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

Course Title : **ELECTRICAL MEASUREMENT AND MEASURING INSTRUMENTS LAB**		Course Code	: 15EE46P
Semester	: **IV**	Course Group	: **Core**
Teaching Scheme (L:T:P)	: **0:2:4**(in Hours)	Credits	: **3 Credits**
Type of course	: **Lecture + Assignments**	Total Contact Hours	: **78**
CIE	: **25 Marks**	SEE	: **50 Marks**

Pre-requisites	**:** Elements of electrical engg, electrical circuits, digital & analog electronics.
Course Objectives	**:**To understand the Electrical measurements, with the,effects of electrical current, analog & digital electronics principles,calibration techniques,range extension,special type measuring instruments,transducers & applications.

Course Outcomes:

On successful completion of the course, the students will be able to,

1. Illustrate the methods of range extension in A.C. & D.C. meters.

2. Compare calibrated meter readings with standard meters (digital meters).

3. Interpret the various methods to measure unknown résistance, inductance & capacitance.

4. Determine the physical & electrical quantities using transducers & sensors.

Note: Staff-in-charge must teach one hour tutorial for each Lab. The Contents to be taught in the one hour tutorial are(mandatory for tutorial=1hr & practical's=2hrs).

Tutorial 1:

1.Using shunt resistances for range extension in d.c ammeter (low range to high range).

2.Need of range extension

3.Types of shunt resistors.

Tutorial 2:

1.Using series multiplier resistances for range extension in d.c. voltmeter(low range to high range).

2.Need of range extension.

3. Types of multiplier resistances.

Tutorial 3:

1. Using C.T.s to extend the range of a.c ammeter from (high range to low range).

2. Need of range extension.

Tutorial 4:

1.Using P.T.s to extend the range of a.c voltmeter from (high range to low range).

2.Need of range extension.

Tutorial 5:

1.Need of calibration.

2.Necessity of minimizing errors in a.c. instruments.

3. Calibration of instruments.

Tutorial 6:

1. Need of calibration.

2. Necessity of minimizing errors in d.c. instruments.

3. Calibration of instruments.

Tutorial 7:

1. What is power, power factor.

2. Measurement of power by volt meter, ammeter by indirectly.

3. Use of watt meter for power measurement directly, determine p.f. indirectly.

Tutorial 8:

1. Measurement of power indirectly by voltmeter & ammeter, directly by wattmeter.

2. Measurement of p.f..

3. Comparison of above reading with compared with digital p.f. meter readings.

Tutorial 9:

1.Measurement of power by volt meter, ammeter by indirectly.

2.Use of watt meter for power measurement directly.

3. Determine p.f. by wattmeter, voltmeter & ammeter reading compared with digital p.f meter

Tutorial 10:

1. Measurement of power directly by two wattmeters.

2. Measurement of p.f. by comparison of two wattmeters reading.

Tutorial 11:

1. Measurement of power directly by two wattmeters.

2. Measurement of p.f. by comparison of two wattmeters reading.

3. Comparing obtained p.f. readings with digital p.f meter.

Tutorial 12:

1. Need & understanding of calibration.

2. Necessity of minimizing errors in wattmeters.

Tutorial 13:

1. Meaning of energy.

2. Operation of energy meter

3. Measurement of energy by using analog energy meter.

Tutorial 14:

1. Measurement of energy by analog energy meter.

2. Comparison of analog energy meter readings with digital energy meter for accuracy.

Tutorial 15:

1. Measurement of energy by 3phase analog energy meter.

2. Comparison of 3phase analog energy meter readings with 3phase digital energy meter for accuracy.

Tutorial 16:

1. Calibration of energy meter.

2. Necessity of calibration to reduce error in measurement of energy.

Tutorial 17☹Same tutorial for expt. 18 & 19)

1. Need of measuring unknown R,L,C .

2. Operation and applications of various bridges used in d.c and a.c circuit parameter determination.

Tutorial 18:

1. Explain operation of transducers.

2. Application of transducers in various electrical circuits.

Tutorial 19:

