
6	Electronic Work Bench	: Bread Board 840 -1000 contact points: Positive and Negative power rails on opposite side of the board , 0-30 V, 2 Amp Variable DC power supply, Function Generator 0-2MHz, CRO: 0-30 MHz, Digital Multimeter	All

N) Mapping of POs & PSOs with COs:

Course Outcomes (COs)	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)	
	PO-1 Basic knowledge	PO-2 Discipline knowledge	PO-3 Experiments and practice	PO-4 Engineering Tools	PO-5 The engineer and society	PO-6 Environment and sustainability	PO-7 Ethics	PO-8 Individual and team work	PO-9 Communication	PO-10 Life-long learning	PSO-1 Electrical Equipment	PSO-2 Electrical Power Systems
CO-1 Use semiconductor diodes in various electronics circuits.	2	2	3	3	1	1	3	3	3	3	2	2
CO-2 Test the performance of different types of rectifiers and filters.	2	3	3	3	1	1	3	3	3	3	2	2
CO-3 Test function of Zener diode, clipper and clamper circuit.	3	3	3	3	2	2	3	3	3	3	2	2
CO-4 Test the working of Bipolar Junction Transistor (BJT) and FET.	3	3	3	3	2	2	3	3	3	3	2	2
CO-5 Use OP-AMP for various applications.	3	3	3	3	2	2	3	3	3	3	2	2

Legend: 1 – Low, 2 – Medium, 3 – High

O) Course Curriculum Map:

POs & PSOs No.	COs No. & Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
PO - 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 PSO – 1, 2	CO-1 Use semiconductor diodes in various electronics circuits.	SO1.1 SO1.2 SO1.3 SO1.4	LE1.1 LE1.2 LE1.3	Unit-1.0 Semiconductor Diode 1.1, 1.2, 1.3, 1.4	As mentioned in relevant page numbers
PO - 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 PSO – 1, 2	CO-2 Test the performance of different types of rectifiers and filters.	SO2.1 SO2.2 SO2.3	LE2.1 LE2.2 LE2.3	Unit 2.0 Rectifiers and Filters 2.1, 2.2, 2.3	
PO - 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 PSO – 1, 2	CO-3 Test function of Zener diode, clipper and clamper circuit.	SO3.1 SO3.2 SO3.3	LE3.1 LE3.2 LE3.3 LE3.4	Unit 3.0 Diode Circuits 3.1, 3.2, 3.3, 3.4	
PO - 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 PSO – 1, 2	CO-4 Test the working of Bipolar Junction Transistor (BJT) and FET.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5	LE4.1 LE4.2 LE4.3 LE4.4 SO4.5 SO4.6	Unit-4.0 Electrostatics , Magnetism and Electric current 4.1, 4.2, 4.3, 4.4, 4.5	
PO - 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 PSO – 1, 2	CO-5 Use OP-AMP for various applications.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5	LE5.1 LE5.2 LE5.3 LE5.4 LE5.5	Unit 5.0 Introduction to Operational 5.1, 5.2, 5.3	

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning.

A) Course Code : 2024365(024)

B) Course Title : Electrical Workshop Practice – I (Lab)

C) Pre- requisite Course Code and Title : Workshop Practice (Mechanical)

D) Rationale :

Electrical and Electrical &Electronics diploma holders are expected to handle various electrical wiring tools and measuring instruments used for maintaining reliable power supply at workshop. They have to supervise work related to fitting of electrical wiring accessories, soldering of components for maintaining power supply to low power electrical equipment's. This course will develop skills in handling tools and instruments to maintain the power supply to equipment's used in the electrical workshop.

E) Course Outcomes:

CO-1 Use measuring devices and hand tools effectively.

CO-2 Identify wiring accessories, cables, illumination sources and switches

CO-3 Perform the wiring for control of house hold and commercial loads

CO-4 Maintain lighting and heating appliance

CO-5 Use firefighting equipment and other safety related accessories

F) Scheme of Studies:

S.No.	Board of Study	Course Code	Course Title	Scheme of Studies (Hours/Week)			
				L	P	T	Credit L+T+(P/2)
1.	Electrical Engineering	2024365(024)	Electrical Workshop Practice-I (Lab)	-	2	-	1

Legend: **L**- Lecture **T**- Tutorial **P-** Practical

Lecture (L)→CL Classroom Instruction (Includes different instructional Strategies i.e Lecture and others.)
Practical (P)→LI Laboratory Instruction (Includes practical performances in Laboratory workshop, field or other locations using different instructional strategies).
Tutorial (T)→ Includes sessional work (SW) (assignment)

