GUJARAT TECHNOLOGICAL UNIVERSITY

ENERGY ENGINEERING (39)

INSTRUMENTATION IN ENERGY SYSTEMS

SUBJECT CODE: 2723914

SEMESTER: II

Type of course: Elective II

Prerequisite: Thermodynamics & Mechanical measurements

Rationale: The course is designed to provide the fundamental knowledge related to instruments used for energy systems

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks		Practical Marks				
				ESE (E)	PA (M)	PA (V)		PA (I)		
						ESE	OEP	PA	RP	
3	2#	2	5	70	30	20	10	10	10	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**MEASUREMENT CHARACTERISTICS** Instrument classification - characteristics of instruments – static and dynamic - experimental error analysis - systematic and random errors - statistical analysis – uncertainty - experimental planning and selection of measuring instruments - reliability of instruments	**07**	15%
2	**IINSTRUMENTATION AND MEASUREMENT** Measurement of thermo – physical properties, Temperature Measurement - Bimaterials, Pressure thermometers, Thermocouples, RTD, Thermisters, and Pyrometry, pyrometers- Calibration of Pressure measuring equipment.Flow Measurement- Variable head flow meters- Rota meters, Pitot Tube and manometer, Electromagnetic flow meters, Hot wire anemometers, Hot film transducers, Ultrasonic flow meters. Speed measurements, Leak detectors, Lux meters, Air pollution and Miscellaneous Measurements- Particulate sampling techniques, SO2, Combustion Products, Opacity , odour measurements - Measurement of liquid level, Humidity, O2,CO,CO2,NO_X,SO_x in flue gases- pH measurement, Electric Measuring instruments for measuring kVA, kW, PF, Hertz, kVAr, Amps and Volts in addition to harmonics	**17**	40%
3	**ADVANCE MEASUREMENT TECHNIQUES** Shadow graph – Schileren – Interferometer - Laser doppler anemometer - Hot wire anemometer, Heat flux sensors - Telemetry in measurement	**07**	15%
4	**DATA ACQUISITION AND PROCESSING** Multi Channel Data acquisition system – Architecture of data acquisition and computer control system - Compact Data loggers – Sensor based, Computerized data	**07**	15%

	systems - Micro – computer interfacing - Intelligent instruments in use.		
5	**CONTROL SYSTEMS** Introduction - controllability, observability, Continuous and discrete process Controllers – Control Mode – Two – Step mode – Proportional Mode – Derivative Mode – Integral Mode – PID Controllers – Programmable Logic Controllers - Microprocessor PC based control applications	**07**	15%

Reference Books:

1. Mechanical Measurements – Buck & Beckwith – Pearson
2. Measurement systems, Application and Design - E.O. Doebelin - McGraw-Hill 1990
3. Measurements and Instrumentation in Heat Engineering - Prebrashensky V., Volume I &II, MIR Publishers, 1980
4. Experimental Methods for Engineers - J.P. Holman - McGraw-Hill, 1994
5. Instrumentation Devices and Systems - Raman C S, Sharma G R, Mani V S N - TMH, New Delhi, 1983
6. Principles of Measurements and Instrumentation- Morris. A.S, - Prentice Hall of India, 1998.
7. Mechanical and Industrial Measurements – R.K. Jain – Khanna Publishers.
8. Manabendra Bhuyan, "Intelligent Instrumentation", CRC Press, 2009
9. Industrial Instrumentation and Control, Singh. S. K.,Tata McGraw-Hill, 2003
10. Instrumentation Devices and Systems, Rangan, Tata McGraw-Hill Education, 2001
11. The Measurement, Instrumentation, and Sensors Handbook, John G. Webster, Springer, 1999
12. Guide book for National Certificates Examination for Energy Managers and Energy Auditors, Bureau of Energy efficiency, New Delhi

Course Outcome:

After learning the course the students should be able to:

- Understand the basic concept of engineering experimentation.
- Acknowledge, access and analysis various experimental techniques.
- Carry out Error and uncertainty analysis of energy system.

List of Experiments:

1. Errors in Measurement and basic statistical sampling
2. fundamentals of temperature measurement by experimentation using
    a. Non-electrical methods: gas- and liquid-filled thermometers, bimetallic thermometers and temperature measuring strips
    b. Electric methods: Thermocouple, RTD, thermistor
3. Determining air humidity with a psychrometer
4. To study construction and working of Bourdon Tube pressure gauge and calibration of the same using Dead Weight Pressure tester
5. To measure flow rate through a pipe using flow measuring instruments
6. To measure basic electrical parameters using electrical instruments
7. To evaluate Flue gas/Exhaust gas analysis using combustion analyzer or Gas analyzer
8. Measurement of speed/RPM using contact type or non contact type instruments
9. Measurement of leaks of compressed air and other gases using Leak Detectors
10. To study P, PI and PID controller

Open Ended Problems:

1. Perform uncertainty analysis for measuring energy related parameters
2. Simulate P, PD, PI and PID controller for Energy system with appropriate software

Major Equipments:

1. Mercury, bimetallic and gas pressure thermometers
2. Exhaust gas analyzer/ Smoke meter and Data Acquisition System
3. Temperature sensors: Pt100, thermocouple type K, thermistor (NTC)
4. Psychrometer for humidity measurement
5. Dead Weight pressure tester
6. Rotameters, Pitot Tube and Manometer
7. Electrical Power analyzer
8. Leak Detectors
9. Lux meters

List of Open Source Software/learning website:
www.nptel.iitm.ac.in/courses/;

Review Presentation (RP): The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website.