GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering
Subject Code: 3720318
Semester – II
Subject Name: Instrument Design Engineering

Type of course: Major Elective IV

Prerequisite: Fundamental knowledge of sensor measurement and design

Rationale: This course covers the fundamentals of various sensor designs, installation and provides essential knowledge so that students will be able to readily apply this knowledge in R&D organization and Industry.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	Design and Construction of Instruments: Instrument Design ,The Designer's Viewpoint ,Marketing Special Instruments ,Elements of Construction ,Electronic Components and Printed Circuits ,Surface-Mounted Assemblies ,Interconnections Materials, Mechanical Manufacturing, Processes, Functional Components, Construction of Electronic Instruments ,Site Mounting ,Panel Mounting Bench-Mounting Instruments ,Rack-Mounting Instruments ,Portable Instruments Encapsulation, Mechanical Instruments ,Kinematic Design ,Proximity Transducer, Load Cell ,Combined Actuator Transducer	**10**
2	Instrument Installation and Commissioning Introduction, General Requirements ,Storage and Protection, Mounting and Accessibility ,Piping Systems ,Air Supplies, Pneumatic Signals, Impulse Lines, Cabling ,General Requirements ,Cable Types ,Cable Segregation, Grounding, General Requirements ,Testing and Pre-Commissioning ,General Pre-Installation Testing ,Piping and Cable Testing ,Loop Testing Plant Commissioning	**10**
3	Reliability in Instrumentation and Control Reliability Principles and Terminology, Definition of Reliability, Reliability and MTBF The Exponential Failure Law, Availability Choosing, Optimum Reliability, Compound Systems, Reliability Assessment ,Component Failure Rates ,Variation of Failure Rate with Time ,Failure Modes, The Effect of Temperature on Failure Rates, Estimating Component Temperature ,The Effect of Operating Voltage on Failure	**15**

	Rates ,Accelerated Life Tests, Component Screening, Confidence Limits and Confidence Level ,Assembly Screening ,Dealing with the Wear-out Phase ,Estimating System Failure Rate ,Parallel Systems, Environmental Testing ,System Design ,Signal Coding, Digitally Coded Systems ,Performance Margins in System Design, Coping with Tolerance ,Component Tolerances ,Temperature Effects, Design Automation ,Built-in Test Equipment ,Sneak Circuits, Building High-Reliability Systems, Reliability Budgets ,Component Selection, The Use of Redundancy ,Redundancy with Majority Voting ,The Level of Redundancy ,Analog Redundancy ,Common Mode Faults ,The Human Operator in Control and, Instrumentation ,The Scope for Automation ,Features of the Human Operator, User-Friendly Design ,Visual Displays, Safety Procedures Safety Monitoring ,Types of Failure ,Designing Fail-Safe Systems ,Relay Tripping Circuits, Mechanical Fail-Safe Devices ,Control System Faults Circuit Fault Analysis ,Software Reliability ,Comparison with Hardware Reliability, The Distinction between Faults and Failures,,Typical Failure Intensities ,High-Reliability Software ,Estimating the Number of Faults ,Structured Programming ,Failure-Tolerant Systems, Electronic and Avionic Systems ,Radio Transmitters ,Satellite Links, Aircraft Control Systems ,Railway Signaling and Control ,Robotic Systems ,Nuclear Reactor Control Systems ,Requirements for Reactor Control, Principles of Reactor Control ,Types of Failure ,Common Mode Faults Reactor Protection Logic ,Process and Plant Control .Additional Hazards in Chemical Plants, Hazardous Areas	
4	Telemetry Introduction, Communication Channels ,Transmission Lines ,Radio Frequency Transmission ,Fiber-Optic Communication, Signal Multiplexing ,Pulse Encoding Carrier Wave Modulation, Error Detection and Correction Codes, Direct Analog Signal Transmission, Frequency Transmission, Digital Signal Transmission Modems Data Transmission and Interfacing, Standards	**10**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	**25**	**15**	**15**	**15**	**15**

Legends: 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.

Reference Books:

1. Instrumentation reference book , Walt Boyes. —4th ed. Elsevier Inc

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Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Understanding concept and importance of sensor design and installation	40
CO-2	Applying concept of design on various process parameters	30
CO-3	Analyze various technique of instrumentation reliability with respect to process instrumentation	30

List of Experiments:

Student has to prepare various Instrumentation design concept, compare hardware testing along with software simulation using any computing tools (MatLab,LabVIEW, Scilab, etc...). Prepare research paper on various topics like instrumentation testing, installation technique, reliability check this course.

Major Equipment:

Electronics Laboratory, computer facility , analog and digital sensors

List of Open Source Software/learning website:

- Virtual Lab
- NPTEL