GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Subject Code: BE03000031
Subject Name : Measurement and Instruments

WEF Academic Year:	2024 - 2025
Semester:	3
Category of the Course:	Professional Core Course

Prerequisite :	Basics of Electrical Engineering and basics of Physics
Rationale :	To prepare students for experiments and design with various electrical, electronic measurements and instrumentation systems.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level*
01	Understand basics of measurement	RM/UN
02	Understand working of various AC/DC meters, digital meters and Oscilloscope	UN
03	Demonstrate measurement of various parameters	AP
04	Analyze signal sources, interference signals and their elimination	AN
05	Evaluate various standards of data transmission in digital instrumentation systems	EL

*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	45	120	04	70	30	20	30	50	200

*** 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 and types of measurement, Classification of Instrument System, Types of Instruments and elements of Instruments and Measurement Systems ***Experimental Data and Errors:*** Measurement Recording and Reporting, Graphical Presentation of Data, Precision and Accuracy, Resolution and Sensitivity, Errors in Measurement, Statistical Evaluation of Measurement Data and Errors	**4**	**8**
2	**Analog DC and AC meters:** Electromechanically meter movements, PMMC, Analog DC ammeters, Analog DC voltmeters, Analog AC ammeters and Voltmeters, Analog multimeters, Special purpose analog meters, Use of basic meters, meter errors.	**5**	**11**
3	**Digital Meters:** DVM and Digital multimeter, 7 Segment LED and LCD display.	**3**	**6**
4	**Oscilloscope:** Oscilloscope subsystem, Principle of Operation, Display Subsystems, Vertical Deflection Subsystem, Dual Trace Feature, Horizontal Deflection Subsystem, Oscilloscope Probes, Oscilloscope Controls, How to operate an Oscilloscope – Measurement of Voltage, Current and Time, frequency, phase, Lissajous figures and different measurement using it, errors; oscilloscope photography, Digital storage oscilloscopes (DSO).	**6**	**13**
5	**Time & Frequency Measurement:** Time Measurements, Frequency measurement, Harmonic Analysis and spectrum analyzers.	**2**	**5**
6	**Power & Energy Measurement:** Power in AC-DC circuits, single-phase power measurements, Poly-phase power and measurements, Measurement of Power factor, Electrical energy measurements, Power measurements at higher frequencies.	**3**	**6**

7	**Measurement of Parameters :** ***Resistance:*** Resistance and resistor, resistor type, measurement of resistance, Wheatstone Bridge, Ammeter-voltmeter method, substitution method, Carey Foster Slide Wire bridge, Kelvin Varley Slide, Kelvin Double Bridge method, difficulties in measurement of high resistances, use of guard circuit, methods for measurement of high resistance, direct deflection ;method, Loss of charge method, megohm bridge method, measurement of insulation resistance with power on. ***Inductance:*** Inductors and inductance, Maxwell bridge, Hays Bridge, Anderson Bridge, Owen's Bridge, Heaviside Mutual Inductance Bridge, Carrey Foster ridge, Campbell's Bridge ***Capacitance:*** Capacitance and capacitors, capacitor circuit models and losses, capacitor types, color coding of capacitor, DeSauty's Bridge, chering Bridge ***Frequency:*** Wien's Bridge and its sources of errors ***Impedance:*** Impedance and Complex Impedance Measurements	**15**	**35**
8	**Transformers:** Current Transformer, Voltage Transformer, Testing and Applications	**2**	**5**
9	**Signal Sources, Interference Signals and their Elimination or Reduction:** Sweep Frequency generators, Pulse generators, Function generators, Oscillators, Capacitance interference, inductive interference and shielding, electromagnetic interference and shielding, conductive coupling interference, input guarding to reduce ground loop interference, internal noise.	**3**	**6**
10	**Data transmission in Digital Instrument System:** RS 232C Standard, 20mA Current Loop	**2**	**5**
	Total	**45**	**100**

Reference Book:

1. Wolf & Smith, "Student reference manual for Electronic and Instrumentation measurement", PHI Publication.
2. A. K. Sawhney, "A Course in Electrical and Electronic Measurements and Instrumentation", Dhanpatrai Publication.

A.K.Sawhney, A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpatrai Publication. [1] Rahul Dubey, "An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications", Cengage India Publication

1. Raj Kamal, "Internet of Things: Architecture and Design Principles, Mc Graw Hill Education
2. Hanes et al "IoT Fundamentals", Cisco Press
3. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", , Paperback, 2015.
4. A. McEwen, H. Cassimally, "Designing the Internet of Things", Wiley, 2013.
5. YashwantKanetkar, "21 Internet of Things Experiments", Kindle edition
6. AdeelJaved, "Building Arduino projects for Internet of Things", Apress publication
7. Donald Noris, "The Internet of Things: Do it yourself Projects with Arduino, Raspberry PI and BeagleBone Black" Mc Graw Hill Publication
8. Adrian McEwen & Hakim Cassimally, "Designing the Internet of things", Willey publication
9. Rahul Dubey, "An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications", Cengage India Publication
10. Raj Kamal, "Internet of Things: Architecture and Design Principles, Mc Graw Hill Education Hanes et al "IoT Fundamentals", Cisco Press
11. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", , Paperback, 2015.
12. A. McEwen, H. Cassimally, "Designing the Internet of Things", Wiley, 2013.
13. YashwantKanetkar, "21 Internet of Things Experiments", Kindle edition
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16. Adrian McEwen & Hakim Cassimally, "Designing the Internet of things", Willey publication
17. Rahul Dubey, "An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications", Cengage India Publication

Suggested Course Practical List:

1. Introduction to Lab Equipment: Experimental data and Errors
2. Measurement of current and voltage using Analog meter
3. Extension of range of voltmeter
4. Extension of range of ammeter
5. Measurement of Resistance using Wheatstone Bridge
6. Low Resistance measurement using Kelvin Bridge
7. Self-Inductance Measurement using Maxwell Bridge
8. Measurement of Capacitance using De-Sauty Bridge
9. Measurement of Self Inductance of High-Quality Factor Coil by Hay's Bridge
10. Measurement of Capacitance by Schering Bridge
11. Introduction to Oscilloscope
12. Measurement of Frequency and Phase using Lissajous Pattern
13. Calibration of Single-phase Energy meter

14. Application of Wheatstone bridge for sensor signal conditioning
15. Mini project

List of Laboratory/Learning Resources Required:

1. Common Lab Manual (DTE)
2. Virtual Laboratory (vLab.co.in)
3. NPTEL Website

- **List of suggested activities for Problem Based Learning:**

Sr. No.	Name of the activity	No. of hours per activity	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 the 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 assignment 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 problem. 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 paper = 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 = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
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
15	Online Technical Quizzes/Simulations	Multiple quizzes summing up to 10h	Based on quiz scores and reflection report after each quiz.
16	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.

Note:

1. All the suggested activity should be related to the subject.
2. Subject coordinator shall identify activities from above list as per the subject needs, they also declare list of activities wise hours, evaluation scheme and rubrics to students at the start of semester.
3. The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
4. 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.
5. 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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