Note: SW has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

NOTE: **The minimum number of Laboratory Instruction (LI) to be performed in the semester is ten, with at least two laboratory instructions to be performed from each Course outcome (CO)**

G) Scheme of Assessment:

S.No	Board of Study	Course Code	Course Title	Scheme of Examination					
				Theory			Practical (PRA+PDA+Viva)		Total Marks
				ESE	CT	TA	ESE	TA	
1.	Electrical Engineering	2024365(024)	Electrical Workshop Practice-I (Lab)	-	-	-	30	50	80

Legend: **ESE:** End semester exam **CT:** Class Test **TA:** Teachers Assessment

PRA: Process Assessment, **PDA:** Product Assessment

Note: i. TA in Practical includes performance of PRA, PDA and Viva-Voce with weightage of 50%, 40% and 10 % weightage of total respectively.

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Laboratory Instruction (LI) and Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

CO- 1 Use measuring devices and hand tools effectively.

(Approx. Hrs: LI+SW =4)

Session Outcomes (SOs)	Laboratory Instruction (LI)
SO1.1 List various measuring tools and instrument for given application. SO1.2 Describe measuring unit and its conversion. SO1.3 Select suitable wires for a given application. SO1.4 List workshop hand tools.	LE1.1 Identify different type of measuring tools available in workshop. LE1.2 Use hand tools in a given situation. LE1.3 Measure the wire gauge size for the given application LE1.4 Identify different type of meters used for measurement of voltage, current and energy consumed

Legend: LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies)

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Collect information about the different wire used for house wiring

ii. Visit nearby electrical workshop and collect information and prepare the list of tools and equipment along with specification.

CO-2 Identify wiring accessories, cables, illumination sources and switches

(Approx. Hrs: LI+SW =6)

Session Outcomes (SOs)	Laboratory Instruction (LI)
SO2.1 Select suitable cable for a given load application. SO2.2 List the wiring materials required for a given load application. SO2.3 Select illumination source for a given application. SO2.4 List the different type of switches andcircuit breakers for different application as per their current and voltage rating	LE2.1 Identify cables of different current ratings and voltage grade. LE2.2 Identify the accessories /materials used for house wiring LE2.3 Identify the different types of illumination sources and their control gear LE2.4 Identify the different types of switches and circuit breakers used for control of low power loads

Legend: LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies)SW: Sessional wok,

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Collect information about the major manufacturers of Low voltage cables and LED lights

CO-3 Perform the wiring for control of house hold and commercial loads

(Approx. Hrs: LI+SW = 8)

Session Outcomes (SOs)	Laboratory Instruction (LI)
SO3.1 Selection of wire size and its connection on a given switch board SO3.2 Select PVC conduit and the conduit accessories required for open wiring SO3.3 List the wiring materials required for control of domestic appliances. SO3.4 Maintain low power switch boards	LE3.1 Perform wiring connection on a switch board LE3.2 Perform the PVC conduit wiring for control of a given load. LE3.3 Prepare switch board for control of a given load. LE3.4 Connect a given load from the main supply using Circuit breakers LE3.5 Prepare series testing board

Legend: LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SW: Sessional wok

SW-3 Suggested Sessional Work (SW):

a. Assignments:

i. Collect information about the materials required for concealed conduit wiring.

ii. Perform wiring using PVC casing and capping for control of Electric water geyser

CO-4 Maintain lighting and heating appliance

(Approx. Hrs: LI+SW =8)

Session Outcomes (SOs)	Laboratory Instruction (LI)
SO4.1 Describe the wiring and mounting procedures on a switch board for control of electrical appliances. SO4.2 Select the wiring materials for installation and control of illuminations loads for Stair case and Godown wiring. SO4.3 Describe the wiring procedures to measure the energy consumed by a given load. SO4.4 Describe the wiring procedures for control of given illumination SO4.5 Describe the steps to use the given type of meters for testing and measurement SO4.6 Describe the procedures for maintaining a given electrical load.	LE4.1 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 LE4.2 Prepare the wiring installation for control of two Lamps by Series - Parallel connection using one 1-way switch &2-way switches LE4.3 Prepare the wiring installation for control and practice of a given lighting load. LE4.4 Prepare the wiring installation using sub circuits for control of a given heating and illumination load through energy meters, switches, cut outs/ breakers LE4.5 Measure voltage and current for single and three phase Supply using multimeter and clip on meter. LE4.6 Perform continuity and polarity test of given electrical wiring component using Multimeter. LE4.7 Test wiring installation using megger

Legend: LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SW: Sessional work

SW-4 Suggested Sessional Work (SW):

Assignments:

i. Wire up a 1.5-ton capacity window type A/C equipment wiring system as per layout and test it.
ii. Wire up to control an Electric bell from three locations with lamp indicators and test it.
iii. Familiarization and use of various soldering tools and components.
iv. List specifications of various electrical and electronic home appliances

CO-5 Use firefighting equipment and other safety related accessories.

