GUJARAT TECHNOLOGICAL UNIVERSITY Program

Name: Bachelor of Engineering
Level: UG
Branch: ALL (Except Instrumentation and Control Engineering & Allied Branches, Electrical Engineering & Allied Branches)
Subject Code : BE05000501
Subject Name : Instrumentation and Measurement Techniques

WEF Academic Year:	2024 -2025
Semester:	5
Category of the Course:	MOPEC

Prerequisite:	Students are informed to study with an open mind. No prerequisites are required.
Rationale:	This course covers the fundamental principles of sensors, transducers, and measurement systems. Students will develop the essential skills to select, calibrate, and implement modern instrumentation—including smart sensors—for monitoring critical parameters like temperature and pressure in industrial automation and process control.

Course Outcome:

Sr. No	Course Outcomes	Marks % weightage
CO-1	Explain the fundamental concepts, static and dynamic characteristics, and error classifications of transducers and measurement systems.	10
CO-2	Apply the working principles of various sensors to select appropriate temperature and pressure measurement instruments for specific industrial applications.	25
CO-3	Analyze the operation, construction, and selection criteria of diverse level and flow measurement techniques used in process industries.	25
CO-4	Evaluate the performance of smart sensors by understanding their signal conditioning, compensation methods, and communication standards in automation.	20
CO-5	Recommend and design appropriate instrumentation setups for complex real-world process measurement and automation problems.	20

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	TW/SL	TH		ESE (E)	PA (M)	PA/ (I)	TW/ SL (I)	ESE (V)	
45	0	0	15	60	02	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	**Basics of sensors, transducers and measurement:** Definition and block diagram of instrumentation and measurement system, Characteristics of an instrument and its classification, Static characteristics: accuracy, precision, resolution, sensitivity, scale, threshold, hysteresis, drift, dead zone, repeatability, reproducibility and error and its classification, Dynamic Characteristics: Speed of response, lag, fidelity and error, Transducer and sensors and their difference and classification. **Measurement Technique:** Wheatstone bridge and its operation and working	**2**	**6**
2	**Temperature Measurement:** Definition, Scales, Selection Criteria, Calibration, classification of different types of temperature sensors, Principle, Material of Construction, Construction, Working, Range, advantages, disadvantages and applications of Thermometer: Mercury and Digital, RTD, Thermocouple, Bimetallic Thermometer, Pyrometers: Optical and Radiation.	**8**	**17**
3	**Pressure Measurement:** Definitions of pressure and its types, scales, selection criteria, calibration, classification of different type of pressure sensors, Principle, Material of Construction, Construction, Working, Range, advantages, disadvantages and applications of Manometers, Bourdon tube, bellows and diaphragm gauges, vacuum pressure measurement: McLeod Gauge, Thermal conductivity gauges, and ionization gauges, Strain gauges and Load cell, dead weight tester.	**9**	**20**
4	**Level Measurement:** Definition, Scales, Selection Criteria, Calibration, classification of different types of level sensors, , Principle, Material of Construction, Construction, Working, Range, advantages, disadvantages and applications of Resistance, Inductance and Capacitance Level Measurement, Float, displacer and air purge bubbler type level measurement, Ultrasonic and radar level measurement	**9**	**20**

5	**Flow Measurement:** Definition and classification of flow, Scales, Selection Criteria, Calibration, Principle, Material of Construction, Construction, Working, Range, advantages, disadvantages and applications of Head type: Orifice, Venturi, Pitot tube and flow nozzle, Area type: Rotameter, Mass flow meters: Turbine, Electrical types: Electromagnetic, Ultrasonic and hotwire anemometer, Digital type: Vortex and flow marker type, Open channel type and Solid flow meters.	**9**	**20**
6	**Smart Sensors:** Introduction, Primary Sensors, Excitation, Amplification, filters, Converters, Compensation: Non Linearity, Noise and Interference, Response time, drift, cross sensitivity, Information Coding/Processing, Data Communication, Standards for Smart Sensor Interface and The Automation	**8**	**17**
	Total	**45**	**100**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**30**	**30**	**10**	**5**	**5**

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

The syllabus of *Instrumentation and Measurement Techniques* directly contributes to

SDG 6	**Clean Water and Sanitation**
SDG 7	**Affordable and Clean Energy**
SDG 9	**Industry, Innovation and Infrastructure**
SDG 12	**Responsible Consumption and Production**

Reference Book:

1. Instrument Engineers' Handbook: Process Measurement and Analysis by B. G Liptak.
2. Principles of Industrial Instrumentation by D. Patranabis, McGraw – Hill Publication.
3. Sensors and Transducers by D. Patranabis, Second Edition, PHI Publication
4. Handbook of Applied Instrumentation by D. M. Considine and Sidney David Ross, McGraw – Hill Publication.
5. Encyclopedia of Instrumentation and Control by D. M. Considine, Kriege Publication Co.