1. Need of measuring unknown R,L,C using digital LCR meters .

2. Operation and applications of digital LCR meters.

LIST OF GRADED EXCERCISES

Unit No	Graded Exercises	Hour
1.	Extend the range of D.C. ammeter by using shunt resistances (low range to high range)	03
2.	Extend the range of D.C. voltmeter by using series multiplier(low range to high range)	03
3.	Extend the range of A.C. ammeter by using C.T.(high range to low range)	03
4.	Extend the range of A.C. voltmeter by using P.T.(high range to low range)	03
5.	Calibrate a D.C. voltmeter by standard method.	03
6.	Calibrate a A.C. ammeter by standard method.	03
7.	Measure power and p.f. of single phase circuit using wattmeter by indirect method.	03
8	Measure p.f. of single phase circuit by direct method using digital p.f. meter and compare the same with indirect method.	03
9	Measure power and p.f. of three phase circuit using 2-wattmeters by indirect method.	03
10	Measure p.f. of three –phase circuit using digital p.f.meter and compare the same with indirect method.	03
11	Calibrate a wattmeter by standard method.	03
12.	Measure energy consumed by single- phase circuit using analog single- phase energy meter.	03
13	Measure energy consumed by single- phase circuit using digital single- phase energy meter and compare the same with analog single-phase energy meter readings.	03
14.	Measure energy consumed by three phase circuit using analog three- phase energy meter.	03

15.	Measure energy consumed by three- phase circuit using digital three- phase energy meter and compare the same with analog three-phase energy meter readings.	03
16.	Calibrate single phase energy meter by standard method.	03
17.	Conduct an experiment to determine unknown 1. Resistance using Wheat stone's bridge. 2.Inductance by Maxwell's bridge. 3. Capacitance by Schering bridge.	09
18.	Conduct an experiments to determine physical & electrical parameters using 1.LVDT 2. STRAIN GUAGES. 3. RVDT. 4. PYROMETERS. 5. THERMOCOUPLES. 6. BOLOMETER. 7. OPTO SENSORS. 8. PIEZO-ELECTRIC SENSORS.	21
19.	Measure R,L,C by using digital LCR meter and current flowing in any phase a.c. circuit using digital tong tester.	03
2**0.**	Internal assessments	06

E-Resources:

1. *www.academia.edu/.../A_K.Sawhney-A_course_in_Electrical_and_Elect...*
2. *https://en.wikipedia.org/.../List_of_electrical_and_electronic_measuring_*
3. *nptel.iitg.ernet.in › ... › Electrical and Electronic Measurements (Video)*

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	Weightage (%)
1	Remembering	20
2	Understanding	20
3	Application/ Analysis	60
Total		**100**

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

Course Outcome		Experiment linked	PO Mapped	Cognitive Level	Lab Sessions
CO1	Illustrate the methods of range extension in A.C. & D.C. meters.	1,2,3,4	2, 3, 8, 9, 10	R/U/A	12
CO2	Compare calibrated meter readings with standard meters (digital meters).	5,6,11,16	2, 3, 8, 9, 10	U/A	12
CO3	Interpret the various methods to measure unknown résistance, inductance & capacitance.	17,18,19,	2, 3, 8, 9, 10	U/A	15
CO4	Determine the physical & electrical quantities using transducers & sensors.	7,8,9,10,12, 13,14,15	2, 3, 8, 9, 10	U/A	15

U-Understanding; A-Analysis; App-Application

Course-PO Attainment Matrix

Course	Programme Outcomes									
	1	2	3	4	5	6	7	8	9	10
EMMI 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 Assessment and Evaluation Scheme:

	What		To Whom	Frequency	Practical Marks	Evidence Collected	Course Outcomes
Direct Assessment	CIE (Continuous Internal Evaluation)	I A Tests	Students	Two IA tests for Practical (Average marks of both the tests are considered)	10	Blue Books	1 to 4
		Classroom Assignments		Student activity	05	Report	1 to 4
		Record Writing		Record Writing (Average of Marks allotted for each expt.)	10	Record Book and log book	1 to 4
				TOTAL	**25**		
	SEE (Semester End Examination)	End Exam	Students	End Of the Course	50	Answer Scripts at BTE	ALL COs
Indirect Assessment	Student Feedback on course		Students	Middle Of The Course	Feed Back Forms		1 – 4
	End Of Course Survey			End Of The Course	Questionnaire		All COs

*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 ACTIVITY:

1. Calculate resistance & inductance of field winding & armature winding of D.C.generator using any digital meter.

2.Calculate resistance & inductance of primary winding of single phase transformer using any digital meter.

3**.**Calculate resistance & inductance of 3phase induction motor & alternator using any digital meter.

4.Detemine the capacitance of capacitor used in fan, single phase induction motors, fluorescent tube using Schering bridge compare with digital LCR meter.

Student has to submit a self hand written report of min two pages of any one activity in group of 5 members.

