Government of Karnataka
Department of Technical Education
Board of Technical Examinations, Bengaluru

Course Title: **TRANSFORMERS AND AC MOTORS LAB**		Course Code	: 15EE45P
Semester	: **IV**	Course Group	: **Core**
Teaching Scheme (L:T:P)	: **0:2:4** (in Hours)	Credits	: **3 Credits**
Type of course	: **Tutorial + Practical**	Total Contact Hours	: **78**
CIE	: **25 Marks**	SEE	: **50 Marks**

Pre-requisites	**:** Knowledge about Fundamentals of Electrical Engineering, Electrical circuits, Transformers and AC Motors.
Course Objectives	**:** To impart technical skills to the students through practical training that would enable the students to conduct experiments on Transformers, A.C. Motors and starters using suitable tools and equipments adopting safety measures, interpret the results, identify and locate faults, suggest remedies and perform general preventive maintenance on Transformers, A.C. Motors and starters.

Course Outcomes:

On successful completion of the Course, the student will be able to:

1. Identify the physical components of transformer, 3 Ph Induction motor, synchronous motor ,1 ph Induction motors and AC motor starters.
2. Connect, start and run AC Motors using suitable starters.
3. Determine and interpret efficiency and regulation of a 1 Ph transformer.
4. Operate two single phase Transformers parallel.
5. Determine and interpret the Speed-Torque characteristics of a 3 Ph Induction motor.
6. Test and Identify faults in transformer, 3 Ph Induction motor, synchronous motor,1 ph Induction motor, DOL and star-delta starters in the Electrical laboratory and Suggest remedies.

LIST OF GRADED EXPERIMENTS:

Expt. No.	GRADED EXPERIMENTS	HOURS
01	Identify the physical parts of 1 Phase and 3 phase transformers and Autotransformers. Note down the name plate details and interpret it.	03
02	Identify the terminals of a 1 Phase transformer, test it for open circuit, short circuit and ground faults using test lamp / megger, check the insulation resistance, identify and locate the possible faults. Suggest remedies.	03
03	Identify the HV/LV terminals, type of primary and secondary connections of a 3 Phase transformer, test it for open circuit, short circuit and ground faults using test lamp / megger, check the insulation resistance, identify and locate the possible faults. Suggest remedies.	03
04	Identify the parts of single phase induction motors, test it for open circuit, short circuit and ground faults using test lamp / megger, check the insulation resistance, identify and locate the possible faults. Suggest remedies.	03
05	Identify the terminals and parts of 3 Phase synchronous motor, test it for open circuit, short circuit and ground faults using test lamp / megger, check the insulation resistance, identify and locate the possible faults. Suggest remedies.	03
06	Trace and draw the layout of Transformers and A/C motors in the labarotary and their power circuit wiring, healthy condition of fuses, switches ,MCB, ELCB check them for proper voltage, identify faults if any ,and rectify.	03
07	Identify the parts of a DOL starter, test its parts locate faults if any. Suggest remedies.	03
08	Identify the parts of a Star-Delta starter, test its parts and locate faults if any. Suggest remedies.	03
09	Identify the parts of Autotransformer starters, test its parts locate faults if any. Suggest remedies.	03
10	Conduct Polarity and Ratio tests on 1-ph transformer.	03
11	Determine the efficiency and regulation of 1-ph transformer by direct loading.	03
12	Pre-Determine the Regulation and Efficiency of 1-ph transformer by	03

	conducting O.C. and S.C. tests	
13	Parallel operation of two single phase transformers and analyse load sharing pattern for a given KVA rating.	03
14	Measure Phase & Line Voltage and Phase & Line Current for the Star-Star. (Y-Y Connection) transformer bank using 3 single phase transformers.	03
15	Measure Phase & Line Voltage and Phase & Line Current for the Star-Delta. (Y- Δ Connection) transformer bank using 3 single phase transformers.	03
16	Connect ,Start, Run and Reverse the direction of rotation of 3-phase Induction Motor using DOL starter.	03
17	Trace the start terminals and end terminals of three phase windings and mark the terminals u1,v1,w1 and u2,v2,w2 Connect, Start, Run and Reverse the direction of rotation of 3-phase Induction Motor using star delta starter.	03
18	Start and run 3 ph Induction Motor using Autotransformer starter. Measure the speed for different voltages.	03
19	Plot the Speed-Torque (Slip Vs Torque) Characteristics of 3-Phase Induction motor by mechanical loading (Brake-drum apparatus).	03
20	Start, Run and Reverse the direction of rotation of synchronous motor.	03
21	Identify and connect the starting winding, running winding , capacitor ,centrifugal switch terminals rotation of 1-ph capacitor start Induction Motor. Start, Run and Reverse the direction of rotation.	03
22	Perform general preventive maintenance on transformers and synchronous Motors in the Electrical laboratory.	03
23	Perform general preventive maintenance on 3 ph Induction motor and 1 ph Induction Motors in the Electrical laboratory.	03
24	Perform general preventive maintenance on different types of motor starters.	03
26	TESTS	06
	TOTAL	78