(Approx. Hrs: LI+SW =4)

Session Outcomes (SOs)	Laboratory Instruction (LI)
SO5.1 Describe the safety procedures and practices followed for electrical hazards	LE5.1 Identify Safety Signs and symbols
SO5.2 Select the fire extinguisher to extinguish the given situation type of fire.	LE5.2 Conduct mock artificial respiration and first Aid exercises to learn about safety procedures of first Aid in case of electrical hazards.
SO5.3 Describe the procedures to use given firefighting equipment.	LE5.3 Identify different types of fire extinguishers
SO5.4 List the materials used for first Aid.	LE5.4 Use Fire extinguisher to extinguish the fire in a given situation.
SO5.5 Describe the ways to maintain good housekeeping in the given situation.	

Legend: LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Sessional work

SW-5 Suggested Sessional Work (SW) :

a. Assignments:

i Collect information about the major manufacturers of fire extinguishers

Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

I) Suggested Specification Table (For Assessment of Laboratory Instruction*):

Laboratory Instruction Number	Short Laboratory Experiment Titles	Assessment of Laboratory Work (% Marks)		
		Performance		Viva-Voce
		PRA	PDA	
LE1.1	Identify different type of measuring tools	50	40	10
LE1.2	Use hand tools	50	40	10
LE1.3	Measure the wire gauge size	50	40	10
LE 1.4	Identify different type of meters used for measurement	50	40	10
LE2.1	Identify cables of different current and voltage ratings	50	40	10

LE2.2	Identify the accessories /materials used for house wiring	50	40	10
LE2.3	Identify the different types of illumination sources	50	40	10
LE2.4	Identify the different types of switches and circuit breakers	50	40	10
LE3.1	Perform wiring connection on a switch board	50	40	10
LE3.2	PVC conduit wiring	50	40	10
LE3.3	Prepare switch board	50	40	10
LE3.4	Connect a given load from the main supply using Circuit breakers	50	40	10
LE3.5	Prepare series testing board	50	40	10
LE4.1	Control of one lamp, one fan and one socket from one switch board	50	40	10
LE4.2	control of two Lamps by Series - Parallel connection using one 1-way switch &2-way switches	50	40	10
LE4.3	Control and practice of a given lighting load	50	40	10
LE4.4	Control using sub circuits for a given heating and illumination load	50	40	10
LE4.5	Using multimeter and clip on meter.	50	40	10
LE4.6	Continuity and polarity test of given electrical wiring component	50	40	10
LE 4.7	Test wiring installation using megger	50	40	10
LE 5.1	Identify Safety Signs and symbols	50	40	10
LE5.2	Artificial respiration and first aid kit	50	40	10
LE5.3	Mock drill session for extinguishing fire	50	40	10
LE5.4	Different types of fire extinguishers	50	40	10

*Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practical's

Legend: PRA: Process Assessment, PDA: Product Assessment

Note: Only one experiment has to performed at the end semester examination of **30 Marks** as per assessment scheme

J) Suggested Instructional/Implementation Strategies:

1. Industrial visits
2. Expert Lecture
3. Field Trips
4. Self-Learning
5. Observation, Practice and Feedback
6. Laboratory, Workshop, Field, Video, Live Demonstrations
7. Charts
8. Demonstration
9. ICT Based Teaching

L) Suggested Learning Resources:

(a) Books :

S. No.	Titles	Author	Publisher	Edition & Year
1.	Elements of Workshop Technology	Hajra; Choudhary;	Media Promoters and Publishers ISBN: 10-8185099146	
2.	Handbook of Electrical Engineering	Bhatia, S.L.	Khanna Publication	2012
3.	Electrical Wiring, Estimating and Costing	Uppal, S.L. & Garg ,G.C.	Khanna Publication	2012
4.	Electrical Workshop	Satish Dahiya	Neelkanth Publishers Pvt. Ltd	ISBN: 8184445393 2016
5.	Workshop Calculation and Science(Electrical)	A Kumar	Arihant Publications	ISBN: 9789313161349, 9789313161349
6.	Electronic Components Handbook	Jones, Thomas H.	Reston Publishing, Reston, Virginia, United states	ISBN: 9780879092221

