GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Power Electronics
Subject Code: BE04024011
Subject Name: Electrical Measurement and Electronics Instrumentation

WEF Academic Year :	2024-25
Semester :	4
Category of the Course :	Basic Science Course

Prerequisite:	Basic Electronics, Basic Electrical Engineering
Rationale:	In the modern engineering landscape, **Electrical Measurement and Electronics Instrumentation** serves as a cornerstone subject that bridges theoretical understanding with practical application. Its relevance spans across power systems, electronics, automation, and emerging technologies like IoT and smart grids. This becomes more significant considering Industry 4.0

Course Outcomes:

After Completion of the Course, Student will be able to:

No	Course Outcomes	RBT Level*
01	Explain the principles of measurement and instrumentation systems	UN
02	Use principles learnt to measure electrical quantities (voltage, current, resistance, inductance, capacitance) accurately	AP
03	Apply bridge circuits and potentiometers	AP
04	Implement proper measuring method for measurement of physical quantities like temperature, pressure, flow, torque, and speed using appropriate transducers	AP
05	Compare various transducers and measuring methods	AN

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA (I)	PBL (I)	ESE (V)	
45	0	30	15	90	3	70	30	20	30	50	200

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Course Content:

Sr. No.	Course Content	No. of Hours	% of Weightage
1.	**Introduction:** Methods of Measurement, Measurement System, Classification of instrument system, Characteristics of instruments & measurement system, Errors in measurement, error analysis, Standards.	4	10
2.	**Analog Measurement of Electrical Quantities:** Electro dynamic, Thermocouple, Electrostatic and Rectifier type Ammeters, Voltmeters, Electro dynamic Wattmeter, Three Phase Wattmeter, Power in three phase system, errors & remedies in wattmeter and energy meter. Instrument Transformer and their applications in the extension of instrument range, Introduction to measurement of speed, frequency and power factor.	10	20
3.	**Measurement of Parameters:** Different methods of measuring low, medium and high resistance, measurement of inductance & capacitance with the help of AC Bridges, Q-Meter.	10	20
4.	**Digital Measurement of Electrical Quantities:** Concept of digital measurement, digital voltmeter, frequency meter, Power Analyzer and Harmonics Analyzer, Electronic Multimeter.,	6	15
5.	**Transducers:** Definition - different types of transducers – criteria for selection –general characteristics–dynamic characteristics – transducers for measurement of displacement (RVDT, LVDT), speed, angular rotation, altitude, force, torque, humidity and moisture, pressure, strain and temperature (Thermocouple and RTD method), Hall Effect transducer and applications Instrumentation amplifiers – differential amplifiers-Data transmission and telemetry – methods of data transmission, General telemetry systems – Digital methods of frequency, phase, time and period measurements.	10	20
6.	**Display methods, recorders:** Display methods and devices – different types of recorders – galvanometric recorders – pen driving system– magnetic recorders – digital recorders, digital storage oscilloscope, construction and working of DSO, measurement using DSO	5	15
Total			100

Reference Books:

1. A. K Sawhney, A course in Elect. & Electronic Measurement and Instrumentation, Dhapat Rai & Co.
2. Golding & Widis, Electrical Measurement and Measurement instrument, Wheelar Books

3. H.S. Kalsi, Electronic Instruments, Tata Mc-Graw hill.
4. Carr, Elements of Electronic Instrumentation and Measurement, Pearson Education.
5. D. Patranabis, Sensors & Transducers, PHI.
6. H.K.P. Neubert, Instrument transducers, Oxford University Press.
7. A.D. Heltric & W.C. Copper, Modern Electronic instrumentation & Measuring instruments, Wheeler Publication
8. A.J. Bouwens, Digital Instrumentation, Tata Mc-Graw hill.

Suggested Course Practical List:

1. Measurement of resistance using Wheastone's Bridge and Kelvin Double bridge.
2. Extension of range of wattmeter using CT & PT
3. Displacement measurement using LVDT
4. Measurement of current/ voltage using Hall effect transducer.
5. Measurement of physical quantities – strain, torque and angle
6. Measurement of temperature by RTD / Thermocouple
7. Low Resistance measurement by Kelvins double bridge.
8. Measurement of voltage, current and resistance using dc potentiometer.
9. Measurement of inductance by Maxwells bridge, Hays bridge, Anderson's bridge.
10. Measurement of capacitance by Owens bridge, De Sauty bridge, Schering bridge.
11. Measurement of flow rate by anemometer.
12. Study of DSO

List of Laboratory/Learning Resources Required:

1. DC Power Source, DSO / Logic analyzer, Multimeter
2. Discrete components like bread board, switches, LEDs, Buzzers, single lead wires(connectors), Trainer board
3. Open-source software: Pspice and NGspice based simulation software like KiCAD, Scilab, IIT Virtual Laboratory
4. Learning resources: NPTEL website.

List of suggested activities for Problem Based Learning:

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry/ Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on video learning outcomes.
3.	Assignment writing. Numerical based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding-based assignments of 2h each. Total = 10h	Based on the coding solution submitted.
5.	Self-learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course based on the certificate produced.
6.	Complex problem solving	Maximum 2 problems. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/ report submitted
8	Discussion on research paper based on relevant subject	5 research papers = 20 h	Summarize research paper and evaluation critical parameters
9.	Poster/chart /power point preparation on technical topics	Duration = 6 h	Based on poster / chart Preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 h non-working = 8 h	Based on inter department/ external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/ environment/ health/ any other issue	Duration = 10 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
12	Group Discussion on emerging / trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/ study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration = 10 h	Depending on the complexity of the Application/Software

Note:

- All the suggested activities should be related to the subject.
- The number of hours are suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
- Rubrics for the evaluation can be prepared by the faculty.
- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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