Reference Books:

1. Experiments in Basic Electrical Engineering by S. K. Bhattacharya, New Age International Publications, 2007 Edition.
2. Electrical trade theory and trade practice (1st and 2nd year) – National Instructional Media Institute (NIMI).
3. Laboratory courses in Electrical Engineering. by S.G. Tarnekar, P. K. Karbanda and others, S. Chand Publishers.
4. Electrical Machines by M.V.Deshpande- PHI Publications.
5. Electrical Motors Application and control by M.V.Deshpande- PHI Publications.

e-Resources:

1. www.controlmanual.com / testing and maintenance of electrical machines.
2. accessengineeringlibrary.com/.../electrical-equipment-handbook-troubles.
3. www.slideshare.net/.../electrical-powerequipmentmaintenanceandtesting.
4. https://www.crcpress.com/Electrical...Equipment-Maintenance...Testing...
5. electrical-engineering-portal.com › Resources.
6. https://books.google.co.in/books?isbn=1574446568
7. http://www.scribd.com/doc/39578646/New-First-year-Electrical-lab-manual#scribd
8. http://mrcet.ac.in/newwebsite/pdfs/Labmanuals-13/ECE/LabManuals/DC%20LAB%20%28180%29%20II-I.pdf

Composition of Educational Components:

Questions for CIE and SEE will be designed to evaluate the various educational components (Bloom's taxonomy) such as:

Sl. No	Educational Component	% in Weightage
1	Remember	20
2	Understand	30
3	Apply/ Analyze	50

Mapping Course Outcomes with Program Outcomes: (Course Outcome linkage to Cognitive Level)

Course Outcome		Experiment linked	PO Mapped	Cognitive Level	Lab Sessions
CO1	Identify the physical components of transformer, 3 Ph Induction motor, synchronous motor ,1 ph Induction motors and AC motor starters.	1 to 8	2, 3, 8, 9, 10	R/U/A	24
CO2	Connect, start and run AC Motors using suitable starters.	15,16,17,18	2, 3, 8, 9, 10	U/A	12
CO3	Determine and interpret efficiency and regulation of a 1 Ph transformer.	10,11	2, 3, 8, 9, 10	U/A	06
CO4	Operate two single phase Transformers in parallel.	12	2, 3, 8, 9, 10	U/A	03
CO5	Determine and interpret the Speed-Torque characteristics of a 3 Ph Induction motor.	19	2, 3, 8, 9, 10	U/A	03
CO6	Test and Identify faults in transformer, 3 Ph Induction motor, synchronous motor, 1 ph Induction motor, DOL and star-delta starters in the Electrical laboratory and Suggest remedies.	2 to 8	2, 3, 8, 9, 10	U/A	21

U-Understanding; A-Analysis; App-Application

Course-PO Attainment Matrix

Course	Programme Outcomes									
	1	2	3	4	5	6	7	8	9	10
Transformer and A.C Motor lab	**-**	**3**	**3**	**-**	**-**	**-**	**-**	**3**	**3**	**3**

LEVEL 3- HIGHLY ADDRESSED, LEVEL 2-MODERATELY ADDRESSED, LEVEL 1-LOW ADDRESSED.

METHOD IS TO RELATE THE LEVEL OF PO WITH THE NUMBER OF HOURS DEVOTED TO THE COS WHICH ADDRESS THE GIVEN PO.
IF ≥40% OF CLASSROOM SESSIONS ADDRESSING A PARTICULAR PO, IT IS CONSIDERED THAT PO IS ADDRESSED AT LEVEL 3
IF 25 TO 40% OF CLASSROOM SESSIONS ADDRESSING A PARTICULAR PO, IT IS CONSIDERED THAT PO IS ADDRESSED AT LEVEL 2
IF 5 TO 25% OF CLASSROOM SESSIONS ADDRESSING A PARTICULAR PO, IT IS CONSIDERED THAT PO IS ADDRESSED AT LEVEL 1
If < 5% of classroom sessions addressing a particular PO, it is considered that PO is considered not-addressed.