(b) List of open source software/learning website :

1. Measuring device: https://www.youtube.com/watch?v=3M4rsWBYaIA
2. Precision measuring device: https://www.youtube.com/watch?v=JX8gHdNpamk
3. Angular measuring device: https://www.youtube.com/watch?v=dgkLbX4cqr4
4. Workshop hand tools: https://www.youtube.com/watch?v=4o0tqF0jDdo
5. Soldering and brazing: https://www.youtube.com/watch?v=BplzRtQAMw0
6. www.electronicshub.org/types-of-inductors-and-applications/
7. www.radio-electronics.com/info/data/semicond/diodes/types-of-diodes.php
8. learn.sparkfun.com/tutorials/transistors

(c) Others:

1. Learning Packages.
2. Lab Manuals.
3. Manufacturers' operating Manual

M) List of Major Laboratory Equipment and Tools:

S. No.	Name of Equipment	Broad Specifications
1.	Hand tools	Insulated Screw drivers ,Pliers , Rawl plug tool and bit Wood chisel, Poker , Splicers , Files , Hack saw, Wood saw, Punch
2.	Standard Wire gauge	Gauge 1-36 mm
3.	Drilling machine	Chuck capacity 1-10 mm, power 500 watt, 1-phase 230 V

S. No.	Name of Equipment	Broad Specifications
4.	Analog/Digital Multimeter	Analog and Digital AC Voltage : 0-750 V DC Voltage : 0-250 V AC Current : 0-10 A DC Current : 0-10 A Resistance : 0 – 1 M ohm
5.	Analog Voltmeter	Moving iron and Moving Coil type 0-250/0-500 V
6.	Analog Ammeter	Moving iron and Moving Coil type 0-10 A
7.	Digital Clamp on meter	0-500 V, 0-200 A
8.	Electrical tester cum continuity	-----
9.	Single phase wattmeter	0-250/300 V, 0-5 /10 Amp
10.	Single phase energy meter	0-250 V. 0-5 Amp
11.	Hand operated Insulation tester	500V, 100 Mega ohms
12.	Conduit Wiring accessories	Multi strand Wires, PVC conduits, Junction boxes, Inspection Bends, Elbows,Tees, saddles, clamps, Flexible conduits, Reducers, Deep Junction boxes
13.	Switch Board Accessories	Switch boards, 5/6A Switches, Lamp holders,SocketsPlug Top , Metal clad sockets, Modular Boxes 4way/6 way
14.	Main supply board accessories	ICDP, ICTP, Cut outs, SP MCB’s, TPN MCB’s, 4-way DB’s
15.	Soldering Iron	Soldering iron, Flux for soldering and Solder filler material.
16.	Artificial respiration chart& First Aid box	-
17.	Fire Extinguisher (2 Kg)	Class A,B,C,D

N) Mapping of POs & PSOs with COs:

Course Outcomes (COs)	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)	
	PO-1 Basic knowledge	PO-2 Discipline knowledge	PO-3 Experiments and practice	PO-4 Engineering Tools	PO-5 The engineer and society	PO-6 Environment and sustainability	PO-7 Ethics	PO-8 Individual and team work	PO-9 Communication	PO-10 Life-long learning	PSO-1	PSO-2
CO-1 Use measuring devices and hand tools effectively	2	2	3	3	1	1	2	1	1	1	3	1
CO-2 Undertake wood working operations economically and safely.	1	2	3	2	1	1	2	2	1	1	1	2
CO-3 Perform various joining operations using welding, brazing and soldering methods	2	2	3	2	1	1	2	2	1	2	3	2
CO-4 Identify electrical and electronics components	2	3	3	2	-	-	1	3	1	2	2	1
CO-5 Use firefighting equipment and other safety related accessories	2	2	2	1	2	2	2	3	2	2	2	1

Legend:1 – Low, 2 – Medium, 3 – High.

