

Industrial Instrumentation - II

1. MEASUREMENT OF VISCOSITY, HUMIDITY AND MOISTURE

Viscosity terms - say bolt viscometer – rotameter type viscometer – industrial consistency meters – humidity terms – dry and wet bulb psychrometers – hot wire electrode type hygrometer – dew cell – electrolysis type hygrometer – commercial type dew point meter – moisture terms – different methods of moisture measurement – moisture measurement in granular materials, solid penetrable materials like wood, web type material.

2. MECHANICAL TYPE FLOW METERS

Theory of fixed restriction variable head type flow meters – orifice plate – venturi tube – flow nozzle – dall tube – installation of head flow meters – piping arrangement for different fluids – pilot tube.

3. QUANTITY METERS, AREA FLOW METERS AND MASS FLOW METERS

Positive displacement flow meters – constructional details and theory of operation of mutating disc, reciprocation piston, oval gear and helix type flow meters – inferential meter – turbine flow meter – rota meter – theory and installation – angular momentum mass flow meter - coriolis mass flow meters – thermal mass flow meter – volume flow meter plus density measurement – calibration of flow meters – dynamic weighing method.

4. ELECTRICAL TYPE FLOW METER

Principle and constructional details of electromagnetic flow meter – different types of excitation – schemes used – different types of ultrasonic flow meters – laser doppler anemometer systems – rortex shedding flow meter – target flow meter – solid flow rate measurement – guidelines for selection of flow meter.

5. LEVEL MEASUREMENT

Gauge glass technique coupled with photo electric readout system – float type level indication – different schemes – level switches level measurement using displacer and torque tube – bubbler system. Boiler drum level measurement – differential pressure method – hydra step systems – electrical types of level gauges using resistance, capacitance, nuclear radiation and ultrasonic sensors.

Modern Control Systems

1. STATE VARIABLE ANALYSIS AND DESIGN

State models – solution of state equations – controllability and observability- pole assignment by state feedback – full and reduced order observers.

2. NONLINEAR SYSTEMS

Common types of non-linear phenomena – Linearisation – singular points – phase plane method – construction of phase trajectories – system analysis by phase plane method – describing function method – describing function of non-linear elements.

3. STABILITY ANALYSIS OF NON LINEAR SYSTEM

Stability analysis by describing function method – jump resonance – Liapunov's and Popv's stability criteria.

4. OPTIMAL CONTROL

Problem formulation – necessary conditions of optimality – state regulator problem – Matrix Riccati equation – infinite time regulator problem – output regulator and tracking problems – Pontryagin's minimum principles – time - optimal control problem.

5. ADAPTIVE CONTROL

Classification – MRAC systems – Different configuration, classification, mathematical description – direct and indirect MRAC – self tuning regulator – different approach to self tuning, recursive parameter estimation, implicit and explicit STR.

Process Control

1. INTRODUCTION

Need for process control – mathematical model of first order level, pressure and thermal processes – higher order process – interacting and non-interacting systems – continuous and batch process – self-regulation – servo and regulator operation.

2. CONTROL ACTIONS AND CONTROLLERS

Basic control actions – characteristics of on-off, proportional, single-speed floating, integral and derivative control modes – P+I, P+D and P+I+D control modes pneumatic and electronic controllers to realize various control actions.

3. OPTIMUM CONTROLLER SETTINGS

Evaluation criteria – IAE, ISE, ITAE and $\frac{1}{4}$ decay ratio – determination of optimum settings for mathematically described processes using time response and frequency response – tuning – process reaction curve method – Ziegler Nichols method – damped oscillation method.

4. MULTILoop CONTROL

Feed forward control – ratio control – cascade control – inferential control – split range control – introduction to multivariable control – examples from distillation column and boiler systems.

5. FINAL CONTROL ELEMENT

I/P converter – pneumatic and electric actuators – valve positioner – control valves – characteristics of control valves – inherent and installed characteristics – valve body – commercial valve bodies – control valve sizing – cavitation and flashing – selection criteria

Analytical Instruments

1. PH CONDUCTIVITY & DISSOLVED COMPONENT ANALYSER

Sampling systems – ion selective electrodes – conductivity meters – pH meters - dissolved oxygen analyser – sodium analyser – silica analyser – moisture measurement.

2. GAS ANALYSER

Oxygen analyser – CO monitor – Nox analyser – H₂S analyser – dust and smoke measurement-thermal conductivity type – thermal analyser – industrial analysers.

3. CHROMATOGRAPHY

Gas chromatography – liquid chromatography – principles, types and applications – high-pressure liquid chromatography – detectors.

4. SPECTRO PHOTOMETERS

Spectral methods of analysis – Beer's law UV – visible spectrophotometers – single beam and double beam instruments – source and detectors – IR spectrophotometers – sources and detectors – FTIR spectrometers – atomic absorption spectrophotometer – flame emission spectrophotometers – sources of flame photometry – applications.

5. NUCLEAR MAGNETIC RESONANCE AND RADIATION TECHNIQUES

NMR – basic principle – NMR spectrometers – applications – introduction to mass spectrophotometers – nuclear radiation detectors – GM counter – proportional counter – solid state detectors – introduction – to x-ray spectroscopy.

Industrial Instrumentation Laboratory

- Discharge coefficient of orifice plate
- Calibration of pressure gauge
- Calibration of thermocouple
- Calibration of flowmeter
- Torque measurement
- Viscosity measurement
- Vacuum pressure measurement
- Level measurement using d/p transmitter
- UV – Visible spectrophotometer
- IR spectrophotometer
- pH meter standardisation and measurement of pH values of solutions
- Conductivity meter calibration and measurements of conductivity of test solutions

Process Control Laboratory

- Operation of interacting and non-interacting systems
- Responses of different order processes with and without transportation lag
- Response of on-off controller
- Response of P+I+D controller
- Characteristics of control valve with and without positioner
- Operation of on-off controlled thermal process
- Closed loop response of flow control loop
- Closed loop response of level control loop
- Closed loop response of temperature control loop
- Closed loop response of pressure control loop

- Tuning of controllers
- Study of complex control system (ratio / cascade / feed forward)