Course Delivery:

The Course will be delivered through Tutorial, classroom interaction, group discussion, practical exercises and Student Activities.

Tutorial - 1Hr:

Staff-in-charge will

1. Explain the concept of experiment to be conducted.
2. Teach required selection of meters/ Electrical Machines/Equipment specified connecting wires for the experiment to be conducted.
3. Use multimedia - animations and videos for demonstrating dis-assemble, assemble and maintenance of equipments before performing such exercises.
4. Ask the students to draw the circuit and interpret it's working.
5. Give clear instructions about safety precautions to be followed while conducting experiment.

Note: Tutorial includes Identification and listing the parts of , 1-ph Transformer, 3-ph alternator, 1-ph and 3-ph Induction Motor (squirrel cage & slip ring I.M.) and DOL Starter and Star-Delta Starters

Conduction/ Execution - 2 Hr:

Student will rig up the circuit diagram and conduct experiment individually under the supervision of the staff-in-charge.

Course Assessment and Evaluation:

	What		To Whom	Frequency	Practical	Evidence Collected	Course Outcomes
Direct Assessment Method	CIE (Continuous Internal Evaluation)	I A Tests	Students	Two IA tests for Practical (Average marks of both the tests to be computed)	10	Blue Books	1 to 6
		Record Writing		Record Writing (Average of Marks allotted for each experiment.)	10	Lab Record	1 to 6
				Student Activity	05	Log of Activity	1 to 6
				TOTAL	**25**		
	SEE (Semester End Examination)	End Exam	Students	End of the Course	50	Answer Scripts	1 to 6
Indirect Assessment Method	Student Feedback on course		Students	Middle of The Course	Feed Back Forms		1 to 6
	End of Course Survey			End of The Course	Questionnaire		1 to 6

*CIE – Continuous Internal Evaluation *SEE – Semester End Examination

Note:

1. I.A. test shall be conducted as per SEE scheme of valuation. However obtained marks shall be reduced to 10 marks. Average marks of two tests shall be rounded off to the next higher digit.
2. Rubrics to be devised appropriately by the concerned faculty to assess Student activities.

Suggested Student Activities:

Each Student has to prepare and submit at least 3 pages of self hand written report considering any **ONE** of the following topics.

1. Selection of types of motors and their applications in industries
2. Inspection, Repair and Preventive Maintenance of distribution transformer- testing of transformer oil, reconditioning of breather silica gel, testing Bucholz relay etc.,
3. Selection of types of transformers and their applications in industries.
4. Significance of vector group in 3 Phase transformers.
5. Boost test on transformers.
6. Transformer On-line and Off line tap changers.
7. Cooling system for electrical machines.
8. Energy efficient motors.
9. Visit nearby Industry/Substation and make a report of the different motors and transformers used and their purpose.
10. Prepare a suitable panel board for Transformers and A/C motors.

MODEL OF RUBRICS / CRITERIA FOR ASSESSING STUDENT ACTIVITY (Course Coordinator)

Dimension	Scale					Students score (Group of five students)				
	1 Unsatisfactory	2 Developing	3 Satisfactory	4 Good	5 Exemplary	1	2	3	4	5
1	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	3				
2	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2				
3	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	5				
4	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	4				
Note: Concerned faculty (Course coordinator) must devise appropriate rubrics/criteria for assessing Student activity for 5 marks **One activity on any one CO (course outcome) may be given to a group of FIVE students** **Grand Average/Total**						14/4 =3.5 ≈4				

Example only: MODEL OF RUBRICS / CRITERIA FOR ASSESSING STUDENT ACTIVITY-
Task given- Industrial visit and report writing

Dimension	Scale					Students score (Five students)				
	1 Unsatisfactory	2 Developing	3 Satisfactory	4 Good	5 Exemplary	1	2	3	4	5
1.Organisation	Has not included relevant info	Has included few relevant info	Has included some relevant info	Has included many relevant info	Has included all relevant info needed	3				
2. Fulfill team's roles & duties	Does not perform any duties assigned	Performs very little duties	Performs partial duties	Performs nearly all duties	Performs all duties of assigned team roles	2				
3.Conclusion	Poor	Less Effective	Partially effective	Summarises but not exact.	Most Effective	5				
4.Convensions	Frequent Error	More Error	Some Error	Occasional Error	No Error	4				
					Total marks	14/4=3.5 ≈4				