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.Conversions	Frequent Error	More Error	Some Error	Occasional Error	No Error	4				
					Total marks	14/4=3.5 ≈4				

Scheme of Valuation for SEE(Semester End Examination):

The SEE Question paper should be set in such a way that Questions in the Question paper should have equal nos. of Questions from Part A and Part B.

Sl. No.	Particulars	Marks
1.	Identification of meters, equipments, components, tools used.	5
2.	Circuit diagram, Procedure to conduct one experiment	10
3.	Conduction of experiment	20
4	Results	5
4.	Viva (Oral)	10
Total		**50**

Model Question Bank:

Code:15EE46P

1.Extend the range of D.C ammeter by using shunt resistances (low range to high range)

2.Extend the range of D.C.voltmeter by using series multiplier.(low range to high range).

3.Extend the range of A.C.ammeter by using C.T.(high range to low range).

4.Extend the range of A.C.voltmeter by using P.T.(high range to low range).

5. Calibrate a D.C.voltmeter by standard method.

6. Calibrate a D.C ammeter by standard method.

7. Measure power and p.f. of single phase circuit using wattmeter by indirect method.

8.Measure p.f. of single phase circuit by direct method using digital p.f.meter and compare the same with indirect method.

9.Measure p.f. of three -phase circuit using digital p.f meter and compare the same with indirect method.

10.Calibrate a wattmeter by standard method.

11.Measure energy consumed by single- phase circuit using analog single- phase energy meter.

12.Measure energy consumed by single- phase circuit using digital single- phase energy meter and compare the same with analog single-phase energy meter readings.

13.Measure energy consumed by three phase circuit using analog three- phase energy meter.

14.Measure energy consumed by three- phase circuit using digital three- phase energy meter and compare the same with analog three-phase energy meter readings.

15.Measure energy consumed by three- phase circuit using digital three- phase energy meter and compare the same with analog three-phase energy meter readings.

16.Calibrate single phase energy meter by standard method.

17.Conduct an experiment to determine unknown
1. Resistance using Wheat stone's bridge.

18. Conduct an experiment to determine unknown
    2.Inductance by Maxwell's bridge.
19. Conduct an experiment to determine unknown
    3. Capacitance by Schering bridge.
20. Conduct an experiments to determine physical & electrical parameters using
    1.LVDT
    2. STRAIN GUAGES.
21. Conduct an experiments to determine physical & electrical parameters using
    3. RVDT.
    4. PYROMETERS.
22. Conduct an experiments to determine physical & electrical parameters using
    5. THERMOCOUPLES.
    6. BOLOMETER.
23. Conduct an experiments to determine physical & electrical parameters using
    7. OPTO SENSORS.
    8. PIEZO-ELECTRIC SENSORS.

24. Measure R,L,C by using digital LCR meter and current flowing in any phase a.c circuit using digital tong tester.

LIST OF EQUIPMENTS:

Sl no	Name equipments/ meters	Quantity
1.	Current transformers(multi-range)	3 No
2.	Potential transformers(multi-range)	3 No
3.	Shunts (resistors)	10 No
4.	Series multipliers	10 No
5.	Moving coil voltmeter(0-25V/0-15V/0-10V/0-5V) (Table top)	2 Each
6.	Moving iron voltmeter(0-25V/0-15V/0-10V/0-5V) (Table top)	2 Each
7.	Moving coil ammeter(0-15A/0-10A/0-5A/0-1A) (Table top)	2 Each
8.	Moving iron ammeter(0-15A/0-10A/0-5A/0-1A) (Table top)	2 Each
9.	Wattmeter 0-300V/0-10A,LPF.(Table top)	2 No
10.	Wattmeter 0-300V/0-10A,UPF.(Table top)	2 No
11.	1Phase,2wire energy meter analog. (Table top)	2 No
12.	1Phase,2wire energy meter digital. (Table top)	2 No
13	3Phase,4wire energy meter analog. (Table top)	2 No
14	3Phase,4wire energy meter digital. (Table top)	2 No
15.	Wheatstone's bridge. (Table top)	2 No
16.	Kelvin's bridge. (Table top)	2 No
17.	Maxwell bridge. (Table top)	2 No
18.	Schering bridge. (Table top)	2 No
19.	Digital LCR meter, Digital frequency meter, digital tong tester, digital p.f meter, digital voltmeter, digital tri-vector meter, digital synchronoscope,digital non contact type tachometer, digital multimeter. (Table top)	2 Each
20.	Strain gauges, LVDT,RVDT, opto sensors, thermocouple.	2 Each
21.	Bolometer for AF & RF power measurement.	2 Each
22.	Pyrometer.	2 No