
Unit-2: Measurements and Signal Conditioning: Signal Conditioning for Voltage and Current measurements, Ac and DC bridges, Resistance, Capacitance and inductor measurements, power and energy measurements, frequency measurement, time interval measurement, fibre-optic sensors, power measurements, measurement of fibre system loss, specific gravity, viscosity, turbidity, consistency, humidity and moisture measurement, pH and conductivity measurement. Need of processing signals digitally, microcontrollers and signal processing.

Unit-3 Instrumental methods of Analysis Electromagnetic spectrum, Laws of photometry: Lambert’s and Beers law, Spectrophotometers: UV, VIS, IR, FT IR instrumentation, Sources and detectors for UV, Visible and IR radiations, Prisms and Gratings, mountings for dispersive devices, Raman instrumentation, Electron paramagnetic resonance, Nuclear Magnetic Resonance, FT-NMR, Mass Spectrometer, GC-MS instrumentation, gas chromatography, nuclear instrumentation: Geiger Muller Counter, ionization Gauge, X-ray based spectroscopic methods.

Unit-4: Digital Processing of Signals: Signal conditioning and digital processing of signals from sensors and transducers, signal decomposition, sampled signals, sampling theorem, pulse transfer function, linearization and interpolation. Polynomial fitting in data obtained from transducers e.g. thermocouple linearization. Signal estimation methods: least square method, Maximum likelihood (ML) estimation, Mean square estimation, linear prediction and data analysis, Eigen values and eigenvectors, Singular valued decomposition, Correlation analysis, Discrete Fourier Transform and spectrum
estimation, Fourier filtering, the concept of inverse filtering, Discrete time Kalman filtering, Fourier analysis of nonstationary signals, Short Time Fourier Transform, and Discrete Wavelet Transform. (15 hours)

References/Additional Readings:

Text Books:

13. Vivek Sahai and Vikas Bist, ”Linear Algebra”, Narosa, 2002
Instrumentation Engineering  Paper No: III

Biomedical Instrumentation

Teaching Scheme
Theory: 3 hours/week
Tutorials: 1hrs/week

Examination Scheme
Theory paper 80 marks
TW: 20 marks

Unit-1: Biopotential Measurement: Electrode-Electrolyte interface, half-cell potential, Polarization- polarisable and nonpolarizable electrodes, Ag/AgCl electrodes, Electrode circuit model; motion artifact. Body Surface recording electrodes for ECG, EMG, and EEG. Internal Electrodesneedle and wire electrodes. Micro electrodes- metal microelectrodes, Electrical properties of microelectrodes. Electrodes for electric stimulation of tissue, Selection & specifications for the bio transducers to measure parameters, Biosensors (15 hours)


Unit-3: Central Nervous System and signal measurements: Brain & its parts, different waves from different parts of the brain, brain stem, cranium nerves, structure of neuron, Neuro muscular transmission, Electroencephalography, Evoked Response, EEG amplifier, Biofeedback. Classification of muscles: Muscle contraction mechanism, myoelectric voltages, Electromyography (EMG). Functional Imaging of brain using magnetic resonance imaging. (15 hours)

Unit-4: Biomedical Imaging: X-Ray based methods: X Ray properties, Generation of X-rays, X- Ray machine, image intensifier, limitations and advantages of x-ray imaging, CT Scanning, basic CT scanning system. Image reconstruction and processing for CT images. Magnetic Resonance Imaging (MRI) and Spectroscopy (MRSI): Basics of MRI,
image reconstruction, image artifacts, magnetic resonance spectroscopic imaging, signal and image processing approaches in MRI. Radionuclide Imaging: Rectilinear Scanner, Scintillation Camera, Positron Emission Tomography, Single Photon Emission Computed Tomography, Ultrasound Imaging: Echocardiography, Thermography.

(15 hours)

References/Additional Readings:

Text Books:
2. Carr & Brown “Introduction To Biomedical Equipment Technology”, 4th e/d, PHI, 2005
4. Tompkins Willis“ Biomedical Digital Signal Processing”, PHI Learning

Reference Books:
Advanced Process Control & Instrumentation

Teaching Scheme
Theory: 3 hours/week
Tutorials: 1hrs/week

Unit 1: Process characteristics: Background of process control, Process Variables types and selection criteria, degree of freedom, Period of Oscillation in Loop and Damping, Characteristics of physical System: Resistance, Capacitive and Combination of both. Elements of Process Dynamics, Types of processes- Dead time, Single/multicapacity, self-Regulating/non self regulating, Interacting/noninteracting, Linear/non linear, and Selection of control action for them. Study of Liquid Processes, Gas Processes, Flow Processes, Thermal Processes in respect to above concepts

Unit 2: Control Loops: Steady state gain, Process gain, Valve gain, Process time constant, Variable time Constant, Transmitter gain, linearising equal percentage valve, Variable pressure drop. Analysis of Flow Control, Pressure Control, Liquid level Control, Temperature control, SLPC-features, faceplate, functions, MLPC-features, faceplate, functions, SLPC and MLPC comparison. Concept of Multivariable Control: Interactions and it’s effects, Modeling and transfer functions, Influence of Interaction on the possibility of feedback control, important effects on Multivariable system behavior Relative Gain Array, effect of Interaction on stability and Multiloop Control system.

Unit 3: Controllers:

Unit 4: MultiLoop & Nonlinear Systems:
Cascade control, Feed forward control, feedback-feedforward control, Ratio control, Selective Control, Split range control- Basic principles, Design Criteria, Performance, Controller Algorithm and Tuning, Implementation issues, Examples and any special features of the individual loop and industrial applications. Nonlinear Elements in Loop: Limiters, Dead Zones, Backlash, Dead Band Velocity Limiting, Negative Resistance, Improvement in nonlinear process performance through: Deterministic Control Loop Calculations, Calculations of the measured variable, final control element selection, cascade control design, Real time implementation issues
References/Additional Readings:

Text Books:


Reference Books: