Course code	Course Name	L-T-P-Credits	Year of Introduction
CH403	PROCESS INSTRUMENTATION	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To study about different instruments and techniques used in chemical industry for measurement of various process variables and understand the theory behind them.
- To understand the range of applicability and characteristics of these instruments.

Syllabus

Applications of measurement instrumentation, functional description of measuring instruments, performance characteristics of instruments. Temperature measurement; Thermal expansion methods, thermoelectric sensors, electrical resistance sensors, radiation thermometer. Pressure measurement; Measurement of low pressure and high-pressure by different methods. Flow measurement of fluids and solids. Level measurement in open vessels; Humidity measurement; Moisture content measurement using thermal method. Composition analysis; liquids using spectroscopic analysis, solids by X-Ray diffraction and Gas analysis by thermal conductivity, polarography & chromatography. developments of P&I, diagram for flow systems, level, PH control temp control, Heat exchangers, Distillation column, reaction system etc.

Expected Outcome

- On completion of this course the students will be able to explain and sketch various measuring instruments used for pressure, temperature, flow, level and composition used in chemical industry and their applicability, static and dynamic characteristics

Text Book:

- Jain R K, Mechanical and Industrial measurements, Khanna publishers.

References:

1. Ernest O Doeblin, Measurement systems, Application and Design, McGraw Hill.
2. Patranabis D, Principles of Industrial Instrumentation, Tata- McGraw Hill.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction-definition of instrumentation-concept of an instrument Basic principles of measurements - Classification methods of measurements - Direct and indirect measurements, various elements in a measuring instrument - Sensing element, transducing element manipulating element and functioning element etc- Principles of working with a suitable example, static and dynamic characteristics of measuring instrument, accuracy, reproducibility, sensitivity, static error, dead zone, dynamic error, fidelity lag, speed of response etc.	8	15%
II	Temperature measurements, temperature scales, basic principles and working of thermometers, mercury in glass thermometers, bimetallic thermometers resistance	6	15%

	thermometers, thermocouples, optical pyrometers, radiation pyrometers, ranges of different types of temperature measuring instruments, sources of errors and precautions to be taken in temperature measurements.		
FIRST INTERNAL EXAMINATION			
III	Pressure measurement - Principles of working of manometers, various types of manometers - McLeod gauge, Knudsen gauge, radioactive vacuum gauge, Bourdon gauge, bellows, diaphragm, electrical pressure transducers, piezoelectric manometers, thermal conductivity gauges- ionization gauge high pressure measuring instruments. Level measurement-direct type and indirect type. Differential pressure method for pressurized vessels. Conductivity meters. Solid level detectors.	8	20%
IV	Flow measurements - Liquid and gas flow measurements, ways of measuring liquids and gas flow, direct volume measurements, quantity meters, gas meters, magnetic flow meters, heat input flow meters, elbow flow meters, impact meters, variable area meters, rotameters, cylinder and piston type - Liquid flow velocity, turbine meters, open channel flow measurements, wires notches, head meters, pitot tube, orifice meters venturi meters, theory and working flow measurements, electrical transducers, turbine type flow meters strain gauge flow meters mass flow meter, measuring flow of dry materials.	8	20%
SECOND INTERNAL EXAMINATION			
V	Moisture content and humidity definition, moisture content determination by thermal drying. Instruments for measuring humidity like hygrometer, psychrometer, dew point apparatus. pH measurement using calomel electrode. thermo gravimetric analysis	6	15%
VI	Composition analysis using spectroscopic methods like absorption, emission and mass spectrometers. Analysis of solids by X-ray diffraction. Gas analysis by thermal conductivity, polarography & chromatography. Developments of P&I, diagram for flow systems, level, PH control temp control, Heat exchangers, Distillation column, reaction system etc	6	15%
END SEMESTEREXAMINATION			

Question Paper Pattern

Maximum marks : 100 Exam Duration ; 3 hours

Part A: There shall be **Three questions** uniformly covering Modules 1 and 2, each carrying 15 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in one main question with a total of 15 marks for all the subdivisions put together. (2 x15= 30 Marks)

Part B: There shall be **Three questions** uniformly covering Modules 3 and 4, each carrying 20 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in one main question with a total of 20 marks for all the subdivisions put together. (2 x20= 40 Marks)

Part C: There shall be **Three questions** uniformly covering Modules 5 and 6, each carrying 15 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in one main question with a total of 15 marks for all the subdivisions put together. (2 x15= 30 Marks)