O) Course Curriculum Map:

POs& PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)
PO 1,2,3,4,5 6,7,8,9,10 PSO 1,2	CO-1 Use measuring devices and hand tools effectively.	SO-1.1,1.2,1.3,1.4	LE1.1,1.2,1.3 1.4
PO 1,2,3,4,5 6,7,8,9,10 PSO 1,2	CO-2 Identify wiring accessories, cables, illumination sources and switches	SO-2.1,2.2,2.3,2.4	LE2.1,2.2,2.3 2.4
PO 1,2,3,4,5 6,7,8,9,10 PSO 1,2	CO-3 Perform the wiring for control of house hold and commercial loads	SO-3.1,3.2,3.3,3.4	LE3.1,3.2,3.3,3.4, 3.5
PO 1,2,3,4, 7,8,9,10 PSO 1,2	CO-4 Maintain lighting and heating appliance	SO-4.1,4.2,4.3,4.4,4.5,4.6	LE4.1,4.2,4.3,4.4,4.5, 4.6,4.7
PO 1,2,3,4,5 6,7,8,9,10 PSO 1,2	CO-5 Use firefighting equipment and other safety related accessories	SO-5.1,5.2,5.3,5.4,5.5	LE5.1,5.2,5.3,5.4

Legend: LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SW: Sessional work

Note: The mapping of CO with PO and PSO shown is indicative only. The subject faculty can modify it as per the strengths of the department where the program is conducted

Name of program: Diploma in Engineering **Semester: III**
Branch : EE/EEE **Code: NIL**
Subject : Health, Hygiene & Yoga **Total Tutorial Periods: NIL**
No. Of Periods : 2 Periods/Week

Course Objectives:

1 To provide understanding the importance of health.
2 To provide insight into the hygiene aspect & quality of life.
3 To study the concepts of various medical therapy.
4 To practice the various yogasans.
5 To provide knowledge about common diseases and its cure through yagasans and pranayam.
6 To develop concentration through various methods.

UNIT- I **HEALTH & HYGIENE:** Concept of health, Physical health and mental health and wellbeing and how to achieve these, longevity and how to achieve it, concept and common rules of hygiene, cleanliness and its relation with hygiene; Overeating and underrating, amount of food intake required, intermittent fasting; adequate physical labour, sleep; consumption of junk fast food vs nutritious food; fruits, vegetables cereals and qualities of each of these.

UNIT-II **INTRODUCTORY KNOWLEDGE OF COMMON STREAMS OF MEDICINAL CURE:** History, development, basic concepts, modes of operation of Alopathy, Ayurved, Homoeopathy, Biochemic, Unani, Siddha, Accurpressure, Accupunture, Naturopathy, Yogic and Herbal system of medicines, Introduction of Anatomy and Physiology concerned.

UNIT- III **YOGASANS:** Meaning and concept of Yoga, Yogasans and its mode of operation, How to perform Yogasans, Common Yogasans with their benefits, such as, Padahastasan, Sarvangasan, Dhanurasan, Chakrasan, Bhujangasan, Paschimottasan, Gomukhasan, Mayurasan, Matsyasan, Matsyendrasan, Pawanmuktasan, Vajrasan, Shalabhasan, Sinhasan, Shashankasan, Surya Namaskar, Halasan, Janushirasan, Utshep Mudra.

UNIT-IV **YOGASANS FOR COMMON DISEASES:** From Yogic Materia Medica with symptoms, causes, asans and herbal treatment.

- **Modern silent killers:** High blood pressure, diabetes and cancer, causes and cure; Common health problems due to stomache disorders, such as, indigestion, acidity, dycentry, piles and fissures, artheritis, its causes, prevention and cure.
- **Asans for relaxation:** Shavasan, Makarasan, Matsyakridasan, Shashankasan.
- **Asans to increase memory and blood supply to brain:** Shirsh padasan, Shashankasan.
- **Asans for eye sight:** Tratak, Neti Kriya .
- **Pranayam:** Definition and types: Nadi Shodhan, Bhastrik, Shitakari, Bhramari useful for students.

UNIT-V **CONCENTRATION:** Concentration Of Mind And How To Achieve It. Tratak (त्राटक), Concentration On Breath, Japa (जप), Ajapajap (अजपाजप), Internal silence(अन्तमौनक्र Visualization In Mental Sky (चिदाकाश धारणाक्र Concentration On Point Of Light(ज्योति ध्यानक्र Concentration On Feeling (भाव ध्यानक्रConcentration On Figure (मूर्ड्ड ध्यानक्र

Text Books:

Health, Hygiene & Yoga, Dr P B Deshmukh, Gyan Book Pvt Ltd. New Delhi.

Reference Books:

(1) Yogic Materia Medica
(2) Asan, Pranayam and Bandh