GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering
Subject Code: 3722105
Semester – II
Experimental Techniques and Instrumentations in Thermal Systems

Type of course: Core subject

Prerequisite: Nil

Rationale: The course is designed to provide the fundamental knowledge of experimentation techniques, related instruments used for thermal engineering applications.

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	**Experimentation Planning:** Planning of experiments, various stages in experimental investigations; preliminary, intermediate and final, steady state and transient techniques, selection of measuring devices based on static, dynamic characteristics and allowable uncertainties, basics of Taguchi method for design of experiments	08
2	**Instrumentation & Measurements:** Fundamental elements of a measuring instrument, static and dynamic characteristics, principles of temperature measurement, calibration of thermocouple, RTD, Orifice plate and Pressure gauge, design of temperature measuring instruments, thermo positive elements, thermocouples in series & parallel, pyrometry, steady state and transient methods of measuring heat flux, measurement of thermal radiation and associated parameters, measurement of turbulence, measurement of thermal conductivity of solids, liquids and gases, measurement of thermo-physical properties, measurement of solar radiation	15
3	**Advancement in measurements:** Data logging and acquisition, use of sensors for error reduction, elements of microcomputer interfacing, intelligent instruments and their use, Basics of P, PI, PID controllers, pneumatic and hydraulic controllers, electronic controllers	08
4	**Advanced measurement techniques and analysis:** Shadowgraph, Schlieren, Interferometer, Laser Doppler Anemometer, Hot wire Anemometer, Telemetry in measurement, Gas Analyzers, Smoke meters, gas chromatography, spectrometry	08
5	**Uncertainty in measurements:** Errors in instruments, Analysis of experimental data and determination of overall uncertainties in experimental investigation, uncertainties in measurement of measurable parameters like pressure, temperature, flow etc. under various conditions	06

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Suggested Specification table with Marks (Theory):

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

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. Mechanical Measurements - Buck & Beckwith - Pearson
2. Measurement systems, Application and Design - E O Doebelin - McGraw-Hill
3. Measurements and Instrumentation in Heat Engineering - Prebrashensky V, Volume I &II, MIR Publishers
4. Experimental Methods for Engineers - J P Holman - McGraw-Hill
5. Instrumentation Devices and Systems - Raman C S, Sharma G R, Mani V S N - McGraw-Hill
6. Principles of Measurements and Instrumentation- Morris AS - Prentice Hall of India
7. Measurement Techniques in Heat Transfer - E R G Eckert and Goldsteen - Technovision
8. Mechanical and Industrial Measurements - R K Jain - Khanna Publishers
9. Experimentation and Uncertainty Analysis for Engineers - Huge W Coleman, W Glenn Steele - John Wiley & Sons.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Discuss experimentation techniques for various thermal systems.	18
CO-2	Discuss the various instruments used for measuring different properties significant for evaluation of performance of thermal systems and to carry out uncertainty analysis.	34
CO-3	Appraise the computing facilities for measurement and acquisition of different properties.	30
CO-4	Appraise advanced measurement techniques and systems.	18

List of Experiments:

1. To calibrate and measure temperature using thermocouple, RTD.
2. To carry out calibration of pressure measuring devices: U-tube manometer, pressure gauge.
3. To measure the thermal conductivity of any fluid.
4. To carry out calibration of flow measuring devices: orifice meter and rotameter.
5. To measure the direct and diffuse solar radiation using pyranometer and pyrheliometer.
6. To carry out exhaust gas analysis with gas chromatographer.
7. To study and familiar with data logging and acquisition system.
8. To study various electronics controllers used in thermal measurements.
9. To study and compare various advanced measurement techniques.
10. To perform experiment with any thermal system and to carry out uncertainty analysis for the same.

Major Equipment: calibration set-ups for various thermo-physical properties, pyranometer, pyrheliometer, gas chromatographer, gas analyzer, data acquisition system, interferometer, laser Doppler anemometer, hot wire Anemometer

List of Open Source Software/learning website: www.asme.org/thermal_science, nptel.ac.in