SEMESTER S8

INDUSTRIAL INSTRUMENTATION

Course Code	PEMRT865	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs.30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To familiarize the students about various types of temperature, pressure, level, pH, density, viscosity, turbidity and conductivity measurement systems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Measurement of Temperature** Definitions and units- Standards of temperature – Thermometry and pyrometry- Thermocouples- Peltier effect- Thomson effect- Seebeck effect- Types of thermocouples (Chromel- copper. Chromel-alumel.copper- constantan, iron-constantan, platinum-rhodium- platinum) Cold junction compensation-Signal conditioning for thermocouple- Thermowells-– Thermopiles- Resistance thermometers- Principle of operation- Platinum RTD- Construction of RTDs- Lead compensation- 3wire method – 4 wire method- Thermistors – Quartz crystal sensors- Expansion thermometers- Bimetallic thermometers – Liquid filled thermometers- Gas filled thermometers- Vapor pressure thermometers- Pyrometry- Stefan Boltzmann's law- Black body radiation- Total radiation pyrometers-Optical radiation pyrometers-Disappearing filament photo electric pyrometer **Conductivity Measurement** Theory of operation, Two electrode cells, Four electrode measurement, electrodeless cell	9
2	**Measurement of Pressure** Introduction – units and definitions – standards of pressure – bellows type pressure sensors: motion balance and force balance pressure sensors, C-	9

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	bourdon, spiral and helical bourdon pressure sensors-Diaphragm or capsule type sensors: motion balance and force balance pressure sensors-Differential pressure elements: dry, force balance and dry, motion balance-Electronic pressure sensors: strain gauge, Capacitance, Potentiometric, Resonant wire, Piezoelectric, Magnetic and Optical transducers, High-Pressure sensors: Dead-Weight piston gauge, Bulk modulus cells, Manometers: U tube manometer – inclined manometer- ring balanced type manometer, Micromanometers. Vacuum pressure measuring elements- McLeod gauge – ionization gauges – Knudsen gauge – momentum transfer gauges- thermal conductivity gauges – Pirani's gauge.	
3	**Level measurement** Bubblers-Capacitance level sensors-Level switches; field effect and diaphragm switch, Differential pressure level detector: electronic d/p transmitters, displacer level detectors: torque tube displacer, interface measurement, Float level devices: float level switch ,Laser level detectors: triangular measurement, time-of-reflection measurement. Level gauges: Flat glass gauge, magnetic level gauge, remote reading gauge, Optical level devices; Light reflection, transmission and refraction. Radar level transmitters: time-of flight determination, radiation level sensor; continuous level measurement, Ultrasonic level measurement, Resistance tape level measurement, Rotating paddle switch	**9**
4	**Density Measurement** Displacement and float type, hydrometer, hydrostatic densitometers. Radiation densitometer, vibrating densitometer, gas densitometers. **pH measurement** Theory-Measurement electrodes -Fibre-optic pH measurement-digital pH meters- amplifiers for pH electrodes. **Viscosity measurement** Laboratory types: Rotational, Saybolt, Redwood, Falling ball and Capillary tube viscometers. Industrial types –Capillary type of viscosity measurements- Falling piston-float viscometer –Oscillating blade. **Turbidity measurement** Forward scattering type, scattered light detectors, backscatter turbidity analyzer	**9**

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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	*Internal Ex*	*Evaluate*	*Analyse*	*Total*
5	**15**	**10**	**10**	**40**

Criteria for Evaluation(Evaluate and Analyse): 20 marks
A micro project with a maximum of 3 students to design and implement a Soft Computing System or model should be given, and the evaluation should be evaluating Bloom's knowledge level. Micro-projects related to Instrumentation and Control Engineering with Society, Sustainability, and ethics in content should be given more weightage.

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	**Part B**	**Total**
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. Each question carries 9 marks. **(4x9 = 36 marks)**	**60**

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Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		**Bloom's Knowledge Level (KL)**
CO1	Explain working principle and measurement techniques of various types of temperature measuring and conductivity measuring instruments	**K2**
CO2	Discuss working principle and measurement techniques of various types of pressure measuring instruments.	**K2**
CO3	Explain working principle and measurement techniques of various types of level measuring instruments	**K2**
CO4	Describe working principle and measurement techniques of various types of density, pH, viscosity and turbidity measuring instruments.	**K2**
CO5	Design and develop an industrial instrumentation project	**K4**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											3
CO2	3											3
CO3	3											3
CO4	3											3
CO5	3	3	2	1	3				3	3	2	3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Instrument Engineers Handbook	Liptak.B.G	Chilton book.co.	Fourth,Volume 1, 2003
2	Instrument technology	Jones.E.B	Scientific Pub	Volume1,Edition3, 1974
3	Instrumentation Reference Book	Walt Boyes	Elsevier	4/e.2010
4	Applied Instrumentation in Process Industries	Andrew and Williams	Gulf publications	Volume 1,2.Edition2,1979

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Mechanical and Industrial Measurements	Jain.R.K	Khanna Publishers	Edition11,1995
2	Principles of Industrial Instrumentation	Patranabis.D	Tata McGraw Hill	Edition2,2008
3	Measurement System - Application and Design	Doebelin.E.O	McGraw hill	Edition4,1990

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Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/content/storage2/112/103/112103261/MP4/mod10lec28.mp4 https://archive.nptel.ac.in/content/storage2/112/103/112103261/MP4/mod10lec29.mp4 https://archive.nptel.ac.in/content/storage2/112/103/112103261/MP4/mod10lec27.mp4
2	https://archive.nptel.ac.in/content/storage2/112/103/112103261/MP4/mod08lec21.mp4 https://archive.nptel.ac.in/content/storage2/112/103/112103261/MP4/mod08lec22.mp4 https://archive.nptel.ac.in/content/storage2/112/103/112103261/MP4/mod08lec23.mp4
3	https://archive.nptel.ac.in/content/storage/103/105/103105130/MP4/mod10lec46.mp4 https://archive.nptel.ac.in/content/storage/103/105/103105130/MP4/mod10lec47.mp4 https://archive.nptel.ac.in/content/storage/103/105/103105130/MP4/mod10lec48.mp4 https://archive.nptel.ac.in/content/storage/103/105/103105130/MP4/mod10lec49.mp4
4	https://archive.nptel.ac.in/content/storage/103/105/103105130/MP4/mod11lec54.mp4 https://archive.nptel.ac.in/content/storage/103/105/103105130/MP4/mod11lec55.mp4

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