LOG BOOK FORMAT

LAB NAME: **SEM:** **STAFF IN-CHARGE:**

Sl.no	Date	Activates performed	Signature of in charge

Scheme of Valuation for SEE (Semester End Examination)

Sl. No.	Particulars	Marks
1.	Identifying the parts and selection of meters/equipment.	05
2.	Circuit diagram with Procedure for one experiment.	10
3.	Connections, Conduction and Tabulation of Readings	20
4.	Calculation and Results	05
5.	Viva-voce	10
Total		**50**

Model Question Bank:

Course Title: **TRANSFORMERS AND A.C. MOTORS LAB**	Course Code: 15EE45P

1. Conduct Polarity test on 1-ph transformer.
2. Conduct Ratio test on 1-ph transformer.
3. Conduct an experiment to determine the efficiency and regulation of 1-ph transformer by direct loading.
4. Conduct an experiment to Pre-determine the Regulation and Efficiency of 1-ph transformer by conducting O.C. and S.C. tests
5. Conduct an experiment for Parallel operation of two single phase transformers and analyse load sharing pattern for a given KVA rating.
6. Conduct an experiment to Measure Phase & Line Voltages and Phase & Line Currents for the Star-Star(Y-Y) transformer bank using 3 single phase transformers.
7. Conduct an experiment to Measure Phase & Line Voltage and Phase & Line Current for the Star-Delta.(Y- Δ) transformer bank using 3 single phase transformers.
8. Trace the 3 phase windings of a Induction Motor and mark the terminals u1,v1,w1, u2,v2,w2.
9. Conduct an experiment to Start, Run and Reverse the direction of rotation of 3-phase Induction Motor using DOL starter.
10. Conduct an experiment to Start, Run and Reverse the direction of rotation of 3-phase Induction Motor using DOL starter.
11. Conduct an experiment to Plot the Speed-Torque (Slip Vs Torque) Characteristics of 3-Phase Induction motor by mechanical loading (Brake-drum apparatus)
12. Conduct an experiment to Plot the Slip Vs Torque Characteristics of 3-Phase Induction motor by mechanical loading (Brake-drum apparatus).
13. Start, Run and Reverse the direction of rotation of synchronous motor.
14. Conduct an experiment to Connect, Start, Run and Reverse the direction of rotation of 1-ph capacitor start Induction Motor.
15. Start and run 3 ph Induction Motor using Autotransformer starter. Measure the speed for different voltages.

Lab Equipment Requirement:

For a Batch of 20 students

Sl. No.	Name of Equipment and Specification	Quantity Required
01	Central distribution board with control gear and power supply panel for all M/C.	One
02	Syn. Motor with Induction Start, 5HP,3phase,50Hz 110/220V D.C. with panel board indicating motor, Generator, meters brought out connections to connecting terminals.	One set
03	I.M 3phase,400V,50HZ 5HP squirrel cage type with starter and brake-drum apparatus with panel board indicating motor, Generator, meters brought out connections to connecting terminals.	two
04	Single phase IM Various types one in each type	One each
05	Single phase transformer 2kVA 1:1	Three
06	Single phase transformer 2kVA 1:0.5	Two
07	Variacs 3phase	Two
08	Variacs single phase	Six
09	Loading Rheostats 2kW,5kW	Two
10	Loading Rheostats-lamp load	Two
11	3phase choke coil-continuously variable	Two
12	3phase Capacitor bank	Two
13	Wire wound rheostats range-assorted	30
14	Tachometers (Analog -3 and Digital-3)	06
15	Portable Moving iron ammeter –multirange (0-1-2-5-10-20)	20
16	Portable Moving iron Voltmeters –multirange (0-5-10-15-30-75-150-300-600V)	20
17	Multimeters analog and digital	04
18	Watt meters i) Dynamometer type lpf 75/300/600V,1/2A ii) Dynamometer type upf 75/300/600V,5/10A iii) Dynamometer type upf 75/300/600V,15/30A	02 04 04
19	3 phase watt meters 0-300/600V 15/30A	02
20	Portable pf meters	02
21	Frequency meters read type and digital type	02
22	Phase sequence indicator	02
22	Knife switches SPST,DPST,DPDT,TPST,TPDT etc.	02
23	Galvanometers centre zero type	40

24	Meggar	10
25	Earth tester	03
26	Tong tester analog and digital	03
27	Compass needles	04
28	Work benches	05
29	Steel almirahs	10
30	Steel racks	10
31	Iron clad switches 30A,60A,100A.	10
32	D-G set 20 kVA ,3phase, 50Hz	20
33	Change over switch 60A,100A	01