GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Subject Code : ME02000521

Subject Name : Experimental Techniques and Instrumentations in Thermal Systems

w. e. f. Academic Year:	2024-25
Semester:	2
Category of the Course:	PCC

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

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT level
1	Discuss experimentation techniques for various thermal systems.	Create
2	Examine the various instruments used for measuring different properties significant for evaluation of performance of thermal systems and to carry out uncertainty analysis.	Analyze
3	Appraise the computing facilities for measurement and acquisition of different properties.	Evaluate
4	Utilize advanced measurement techniques and systems.	Apply

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
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	18

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 and 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	32
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	18
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	18
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	14
	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**
-	**30**	**40**	**30**	-	-

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Mechanical Measurements - Buck & Beckwith - Pearson
2. Measurement systems, Application and Design - E O Doebelin - McGraw-Hill
3. Experimental Methods for Engineers - J P Holman - McGraw-Hill
4. Instrumentation Devices and Systems - Raman C S, Sharma G R, Mani V S N - McGraw-Hill
5. Principles of Measurements and Instrumentation- Morris AS - Prentice Hall of India
6. Measurement Techniques in Heat Transfer - E R G Eckert and Goldsteen - Technovision
7. Mechanical and Industrial Measurements - R K Jain - Khanna Publishers

8. Experimentation and Uncertainty Analysis for Engineers - Huge W Coleman, W Glenn Steele - John Wiley & Sons

(b) Open-source software and website:

1. https://onlinecourses.nptel.ac.in/noc24_me112
2. https://onlinecourses.nptel.ac.in/noc24_me119
3. https://onlinecourses.nptel.ac.in/noc24_ch72
4. https://onlinecourses.nptel.ac.in/noc24_me134

Suggested Course Practical List:

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.

List of Laboratory/Learning Resources Required: calibration set-ups for various thermo-physical properties, pyranometer, pyrheliometer, gas chromatographer, gas analyzer, data acquisition system, interferometer, laser Doppler anemometer, hot wire Anemometer

Suggested Project List:

Suggested Activities for Students: Students are required to download 3-5 research papers from reputed international journals on the recent advancement in the areas of experimental / measurement techniques, testing standards in the field of thermal engineering. They need to go through the same and prepare a review for the research papers. The review should have three parts: Summary, Critical Evaluation and Creative synthesize

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