Instrumentation Engineering Paper No: II,

Instrumentation & Measurement Technology

Teaching Scheme	Examination Scheme
Theory 4 hrs/week	Th. Paper 100 marks

Unit-1: Instrumentation and Measurement Systems: Measurement of physical quantities, units and standards, errors and uncertainties, static and dynamic characteristics of instruments, time constant and dead time, modeling of instrumentation systems, Calibration. Measurements: thermoelectric, piezoelectric, piezoresistive measurements, electromechanical transducers, Measurement of flow, level, temperature, pressure; mechanical measurements: strain, force, torque and vibrations. Sound and noise measurements. (15 hours)

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.

(15 hours)

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,

(15 hours)

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:

1. P. P. L. Regtien," Measurement Science for Engineers", 1st e/d, Kogan Page Science, 2005.
2. D. Patranabis," *Principles of Electronic Instrumentation*", " Principles of Electronic Instrumentation", Prentice Hall of India, 2008
3. Nakra and Chaudhry," *Instrumentation Measurement and Analysis*", 2nd e/d, Tata McGraw Hill, 2007
4. Albert D. Helfrick and William D. Cooper," Modern Electronic ,"*Instrumentation and Measurement techniques*", Pearson Prentice Hall, *1st* e/d, 2008
5. C. S. Rangan and G. R. Sarma V. S. V. Mani," *Instrumentation Devices and Systems*", 2nd e/d, Tata McGraw, 2007
6. Willard H. L., Merrit J. A. Dean F. A., Settla Jr. "*Instrumental Methods of Analysis*" 7th e/d, Wadsworth Publishing CO.
7. Ewing G. W. ,"*Instrumental Methods of Chemical Analysis*". McGraw-Hill Book Co., Inc., New York-Toronto-London 1960.
8. R. S. Khandpur," *Handbook of Analytical Instruments*", 2nd e/d, Tata McGraw Hill, 2008
9. A. Oppenheim and R. Schafer," *Discrete Time Signal Processing*", Prentice Hall, 1999
10. Proakis and Manolakis,"*Digital Signal Processing*", 4th e/d, Prentice Hall, 2007
11. Stéphane Mallat_ "A Wavelet Tour of Signal Processing", 2nd e/d, Academic Press, 1999
12. David F. Walnut," An introduction to Wavelet Analysis", Birkhäuser, (1st Indian reprint), 2002
13. Vivek Sahai and Vikas Bist, "Linear Algebra", Narosa, 2002
14. H. Vincet Poor, "An Introduction to Signal Detection and Estimation "2nd e/d, Springer 1994
15. Frank L. Lewis, " Optimal Estimation", John Wiley and Sons, 1986

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-2: Biosignals and System : Heart Structure, Cardiac Cycle, ECG Theory, ECG Electrodes, Electrocardiograph, Vectorcardiograph Analog Signal Processing of Biosignals, Amplifiers, Transient Protection, Interference Reduction, Movement Artifact Circuits, Active Filters, Rate Measurement, Averaging and Integrator Circuits, Transient Protection Circuits. Cardiovascular Measurements: Heart Sounds, Phonocardiography, Blood Pressure Measurement (Invasive and Noninvasive), Blood Flow meter. Laser applications in Medicine: Types of Lasers, Properties of Laser, Interaction of Lasers with Tissues -Thermal and Non thermal, Basic Endoscopes system & its characteristics, Laser Applications in ophthalmology- Diabetic Retinopathy, Glaucoma and Retinal hole and detachment treatment.

(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:

1. Vander, Sherman," *Human Physiology- The Mechanism of Body Function*", TMH Ed.1981
2. Carr & Brown "*Introduction To Biomedical Equipment Technology",* 4th e/d, PHI, 2005
3. Leslie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer, "*Biomedical Instrumentation and Measurements*" Pearson Prentice Hall, 2rd e/d, 2008
4. Tompkins Willis" *Biomedical Digital Signal Processing*", PHI Learning
5. Arumugam," *Biomedical Instrumentation*", Anuradha Publishers, 1994
6. Ronald Pitts Crick, Pang Khaw, "*Text book of clinical Ophthalmology*", 2nd e/d, World Scientific publication
7. John G. Webster and John W. Clark "Medical Instrumentation", Wiley, 1995

Reference Books:

1. R. S. Khandpur," *Handbook of Biomedical Instrumentation*", 2nd e/d, Tata McGraw Hill, 2007
2. Jacob Klime ,"*Handbook of Biomedical Engineering*" Academic Press, 2008
3. Joseph D. Bronzino, "*The Biomedical Engineering Handbook"*, Vol. 2, CRC Press, 2000

Instrumentation Engineering: Paper-III

Advanced Process Control & Instrumentation

Teaching Scheme	Examination Scheme
Theory: 3 hours/week	Theory paper 80 marks
Tutorials: 1hrs/week	TW: 20 marks

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

(15 hours)

Unit2: 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 o the possibility of feedback control, important effects on Multivariable system behavior Relative Gain Array, effect of Interaction on stability and Multiloop Control system.

(15 hours)

Unit 3: Controllers:

Basic principles, Elements of the feedback Loop, Block Diagram, Control Performance, Measures for Common Input Changes, Selection of Variables for Control Approach to Process Control. Factors in Controller Tuning, Determining Tuning Constants for better Control Performance, Model Based controllers: Internal Model control, Smith predictor, optimal controller, Model Predictive controller, Dynamic matrix controller (DMC). Self Tunning Controller. Fuzzy logic systems and Fuzzy controllers, Introduction, Basic Concepts of Fuzzy Logic, Fuzzy Sets, Fuzzy Relation, Fuzzy Graphs, and Fuzzy Arithmetic, Fuzzy If-Then Rules, Fuzzy Logic Applications, Neuro-FuzzyArtificial Neural networks and ANN controller (15 hours)

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 (15 hours)

References/Additional Readings:

Text Books:

1. D.R. Coughanour, ' *Process Systems analysis and Control'*, Mc-Graw Hill, 2nd Edition, 1991.
2. F. G. Shinskey, " *Process Control Systems: Application*", McGraw Hill, Ney York, 1967
3. D. E. Seborg, T. F. Edger, and D. A. Millichamp, John Wiley and Sons '*Process Dynamics and Control'*, 2nd e/d, 2004
4. P. Joji," *Pneumatic Controls*", 1st e/d, Wiley India Edition, 2008
5. W. Bolton, "*Mechatronics",* 3rd e/d, Pearson Education, 2007,
6. M. Gopal, " Control Systems", 2nd e/d, Tata McGraw Hill, 2007
7. Ogata K., "Discrete Time Control Systems", 2nd e/d, Prentice Hall, 1995
8. D. Patranabis," *Principles of Industrial instrumentation*", 2nd e/d, Tata McGraw Hill, 2007

Reference Books:

1. C.A. Smith and A. B. Corripio, John Wiley and Sons "*Principle and Practice of Automatic Process Control*", 1985.
2. W. L. Luyben "*Process Modeling Simulation and Control for Chemical Engineers*" , McGraw Hill, 2nd e/d, 1990.
3. Stephanopoulous ," *Chemical Process Control – Theory and Practice* " , Prentice Hall of India Ltd., 1984
1. Bela G. Liptak, "*Instrumentation Engineers Handbook*", Vol. I-III, Chilton Book Company, 1988
2. Bela G. Liptak, " *Handbook of Process Control*", 3rd e/d, Butterworth Heinemann ltd.