Programme Name/s : **Electrical Engineering/ Electrical Power System**

Programme Code : **EE/ EP**

Semester : **Third**

Course Title : **ELECTRICAL AND ELECTRONIC MEASUREMENT**

Course Code : **313334**

I. RATIONALE

Industry comprises of a number of electrical, electronic instruments and transducers for measuring precisely various electrical and mechanical parameters. The diploma students passing this course will possess the required knowledge and skill set not only to use but to calibrate and troubleshoot these measuring instruments.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Troubleshoot electrical and electronics measuring instruments used for laboratory and industrial measurements.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Apply the basics of measurement to the measuring instruments.
- CO2 - Measure precisely electrical power and energy using appropriate meters.
- CO3 - Use digital measuring instruments for different applications.
- CO4 - Maintain required pressure for given application using pressure transducer.
- CO5 - Use appropriate transducer for maintaining required flow, level and temperature in given application.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/ s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
313334	ELECTRICAL AND ELECTRONIC MEASUREMENT	EEM	DSC	3	-	4	1	8	4	3	30	70	100	40	25	10	25#	10	25	10	175

Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Define static and dynamic characteristics of measuring instruments. TLO 1.2 Explain types of errors in a measuring instrument and their compensation. TLO 1.3 Write the classification of measuring instrument. TLO 1.4 Explain different types of torques in measuring instruments. TLO 1.5 Describe the procedure for calibration of given device. TLO 1.6 Describe construction and working of PMMC and PMMI meter. TLO 1.7 Extend the range of given DC/AC ammeter and voltmeter. TLO 1.8 Classify different types of resistance.	**Unit - I Fundamentals of Measurement** 1.1 Measurement: Definition, need and significance. 1.2 Static and dynamic characteristics of measuring instruments. 1.3 Types of errors in measurement and compensation. 1.4 Classification of Instruments. 1.5 Deflecting, controlling and damping torque. 1.6 Calibration: Need, significance and general procedure. 1.7 Construction and working principle of Permanent magnet moving coil (PMMC) and Permanent magnet moving iron (PMMI) meter. 1.8 Range Extension of ammeter and voltmeter- a) Shunt and multiplier (for DC), b) CT and PT (for AC) 1.9 Classification of resistance: Low, Medium and High.	Chalk-Board Flipped Classroom Video Demonstrations Model Demonstration Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Describe the working of the dynamometer wattmeter with the help of neat sketch. TLO 2.2 Describe the procedure for measuring power using appropriate method. TLO 2.3 Justify the effect of Power factor on wattmeter reading in two wattmeter method. TLO 2.4 Describe the working of MDI and four quadrant meter with neat labelled sketch. TLO 2.5 5 Describe the working of a given type of energy meter with help of block diagram. TLO 2.6 Describe the working of a given digital energy meter and smart energy meter with neat sketch.	**Unit - II Measurement of Power and Energy.** 2.1 Construction and working of dynamometer wattmeter, Multiplying factor. 2.2 Active and reactive power measurement: One, two and three wattmeter methods. 2.3 Effect of Power factor on wattmeter reading in two wattmeter method. 2.4 Construction and working of maximum Demand indicator (MDI), four quadrant meters. 2.5 Construction and working of Induction type single phase energy meter, types of errors and compensation. 2.6 Single and three phase digital energy meter: Block diagram, constructional features and working principle. 2.7 Smart energy meter: Basic concept, block diagram, operation and working principle.	Chalk-Board Flipped Classroom Video Demonstrations Model Demonstration Presentations
3	TLO 3.1 Explain the merits of digital measuring instruments. TLO 3.2 Describe the construction and working of a given digital meter with neat sketch. TLO 3.3 Describe the construction and working of a given resistance measurement meters with neat sketch. TLO 3.4 Describe the working of a given meter used for synchronization with neat sketch. TLO 3.5 Describe the working of function generator with neat sketch. TLO 3.6 Describe the working of CRO, Digital storage oscilloscope with neat sketch.	**Unit - III Digital Measuring Instruments.** 3.1 Digital measuring instruments-Essentials and advantages. 3.2 Construction and working of digital Meters-Ammeter, Voltmeter and Multimeter, Clamp-on meter, L-C-R meter, Power factor meter and Tachometer (Contact and Non-contact). 3.3 Construction and working of Resistance measurement meters: Ohm meter, Digital Megger, Digital earth tester. 3.4 Construction and working of meter used for synchronization: Frequency meter, Synchroscope and Phase sequence indicator. 3.5 Function generator: Basic block diagram, function of each block and applications. 3.6 CRO: Basic block diagram, function of each block. 3.7 Digital storage Oscilloscope: Basic block diagram, function of each block.	Chalk-Board Flipped Classroom Video Demonstrations Model Demonstration Presentations
