ICE 2252: INDUSTRIAL INSTRUMENTATION [3 0 0 3]

Hours/ week: 3L **Number of credits: 3**

Temperature Measurement: Bulb thermometer, bimetallic thermometers. Temperature measuring circuits using RTD, Thermistors and thermocouple. Solid-state temperature sensors, radiation methods- black body, tomography, fluorescence, optical pyrometers.
(06 hrs)

Pressure Measurement: Manometers, Elastic types, Bell gauges, Electrical types, Differential Pressure transmitters, Dead weight Pressure gauges. Low Pressure Measurement: McLeod gauge, Knudsen gauge, Pirani gauge, Thermal conductivity gauges, Ionization gauges.
(07 hrs)

Flow Measurement: basics of flow, classification, head type flow meters-Pitot tubes, orifice meters, venturi meter, variable area flowmeters, Anemometers, electromagnetic flowmeter, ultrasonic flowmeters, Doppler flowmeters, cross-correlation flowmeters, and vortex flowmeters. Measurement of mass flowrate: Radiation, angular momentum, impeller, turbine, constant torque hysteresis clutch, twin turbine, coriolis, gyroscopic. Target flowmeters, V-cone flowmeters. **(09 hr.)**

Multiphase flow meters: Introduction to Multiphase Flow, Types of Multiphase Flows, Flow Patterns and Flow-Pattern Maps, Multiphase Flow Metering Trends, Categories of Instruments, Key Factors for the Selection of Multiphase Flow Metering, Momentum Flux Measurement, Mass Flux Measurement, Elemental Analysis, Issues Related to Metering Wet Gas, Issues Related to Metering Heavy Oils, Non-conventional multiphase flow metering - Choke Valves, Virtual Meteringtion concepts**.**
(06 hrs)

Measurement of Speed, velocity and Acceleration: Tachometers - Mechanical, Electric, Contact less, Frequency, Ignition, Stroboscopic tachometers, potential and variable reluctance accelerometer.
(04 hrs)

Level Measurement: Direct methods, indirect methods, Electrical conductivity, Capacitive, Ultrasonic, Nucleonic methods, Level measurement by capacitance probes, solid-state level measurement. **(04 hrs)**

References:

1. Patranabis D, *Principles of Industrial Instrumentation,* TMH, (3e), 2005.
2. Liptak B. G, *Handbook of Process Measurement and Analysis,* Chilton Book Company, (3e), 1995.
3. Gioia Falcone, Geoffrey Hewitt, C Alimonti, *Multiphase Flow Metering- Principles and Applications*, Elsevier Publication, 2009.