GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Cryogenic Engineering

Subject Code : ME02074031

Subject Name : Low Temperature Measurement and Instrumentation

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

Prerequisite:	Basic knowledge of metrology, instrumentation and control engineering
Rationale:	The course is formulated to impart detailed study of low temperature measurement and instrumentation which can be utilized for the different cryogenic applications.

Course Outcome:

On successful completion of the course, the students will be able to

No	Course Outcomes	RBT level
1	Explain basic characteristics of instruments.	R/U
2	Demonstrate the basic knowledge of sensors and transducers and selection for cryogenic application.	R/U
3	Select and use different types of measurement instruments related with temperature, density, flow, volume etc. for cryogenic application	R/U/A
4	Interpret the noise and distortion from the data collected by the measuring instrumentation for accuracy.	R/U
5	Apply the basic skills for the different testing methods of the cryogenic systems.	R/U/A

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	30	20	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1	**Measuring Environment:** Significance of measurement & Instrumentation, Measuring systems--Transducers and Its Environment, The Nature of Measurement, Functional Stages of Measuring Systems, Measuring problems, the instrumentation problems, Static & dynamic, Characteristic of Instruments.	4	10
2	**Transducers:** Physical laws, Static characteristics -Linear Characteristics, Common Non Linearity & Its Effect, Linearization, Transducer types &	3	5

	modelling, Calibration, Errors in measurement, Selection of alternative test methods.		
3	**Sensors:** Electric Sensing devices, Magnetic sensors, Pressure sensors, Piezo-resistive sensors, Strain sensors, Temperature sensors, Fibre optics sensors, Ultra violet detectors, Chemical sensors.	3	5
4	**Level & Volume Measurement:** Practice of level measurement, Calibration of level measuring Instruments, Methods of providing full range level measurement, Methods providing short range detection.	4	10
5	**Density measurement :** Measurement of density using weight, Measurement of density using buoyancy, Measurement of density using hydrostatic head, Measurement of density using radiation	4	10
6	**Flow Measurement:** laminar flow and Turbulent flow, "Direct" flow measurement – Weighing ad volumetric Methods, Positive Displacement Methods, flow visualization, "carrier" systems "Indirect" flow measurement-square root law flow meters, Orifice and venture flow meters, Characteristics of Square root law flow meters, Pitot static tubes, Variable Area flow meters, Drag Force flow meters, Turbine flow meters, ultrasonic flow meter, Electromagnetic flow meter, Impeller flow meter, Thermal mass flow meter, Coriolis flow meter	5	10
7	**Pressure & Sound Measurement:** Pressure measurement, Vacuum measurement, Ultrasound measurement	8	20
8	**Thermometry for low temperature:** Gas thermometers, Vapour pressure thermometers, resistance thermometers, Thermocouples, 3He Melting Curve Thermometers, Noise thermometers, Superconducting Fixed point Thermometers, Nuclear Orientation thermometers, Mossbauer – Effect thermometers, Coulomb Blockade Thermometers, Osmotic pressure Thermometers, Infrared thermometers, Fibre– Optic Thermometers, Secondary thermometers.	8	20
9	**Noise & Distortion:** Electric Noise Measurement, Electric Distortion Measurement, Intermodulation measurement, Measurement of frequency, phase noise, and amplitude Noise.	3	5
10	**Non-destructive Testing:** Introduction, Visual examination, surface inspection methods, ultrasonics, Radiography, Underwater non-destructive testing, Developments, Certification of Personnel	3	5
	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	**40**	**40**	**0**	**0**	**0**

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. Measurement and Instrumentation in Engineering by Francis S. Tse
2. Survey of instrumentation and Measurement by Stephen A. Dyer
3. The measurement, Instrumentation, and Sensors, Handbook by John G. Webster
4. Low temperature physics & superconductivity by Christian Enss & Siegfried Hunklinge

Suggested Course Practical List:

1. Study of static and dynamic characteristics of the measuring instruments.
2. Study of different types of sensors & transducers.
3. Study and demonstration of level & volume measurement instruments.
4. Study of different methods of density measurement.
5. Study and analysis of flow measurement devices.
6. Study of pressure measuring devices.
7. Study and analysis of temperature measuring devices for low temperature.
8. Study of noise, frequency and distortion measurement.
9. Study of Non – destructive testing methods.

List of Laboratory/Learning Resources Required:

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 cryogenic measurements. They need to go through the same and prepare a review for the research papers.

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