4	TLO 4.1 Describe the working of instrumentation system with neat sketch. TLO 4.2 State the difference between sensors and transducer. TLO 4.3 Write the classification of transducer. TLO 4.4 Describe the working of given electrical transducer with neat sketch. TLO 4.5 Describe the working of piezoelectric transducer with neat sketch. TLO 4.6 Classify pressure transducer. TLO 4.7 Describe the working of bourdon tube with LVDT as secondary transducer with neat sketch.	**Unit - IV Transducer and Pressure Measurement** 4.1 Instrumentation System-Block diagram, function of each block. 4.2 Difference between sensors and transducer with examples. 4.3 Classification of transducer. 4.4 Electrical Transducers: a) Resistive transducers- Linear and Angular potentiometers, strain gauge, load cell. b) Capacitive transducer. c) Inductive transducer â€“LVDT, RVDT. 4.5 Working of piezoelectric transducer, classification, examples. 4.6 Pressure measurement: Pressure and its units, types - Absolute, Gauge, Atmospheric, Vacuum. 4.7 Classification of Pressure measuring devices. 4.8 Method of pressure measurement- Bourdon tube with LVDT as secondary transducer.	Chalk-Board Flipped Classroom Video Demonstrations Model Demonstration Presentations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Classify flow transducer. TLO 5.2 Describe the working of given electrical flow meter with neat sketch. TLO 5.3 Classify level transducer. TLO 5.4 Describe the working of given level transducer with neat sketch. TLO 5.5 Classify temperature transducer. TLO 5.6 Describe the working of given temperature transducer with neat sketch.	**Unit - V Flow, Level and Temperature Measurement** 5.1 Flow measurement -Flow and its units, classification of flow transducers -Variable head flow meter, Variable area flow meter. 5.2 Methods of measurement of electrical flow meter: a) Electromagnetic Flow meter. b) Ultrasonic flow meter. 5.3 Level measurement-Level and its units classification of level measurement transducer-Resistive, Inductive and Capacitive. 5.4 Method level measurement: Capacitive, Ultrasonic and Radiation. 5.5 Temperature Measurement-Temperature and its Units, classification -Thermistors, Resistance Temperature Detector (RTD) and Thermocouple. 5.6 Methods of temperature measurement- RTD and thermocouple.	Chalk-Board Flipped Classroom Video Demonstrations Model Demonstration Presentations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify measuring instruments on the basis of symbols on dial, type, accuracy, class, position and scale.	1	*Identification of measuring instruments on the basis of symbols on dial, type, accuracy, class, position and scale.	2	CO1
LLO 2.1 Identify the components of PMMC and PMMI instruments.	2	*Identification of the components of PMMC and PMMI instruments.	2	CO1
LLO 3.1 Troubleshoot PMMC and MI instruments.	3	Troubleshooting of PMMC and PMMI instruments.	2	CO1
LLO 4.1 Calibrate the ammeter /voltmeter for measurement.	4	Calibration of the ammeter /voltmeter for measurement of electrical parameters.	2	CO1
LLO 5.1 Extend the range of voltmeter and ammeter by using shunt and multiplier.	5	Extension of the range of voltmeter and ammeter using shunt and multiplier.	2	CO1
LLO 6.1 Extend the range of ammeter by using CT, take the safety Precautions while using CT.	6	*Extension of the range of ammeter using Current Transformer (CT).	2	CO1
LLO 7.1 Extend the range of ammeter by using CT, take the safety Precautions while using CT	7	*Extension of the range of ammeter using Current Transformer (CT).	2	CO1
LLO 8.1 Measure power in a single-phase circuit by electro-dynamic watt-meter and determining the multiplying factor of a wattmeter also change the current range of wattmeter by making changes in the current	8	*Measurement of power in a single-phase circuit using electro-dynamic watt-meter.	2	CO2
LLO 9.1 Carry out troubleshooting of electro-dynamic watt-meter.	9	Troubleshoot of electro-dynamic watt-meter for measurement.	2	CO2
LLO 10.1 Measure active power in three phase balanced load by using one wattmeter method.	10	*One wattmeter method of measurement of active power in a three-phase balanced load.	2	CO2
LLO 11.1 Measure reactive power in three phase balanced load by using one wattmeter method	11	One wattmeter method of measurement of reactive power in a three-phase balanced load.	2	CO2
LLO 12.1 Measure active power in three phase balanced load by using two wattmeter method.	12	*Two watt-meters method of measuring active power in a three-phase balanced load.	2	CO2
LLO 13.1 Calibrate single phase energy meter by direct loading.	13	*Calibration of single-phase energy meter by direct loading.	2	CO2
LLO 14.1 Carry out troubleshooting of single-phase energy meter.	14	Troubleshoot of single-phase energy meter.	2	CO2
LLO 15.1 Demonstrate the working of smart energy meter.	15	*Demonstration of smart energy meter.	2	CO2