6. Instrumentation Reference Book by Walt Boyes, Butterworth – Heinemann Publisher.
7. Industrial Instrumentation by K. Krishnaswamy and S. Vijayachitra, New Age International Publication.
8. Measurement Systems: Application and Design by E. O. Doeblin, McGraw – Hill Publication
9. D. V. S. Murthy, Transducers and Instrumentation, 2nd Edition, PHI Publisher
10. B. C. Nakra and K. K. Chaudhary, Instrumentation Measurement and Analysis, 3rd Edition, Tata McGraw Hill
11. C. S. Rangan, G. R. Sarma, V. S. V. Mani, Instrumentation Devices and Systems, 2nd Edition, Tata McGraw Hill

List of Tutorials:

1. To study various static and dynamic characteristics of instruments
2. To study calibration techniques of temperature sensors
3. To study calibration techniques of pressure sensors
4. To study calibration techniques of flow sensors
5. To study calibration techniques of level sensors
6. To study HART protocol
7. To study various standard signals used in industry for transmission
8. To study 2 - wire and 4 wire transmitters
9. To study Wheatstone bridge and calculate unknown resistance
10. To study selection criteria of various sensors

List of learning resources/website:

1. Virtual Labs by IITs (Government of India Initiative) (https://vlab.co.in/)
2. DTE Common Lab manual
3. NPTEL / SWAYAM (https://nptel.ac.in/)

Activities suggested under self-learning:

Sr. No.	PBL Category	Name of the activity	No. of hours per activity	Evaluation Criteria
1.	Industry / Research Laboratory Visit	Industry/Research laboratory visit	Visit=5h, Report preparation = 5h Total = 10h	Based on the report submitted. Report should contain observations and calculations Based on industry/lab data.

2.	Video Based Learning	Technical Video based learning related to the subject (MOOC/NPTEL Video)	Duration of video = 5h Report preparation=5h Total= 10h	Report/presentation based on the video learning outcomes.
3.		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.
4.		Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation =5h Total= 10h	Based on quiz/report submitted
5.	Assignment/ Technical Writing / Research Writing	Assignment writing. Numerical Based assignment is preferable.	5 assignments of 2h each. Total= 10h	Based on the assignment submitted.
6.		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.
7	Complex Problem-Solving targeting relevant SDGs. / Mini Project	Complex problem solving	Maximum 2 problems. Study of the problem and solution finding, Total= 10h	Based on the depth of the Solution submitted.
8	Research Paper Review / Analysis	Discussion on research paper Based on relevant subject	5 research paper =20 h	Summarize research paper and Evaluation critical parameters

9.	Poster/ Chart/ Power poin presentation	Poster/chart/power point preparation on technical topics	Duration=6h	Based on poster/chart Preparation and presentation skills
10	Micro Project	Working/non-working model on technical topics	Working=12h Non-working=8 h	Based on inter department/external evaluation
11	Group Discussion / Quiz / Simulation	Online Technical Quizzes/Simulations	Multiple quizzes summing up to 10h	Based on quiz scores and reflection report after each quiz.
12		Group Discussion on emerging/trending technical topics based on subject	Duration=1h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	Case Study Analysis / Seminar	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.	Other	Patent Search and Innovation Gap Identification	10h(Search + Report)	Based on number of relevant patents analyzed and Identification of innovation scope.

Note:

1. In alignment with Outcome-Based Education (OBE) and NBA accreditation requirements, the subject *Instrumentation Measurement Techniques* incorporates;
   - Seminar activities -– 10 Marks

These activities are incorporated as integral Project-Based Learning (PBL) components. These activities are designed to foster experiential learning, encourage innovation, and strengthen problem-solving skills by engaging students in practical applications of power converter design, simulation, and analysis. The inclusion of PBL ensures that learners develop higher-order cognitive abilities mapped to Bloom's taxonomy, while simultaneously enhancing teamwork, communication, and research competencies essential for professional engineering practice.

2. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.

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