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 16.1 Measure low resistance by using bridges.	16	Measurement of low resistance using bridges.	2	CO3
LLO 17.1 Measure medium and high resistance by using bridges.	17	Measurement of medium and high resistance using bridges.	2	CO3
LLO 18.1 Measure of supply voltage, frequency, peak value in single-phase circuit by using CRO/DSO.	18	*Measurement of supply voltage, frequency, peak value in single-phase circuit using CRO/ DSO.	2	CO3
LLO 19.1 Measure linear displacement by using potentiometer.	19	*Measurement of linear displacement using potentiometer.	2	CO4
LLO 20.1 Measure the angular displacement by using potentiometer.	20	Measurement of angular displacement using potentiometer.	2	CO4
LLO 21.1 Measure displacement by using LVDT.	21	Measurement of displacement using LVDT.	2	CO4
LLO 22.1 Measure weights by using strain gauge.	22	Measurement of weights using strain gauge.	2	CO4
LLO 23.1 Measure pressure by using Bourdon tube pressure gauge.	23	*Measurement of pressure using bourdon tube pressure gauge.	2	CO4
LLO 24.1 Measure flow by using orifice meter.	24	*Measurement of flow using orifice meter.	2	CO5
LLO 25.1 Measure flow by using venturi meter.	25	Measurement of flow by using venturi meter.	2	CO5
LLO 26.1 Measure flow by using rotameter.	26	Measurement of flow using rotameter.	2	CO5
LLO 27.1 Measure level by using capacitance transducer.	27	*Measurement of level using capacitance transducer.	2	CO5
LLO 28.1 Measure temperature by using RTD.	28	*Measurement of temperature using RTD.	2	CO5
LLO 29.1 Measure temperature by using thermocouple.	29	Measurement of temperature using Thermocouple.	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- Write the industrial applications of level transducer.
- Write the industrial applications of pressure transducer.
- Write the industrial applications of RTD, thermistor and thermocouple.
- Convert a given temperature scale into another scale.
- Compare analog and digital meters.
- Compare PMMC with PMMI meters.

- Determine earth resistance using digital earth tester and compare with the ideal earth resistance.
- Compare analog with digital energy meter.
- Determine multiplying factor of a wattmeter.
- Write the industrial applications of flow meter.

Suggested Student Activity

- Prepare chart showing real-life examples indicating various types of electrical measuring equipment.
- Collect photographs of PMMC and MI instrument showing internal parts.
- Prepare power point presentation for different types of wattmeters.
- Collect photographs of electronic energy meter and prepare report on it.
- Prepare the report on smart energy meter.
- Collect photographs of CRO and see the practical utilization.
- Prepare charts for measurement system using temperature, pressure, flow, level system.
- Prepare specification broad for basic transducers of temperature, level, pressure and flow.

Micro project

- Electronic energy meter: Collect data of power consumption of the equipment in the departmental laboratories/workshops of your polytechnic using electronic energy meter.
- Prepare a report on usage of level, pressure and flow sensors used in industry.
- Prepare a report on usage of IC LM35 temperature sensor.
- Prepare a report on usage of temperature sensors in mobile, laptop, domestic and consumer appliances.
- DMM: Use DMM for measurement of current, voltage, resistance of different range and check the continuity.
- CRO: Draw the front panel of CRO and write the function of each control on the panel.
- Wattmeter: Dismantle a wattmeter available in the laboratory identify the pressure coil, current coil, spring, magnets, former, dial scale etc. and again assemble the same.
- PMMC and MI instrument: Dismantle any PMMC and MI instrument each available in the laboratory/workshop and identify different parts, material and function i.e. coil, spring, magnets, former, dial scale etc. and again assemble the same.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Model of PMMC and PMMI type instrument (up to 50A)	1,2,3
2	Energy meter (analog/digital) (15A/230V)	13,14
3	Smart energy meter.	15
4	Wheatstone bridge, Mega ohm bridge	16,17
5	CRO (up to 100 MHz)	18
6	Signal Generator (up to 100MHz)/ Function Generator (up to 100MHz)	18
7	Linear potentiometer, angular potentiometer	19,20
8	LVDT trainer kit- Displacement range +/- 20 mm. Accuracy of +/- 2% Primary Excitation 4 KHz and 1 Volt, RMS Output: Digital display of +/- 20mm	21
9	Strain gauge trainer kit: Strain gages of 350 ohms, Accuracy: +/- 1% Power Supply 230 V AC, maximum of 5-kg load, Digital indication	22
10	Bourdon tube pressure gauge: Input pressure range 0 â€“ 50 psi. Accuracy of +/- 2%. Dial gauge indication in the range 0 to 50 psi.	23
11	Orifice meter measurement setup: concentric type, stainless steel, U tube manometer 400 mm height, Range 0-1000LPH, Digital display	24
12	Venturi flow measurement setup: stainless steel, U tube manometer 400 mm height, Range 0-1000LPH, Digital display	25
13	Rotameter flow measurement setup: Range 0-1000 LPH, Glass tube body, Bob Material-stainless steel, mounting inlet bottom top outlet	26
14	Capacitance level measurement: Input range 0 to 500 mm, power supply 230 V AC, 2 wire capacitance type, top mounted, Digital display indication of 0 to 500mm	27

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
15	RTD temperature measurement: Temp range 0-100 ^{0}C, temperature bath, RTD Type pt100, accuracy +/- 1%, power supply 230V AC	28
16	Thermocouple temperature measurement: Temp range 0-1260 ^{0}C, temp bath, Thermocouple K Type, accuracy of +/- 1%, power supply 230V AC, digital indication of temperature	29
17	Voltmeter Range (0-110V), Ammeter (0 to 5A)	4,5
18	Voltmeter, Ammeter, CT (15/5, 25/5), PT (230/110, 440/110)	6,7
19	Wattmeter (5/10A, 110/ 230V), Wattmeter (5/10A, 300/ 600V)	8,9,10,11,12

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Fundamentals of Measurement	CO1	7	2	4	4	10
2	II	Measurement of Power and Energy.	CO2	9	4	6	4	14
3	III	Digital Measuring Instruments.	CO3	10	4	6	6	16
4	IV	Transducer and Pressure Measurement	CO4	9	4	4	6	14
5	V	Flow, Level and Temperature Measurement	CO5	10	2	6	8	16
Grand Total				**45**	**16**	**26**	**28**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two unit tests of 30 marks will be conducted and average of two unit tests considered. For formative assessment of laboratory learning 25 marks. Each practical will be assessed considering appropriate % weightage to process and product and other instructions of assessment.

Summative Assessment (Assessment of Learning)

- End semester summative assessment of 25 marks for laboratory learning. End semester assessment of 70 marks through offline mode of examination.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)	Programme Specific Outcomes* (PSOs)

	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO- 1	PSO- 2	PSO- 3
CO1	3	1	-	1	-	1	1			
CO2	3	2	1	2	1	1	2			
CO3	3	2	2	2	1	1	3			
CO4	3	2	1	2	2	1	2			
CO5	3	1	1	2	2	1	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	A.K.Sawhney	Electrical and Electronic Measurement and Instrumentation	Dhanpai Rai and Sons, New Delhi, 2014; ISBN: 9780000279744
2	J.B.Gupta	Electronics and Electrical Measurements and Instrumentation	S.K.Katariya and Sons, 2013, ISBN: 8188458937
3	Rajput R.K.	Electrical and Electronic Measurement and Instrumentation	S.Chand and Co. New Delhi, 2015, ISBN: 9789385676017
4	A.J.Baowens	Digital Instrumentation	Tata Mc-Graw Hill Publication ISBN: 9780074630488
5	Patranabis D.	Principles of Industrial Instrumentation	Tata Mc-Graw Hill Publication Co. Ltd, New Delhi 2010; ISBN:9780070699717
6	H.S.Kalsi	Electronic Instrumentation and Measurement.	Tata Mc-Graw Hill Publication Co. Ltd, New Delhi 2019; ISBN:9353162513
7	Theraja B.L., TherajaA.K.	A Text Book of Electrical Technology Vol-I (Basic Electrical Engineering)	S.Chand and Co. New Delhi, 2014, ISBN: 9788121924405

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.electrical4u.com/	Digital electronics measurement
2	https://iitb.vlabs.co.in/	Digital measurement concept.
3	https://ndl.iitkgp.ac.in/	Free source of reference books of electrical measurement and instrumentation.
4	www.dreamtechpress.com /ebooks	Free reference books for more practices.
5	https://nptel.ac.in/	Fundamentals of Measurement.
6	https://swayam.gov.in/nc_details/NPTEL	Concepts of electrical and electronics measurements.

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

ELECTRICAL AND ELECTRONIC MEASUREMENT **Course Code : 313334**

Semester - 3, K Scheme

MSBTE Approval Dt. 02/07/2024