Department of Instrumentation Engineering

M.Tech , INSTRUMENTATION ENGINEERING (I E)

Course Structure and Scheme of Evaluation (Semester-wise)

WEF 2015-16 Admitted Batch

Semester – I

S.No	Code	Subject	Credits	Hrs./Week			Evaluation (Marks)		
				L	T	P	Internal	External	Total
1	IE 1.1	Transducers and Measurement Techniques	4	4	0		30	70	100
2	IE 1.2	Advanced Process Control	4	4	0		30	70	100
3	IE 1.3	Analytical Instrumentation	4	4	0		30	70	100
4	IE 1.4	Digital Signal Processing	4	4	0		30	70	100
5	IE 1.5	Elective- I	4	4	0		30	70	100
6	IE 1.6	**Elective - II**	4	4	0		30	70	100
7	IE 1.7	Industrial Instrumentation lab	2			3	50	50	100
8	IE1.8	Seminar	2			3	50	50	100
Total			28	24		6	280	520	800

Elective-I

(a) Fiber Optics and Laser Instrumentation
(b) Fuzzy Logic and Neural Networks and Control
(c) Environmental Analysis Instrumentation

Elective – II

(a) Bio-medical Instrumentation
(b) Electronic Instrumentation
(c) Digital Instrumentation

Semester – II

S.No	Code	Subject	Credits	Hrs./Week			Evaluation (Marks)		
				L	T	P	Internal	External	Total
1	IE 2.1	Microcontrollers and Embedded Systems	4	4	0		30	70	100
2	IE 2.2	Virtual Instrumentation	4	4	0		30	70	100
3	IE 2.3	Computer Control of Process	4	4	0		30	70	100
4	IE 2.4	Power plant Instrumentation	4	4	0		30	70	100
5	IE 2.5	Elective- III	4	4	0		30	70	100
6	IE 2.6	Elective- IV	4	4	0		30	70	100
7	IE 2.7	Process Control Lab	2			3	50	50	100
8	IE 2.8	Seminar	2			3	50	50	100
Total			28	24		6	280	520	800

Elective-III

(a) Industrial Communication Systems
(b) Robotics and Automation
(c) VLSI Design

Elective-IV

(a) Advanced Sensors
(b) Piping and Instrumentation
(c) Steel plant Instrumentation

Semester – III

S.No	Code	Subject	Credits	Marks
1	**IE 3.1**	**Minor Project**	**10**	**100**

Semester – IV

S.No	Code	Subject	Credits	Marks
1	**IE .1**	Project Dissertation	**14**	**100**

I. E - 1.1 TRANSDUCERS AND MEASUREMENT TECHNIQUES

Transducer fundamentals, Classification of transducers, General transducer characteristics, Resistance- Capacitance, Inductance- reluctance- Piezoelectric Magnetostrictive- Hall effect- Photo electric type of transducers and their applications. Smart Transducers- Transducers for Bio-Medical applications- tactile sensors-MEMS and their applications.

Measurement of displacement-velocity-acceleration-force - torque and vibration by strain gauges, accelerometers and tachometers etc. Measurement of weight -Pneumatic, hydraulic and electrical load cells. Pressure measurement: Elastic types-Resistive- Capacitive and Inductive pressure pickups. Piezoelectric- Piezoresistive types. Vacuum measurement: McLeod gauges-Ionization gauges-Alphatron gauge. High Pressure measurement. Force balance and Motion balance type transmitters – P/I and I/P converters. IC pressure sensors and calibration of pressure measuring devices.

Temperatuture measurement: Filled-in thermal systems- Bimetallic thermometers - RTD, Thermistor, Thermocouple - Radiation and Optical pyrometers - Digital IC thermometers - Accuracy, errors and compensation.

Flow measurement: Head flow meters- types, Area flow meters– Rotameter bypass rotameter-Turbine meter. Electromagnetic flowmeter – Principle – DC AC and pulsed type. Ultrasonic flow meters – Principles – transit time – Doppler shift – beam deflection– Cross correlation flowmeters. Vortex flowmeters -Coriolis flowmeters- Solid flow measurement- conveyor belt type. Installation and Calibration procedures of various flowmeters

Level Measurement: Conductive and Capacitive methods –Ultrasonic, Microwave and RADAR level sensors - Solid level measurement by Paddlers method. Capacitance method for powder level measurement. Density, Viscosity and PH measurement.

REFERENCE BOOKS

1. Patranabis.D., “Principles of Industrial Instrumentation,” McGraw-Hill Publishing Company, 1984.
2. D. V.S.Murthy, Transducers in instrumentation, Prentice Hall, 1995.
3. Ernest. O. E. Doebelin, “Measurement Systems”, McGraw-Hill publishing company, 1990.
4. James.W.Dally, “Instrumentation for Engineering Measurement”, John Wiley & Sons, Inc., 1993
5. Bela G. Liptak, Process measurement and Analysis-Instrument Engineers’ Handbook- Vol. I Third edition- Butterworth Heinemann publishing company

I. E -1.2 ADVANCED PROCESS CONTROL

Review of systems: Review of first and higher order systems, closed and open loop response. Response to step, impulse and sinusoidal disturbances. Control valve types-linear, equal percentage and quick opening valve. Design of valves. Transient response. Block diagrams.

Stability Analysis: Frequency response, design of control system, controller tuning and process identification. Ziegler-Nichols and Cohen-Coon tuning methods, Bode-Nyquist Plots -Process modeling.

Special Control Techniques: Advanced control techniques, cascade, ratio, feed forward, adaptive control, selective controls, computing relays, simple alarms, Smith predictor, internal model control, theoretical analysis of complex processes.

Multivariable Control Analysis of multivariable systems, Interaction, examples of storage tanks. Review of matrix algebra, Bristol arrays, Niederlinski index - Tuning of multivariable controllers.

Sample Data Controllers: Basic review of Z transforms, Response of discrete systems to various inputs. Open and closed loop response to step, impulse and sinusoidal inputs, closed loop response of discrete systems. Design of digital controllers.

REFERENCE BOOKS

1 D.R. Coughanour, 'Process Systems analysis and Control', Mc.Graw Hill, II Edition, 1991.

2. D.E.Seborg, T.F.Edger, and D.A.Millichamp, 'Process Dynamics and Control', John Wiley and Sons, II Edition, 2004.

3 C.A.Smith and A.B.Corripio, 'Principle and Practice of Automatic Process Control', John Wiley and Sons, 1985.

4 W.L.Luyben, 'Process Modelling Simulation and Control for Chemical Engineers', McGraw Hill, II Edition, 1990.

5 Stephanopoulos,. 'Chemical Process Control – Theory and Practice', Prentice Hall of India Ltd.,.1984

I. E - 1.3ANALYTICAL INSTRUMENTATION

Design, construction and application of UV, Visible and IR spectroscopy, X-ray absorption and fluorescence spectrometry- X-ray diffraction methods of analysis – energy dispersion analysis — Radiation sources - α, β, γ, sources – detectors –Geiger Mueller counter – proportional counters – Ionization chamber, scintillation counter and Solid State Detectors.

Nuclear Magnetic Resonance (NMR) spectroscopy – Principles of operation and constructional details of NMR spectrophotometer – Broad band spectrometer – Applications. Principles and applications of Electron Spin Resonance (ESR) spectrometer. Mass spectrometry – principle of operation – Co-analyzer – Commercial mass spectrometer.

Flue Gas and Water Analyzers: Flue gas analysis is using thermal conductivity principle – Cathetometer – Oxygen analyzer using paramagnetic, depolarization principles – Zirconium oxide cells – CO_X,SO_X, NO_X Measurement-combustibles analyzer – Different types of Dust and Smoke meters – Visible Emission Monitor – Remote sensing laser instruments – Water purity meter – Conductivity meters – Steam purity measurement – Dissolved oxygen meter using polarographic principle – Sodium analyzer – Silica analyzer.

Gas Chromatography: Basic Principle and construction –Different types of columns – Detectors – Recorders and associated equipment. Industrial and laboratory applications of gas Chromatography.
Liquid Chromatography: Salient features of liquid chromatography Ionizing electrodes - pH and ion sensitive electrodes, ISFET and chemical sensors. Applications of high precision liquid chromatography. Current
trends in analysis instrumentation.

REFERENCE BOOKS

1. D.A. Skoog and D.M. West, Principles of Instrumental Analysis, Holt Saunders's publication, Philadelphian, 1980.
2. C.K. Mann, T.J. Vichers and W.H. Gulick, Instrumental Analysis, Harper and Row Publishers, New York, 1974.
3. H.A. Willard, L L Merrit and J.A. Dean, Instrumental Method of Analysis D. Van Nostrand Co., New York, 1958.
4. E.B.Jones, Instrument Technology, Vol.II, Instruments, Butterworth Scientific Pub., London, 1956.
5. B.G. Liptak, Instrumentation in Process Industries Suppl. To Vol.I& III Chilton Book Co., 1974.

I. E - 1.4 DIGITAL SIGNAL PROCESSING

Discrete time signals – Sequences – Stability and Causality – Frequency domain Representation of Discrete time Systems and Signals – Two-dimensional sequences and systems – Z-transform – Z-Transform theorems and properties – Two–dimensional Z-transform. Structures for discrete time system - Direct, cascade and parallel forms – Lattice structure.

Representation of periodic sequences – The discrete Fourier series – Properties of the discrete Fourier series – Sampling Z-transform – Discrete Fourier transform – Properties of discrete Fourier transform – Linear convolution - Decimation–in– time and decimation–in–frequency – FFT Algorithms, two–dimensional discrete Fourier transform – Spectral analysis – Time, frequency analysis of signals.

Filter design techniques: Introduction – Design of IIR digital filters from analog filters – Analog-digital transformation – Properties of FIR digital filters – Design of FIR filters using windows – A comparison of IIR and FIR digital filters.

Multirate Digital Signal Processing: Introduction, decimation by a factor D, Interpolation by a factor I, sampling rate conversion by a rational factor I/D, implementation of sampling rate conversion, multistage implementation of sampling rate conversion, sampling rate conversion of Band pass signals, sampling rate conversion by an arbitrary factor, applications of multi rate signal processing.

Introduction –Effects of coefficient on quantization – Quantization in sampling analog signals – Finite register length effects in realizations of digital filters, Discrete Fourier transform computations.

REFERENCE BOOKS

1. Alan Oppenheim. V and Ronals W.Schafer, 'Digital Signal Processing', Prentice Hall of India Pvt. Ltd., New Delhi, 1989.
2. John-H Karl, 'An Introduction to digital processing', Academic Press INC, Harcourt Brace Jovanovich, Publishers, 1989.
3. Douglas F.Elliot, 'Handbook of Digital Signal Processing – Engineering Applications', Academic Press, 1987. King, Robert.
4. King, Robert, 'Digital filtering in one and two dimensions, Design and applications', Plenum Press, 1989.
5. V.Oppenheim and Ronald W.Schafer, 'Discrete Time Signal Processing', Prentice Hall of India Pvt. Ltd., New Delhi, 1992.

I. E 1.5- Elective-I (a) **FIBER OPTICS AND LASER INSTRUMENTATION**

Principles of light propagation through fiber- Different types of fibers and their properties– transmission characteristics of optical fibers - absorption losses-scattering losses-dispersion. Fabrication of fiber components- Optical fiber as cylindrical waveguide, fiber-optic polarizer.

Fiber optic sensors – Fiber optic communication and instrument system – Advantages of optical communications – Different types of Modulators – Detectors – Fiber optic communication setup – Applications in instrumentation.Distributed fiber-optic sensors-OTDR and OFDR principles in temperature measurement.

Characteristics and fundamentals of lasers – Laser emission and light amplification – Properties of laser beams – Laser modes – Resonator configuration – Q-switching mode locking – Single frequency operation. Types of lasers – Gas lasers – Solid lasers – liquid lasers – semiconductors lasers.

Lasers for Analysis – Laser application in holographic microscopy – holographic interferometer and applications- Holography for non-destructive testing – Medical applications of lasers.

Industrial application of Lasers – Measurement of distance and length, velocity, acceleration, atmospheric effects, sonic boom, pollutants, Material processing, laser heating, melting, scribing, splicing, material removal, calculation of power requirement of laser for material processing.

REFERENCE BOOKS

1. H.C. Allen, An Introduction to Optical Fibers, McGraw-Hill International Book Co., 1983.
2. John and Harry, Industrial lasers and their applications, McGraw Hill publications,1974
3. Gerd Kaiser, Optical fiber communications, McGraw Hill International Edition,2000
4. D.C. Oshea and W.Russel Callen, Introduction to lasers and their Applications, Addison Wesley, 1978.
5. BS. Wherrelt, Laser Advances and Applications, John Wiley, 1979.
6. W.O.N. Guimarass and A.Mooradian, Lasers and Application Springer Verlag, 1981.

I. E 1.5- Elective-I(b) FUZZY LOGIC, NEURAL NETWORKS AND CONTROL

Neural Networks: Introduction - Biological neurons and their artificial models – Learning, adaptation and neural networks learning rules types of neural networks – Single layer, multiplayer – Feed forward, feedback networks; back propagation – Learning and training – Hop field network.

Neural Networks in Control: Neural network for non-linear systems – Schemes of neuro control – System identification forward model and inverse model – Indirect learning neural network control applications – Case studies.

Fuzzy Logic**:** Fuzzy sets – Fuzzy operation – Fuzzy arithmetic – Fuzzy relations – Fuzzy relational equations – Fuzzy measure – Fuzzy functions – Approximate reasoning – Fuzzy propositions – Fuzzy quantifiers – If–then rules.

Fuzzy Logic Based Control: Fuzzy Controllers: Preliminaries Fuzzy sets in commercial products basic construction of fuzzy controller Analysis of static properties of fuzzy controller Analysis of dynamic properties of fuzzy controller simulation studies case studies fuzzy control for smart cars.

Neuro Fuzzy and Fuzzy Neural Controllers: Neuro fuzzy systems: A unified approximate reasoning approach Construction of role bases by self learning: System structure and learning algorithm. A hybrid neural network based Fuzzy controller with self learning teacher. Fuzzified CMAC and RBF network based self-learning controllers.

REFERENCE BOOKS

1. Jacek. M. Zurada, “Introduction to Artificial Neural Systems”, Jaico Publishing House, 1999.
2. Kosko, B. “Neural Networks and Fuzzy Systems”, Prentice Hall of India Pvt. Ltd., 1994.
3. Klir G.J. & Folger T.A. “Fuzzy sets, uncertainty and information”, Prentice Hall of India Pvt. Ltd., 1993.
4. Zimmerman H.J., “Fuzzy set theory – and its application” – Kluwer Academic Publishers, 1994.
5. Driankov, Hellendroon, “Introduction to Fuzzy Control”, Narosa Publishers.
6. Farin Wah S.S., Filev, D. Langari, R. “Fuzzy control synthesis and analysis”, John Wiley and Sons, 2000.

I. E -1.5 **Elective-I (c) ENVIRONMENTAL ANALYSIS INSTRUMENTATION**

Electromagnetic radiation, Characteristics - Interaction of e.m. radiation with matter - Spectral methods of analysis - absorption spectroscopy - Beer s law - radiation sources - monochromators and filters - diffraction grating - ultraviolet spectrometer - single beam and double beam instruments.

Particles emitted in radioactive decay - nuclear radiation detectors - injection chamber - Geiger - Muller counter - proportional counter - scintillation counter - Semiconductor detectors.

Measurement techniques for water quality parameters - conductivity - temperature - turbidity. Measurement techniques for chemical pollutants - chloride - sulphides - nitrates and nitrites - phosphates - fluoride - phenolic compounds.

Measurement techniques for particulate matter in air. Measurement of oxides of sulphur, oxides of nitrogen unburnt hydrocarbons, carbon-monoxide, dust mist and fog.

Noise pollution measurement of sound, tolerable levels of sound. Measurement of sound level. Measurement techniques for soil pollution.

REFERENCEBOOKS

1. H.H. Willard, Merrit and Dean, Instrumental Methods of Analysis, 5th Edn., 1974.

2. R.K. Jain, Fundamentals of Mechanical and Industrial Instrumentation. 1985.

3. S.P. Mahajan, Pollution Control in Process Industries , Tata McGraw Hill, 1985.

4. G. N. Pandey and G.C. Carney, Environmental Engineering , Tata McGraw-Hill, 1989.

I. E 1.6 - Elective-II (a) BIO MEDICAL INSTRUMENTATION

Basic Concepts of Bio-Medical Instrumentation: Terminology – Generalized medical instrumentation system – Measurement constrains – Classification – Interfacing and modifying inputs – Bio statistics – Static and dynamic characteristic – Regulation of medical devices – Electrical safety in medical environment.

Basic Sensors and Signal Processing: Displacement measurements – Resistive sensors – Bridge circuits – Inductance, capacitance and piezo electric sensor – Temperature measurements – Thermocouples – Radiation thermometry – Fiber optic temperature sensors – Optical measurements – Op-amp circuits – Phase sensitive demodulation – Oscillographic, galvanometric and potentiometric recorders – Microcomputers in bio medical instrumentation.

Bio-potentials and Measurements: Electric activity and excitable cells – Functional organization of peripheral nervous system. ENG, EMG, ECG, EEG & MEG – Bio-potential electrodes – Electrolyte interface. Polarization – Body surface recording electrodes – Electrodes for electric simulation of tissues – Practical hints for using electrodes – Bio potential amplifiers.

Blood pressure, Flow and Sound Measurement: Direct and indirect blood pressure measurement and analysis – Bandwidth requirement – Typical waveforms – Phonocardiography – Electro magnetic and ultrasonic flow meters – Photo plethysmography.

Clinical Measurement and Imaging Systems: Respiratory instruments – Transducers, Spiro meters, pulmonary measurements and instruments – Oxymeter – Laser application in medicines – Pulsed ruby, NdYag, Argon and Carbon-dioxide lasers – X-ray machines – Fluoroscopic machines, thermogram equipments – Ultrasonic imaging – Scanning methods and applications – Image evaluation and processing in medical field – Artificial assist devices.

REFERENCE BOOKS

1. Khandpur R.S., “Handbook of Bio-medical Instrumentation”, Tata McGraw-Hill Publication Company, 1989.
2. Dean D.E. Marre A., “Bio electronic Measurements”, Prentice Hall, 1983.
3. All Evans, “The Evaluation of Medical Images, “Adam Hilger publication, 1981.
4. John G.Webster, “Medical Instrumentation application and design”, John Wiley and Sons, 1999.
5. Cromwell. L.Fred J.Webbell, “Bio medical Instrumentation and measurements”, Prentice Hall, 1995.

I. E 1.6 - Elective-II (b) Electronic Instrumentation

Generalised Instrumentation system – Units and standards- Calibration methods- Standards of measurement- Classification of errors- Error analysis. Static characteristics – Accuracy, precision, sensitivity, linearity, resolution, hysteresis, threshold, input impedance, loading effect etc. – Dynamic characteristics.

Cathode ray oscilloscope : Block diagram vertical and horizontal amplifires, sweep circuits, delay line, electrostatic focusing and electrostatic deflection. Special purpose oscilloscopes- sampling oscilloscopes, analog storage and didgital storage oscilloscopes, dual beam and dual trace oscilloscopes.

Instruments for generating and analyzing wave forms, sqare wave, pulse, standard-signal, random noise and function generators, wave analysers, spectrum analysers, Q-meters, vector – voltmeters,vector impedance meters.

Electronic analog meters: Electronic voltmeters VTVM, TVM, FETVM Voltmeters, electronic – multimeters differential voltmeters.DC voltmeters- Loading- Transfer volt meter- Chopper type– Differential voltmeter – Peak responding voltmeter – True RMS voltmeter – Calibration of DC instrument.

Digital Instruments:– Digital multimeters – Digital frequency meter – Digital Measurement of time – Universal counter – Electronic counter – Digital Tachometer- Digital voltmeter- Introduction – Ramp technique – Dual slope - Integrating type DVM – Successive approximations type DVM – Resolution and sensitivity of digital meters – General specifications of a DVM, Data acquisition system.

Textbooks :

1. Modern electronic instrumentation measurements techniques by Helfrick and cooper.
2. A course in electrical and electronic measurement and instrumentation by A.K.Shawney.
3. Electronic Instrumentation by H.S.Kalsi.

I. E – 1.6Elective-II (c)DIGITAL INSTRUMENTATION

Introduction: Digital codes – Memory devices – Basic building blocks – Gates, FF and counters – Discrete data handling – Sampling – Sampling theorem – Aliasing errors – Reconstruction – Extrapolation – Synchronous and asynchronous sampling.

Digital methods of measurements Review of A/D, D/A techniques – F/V and V/F conversion techniques – Digital voltmeters and multimeters – Automation and accuracy of digital voltmeters and multimeters – Digital phase meters – Digital tachometers – Digital frequency, period and time measurements – Low frequency measurements – Automatic time and frequency scaling – Sources of error – Noise – Inherent error in digital meters, hidden errors in conventional ac measurements – RMS detector in digital multimeters – Mathematical aspects of RMS.

Digital display & recording devices: Digital storage oscilloscopes – Digital printers and plotters – CDROMS – Digital magnetic tapes, dot matrix and LCD display CROs, colour monitor, digital signal analyzer and digital data acquisition.

Current trends in digital instrumentation: Introduction to special function add on cards – Resistance card – Input and output cards – Counter, test and time of card and digital equipment construction with modular designing; interfacing to microprocessor, micro controllers and computers - Computer aided software engineering tools (CASE) – Use of CASE tools in design and development of automated measuring systems – Interfacing IEEE cards – Intelligent and programmable instruments using computers.

REFERENCE BOOKS

1. Digital Instrumentation: Bouwens, A.J., McGraw Hill, 1984.

2. Handbook of Micro computer based Instrumentation and Control John Lenk, D., PHI, 1984.
3. Measurement System, Application & Design: Doebelin, IV Ed, McGraw-Hill, 1990.
4. 'Product catalogue', Hewlett Packard, 1996.

I. E - 2.1 MICROCONTROLLERS AND EMBEDDED SYSTEMS

Architecture of 8/16 bit microcontrollers**:**8748 micro controller architecture: program memory – data memory – I/O ports – BUSPorts, Test and interrupt inputs- instruction set and programming.

8051 Microcontroller family - architecture, parallel and serial I/O - instruction set – programming and hardware interfacing techniques

8096 Microcontroller – CPU, RAM space, memory space, high speed input & outputs, analog inputs - serial I/O ports - parallel I/O ports and watch dog timer.

The concept of embedded systems design. Embedded microcontroller cores, embedded memories. Examples of embedded systems.

Technological aspects of embedded systems: interfacing between analog and digital blocks, signal conditioning, digital signal processing. Sub-system interfacing, interfacing with external systems, user interfacing.

Software aspects of embedded systems: real time programming languages and operating systems for embedded systems.

Texts/References

J.W. Valvano, "Embedded Microcomputor System: Real Time Interfacing", Brooks/Cole, 2000.
Jack Ganssle, "The Art of Designing Embedded Systems", Newnes, 1999.
David Simon, "An Embedded Software Primer", Addison Wesley, 2000.
K.J. Ayala, "The 8051 Microcontroller: Architecture, Programming, and Applications", Penram Intl, 1996.
B.P.Singh ., Microprocessors and Microcontrollers-Golgotia publications-2003

I. E - **2.2 VIRTUAL INSTRUMENTATION**

Virtual instrumentation: Introduction- Block diagram and architecture of a virtual instrument .Data – flow techniques -Graphical programming in data flow, comparison with conventional programming. Review of popular software in virtual instrumentation

VI programming techniques: VI ,sub-VI, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file input/output, instrument drivers.

Data acquisition and instrument interface: Introduction to data acquisition on PC, Sampling fundamentals, Interfacing Anolog to digital converters, Digital to Anolog converters, Digital I/O cards, counter & timer I/o boards – Plug-in DAQ boards etc.

PC communication buses: RS 232/RS485, GPIB, USB, PCI, PXI, PCMCIA&VXIetc. Ethernet control of PXI. Networking basics for office & Industrial applications, VISA and IVI.

Application of Virtual Instrumentation: Instrument control, Development of process database management system, Simulation of systems using VI, Development of control system, Industrial Communication, Image acquisition and processing, Motion control.

REFERENCE BOOKS

1. Gary Johnson, 'Lab view graphical programming', II Ed., McGraw Hill, 1997
.
2. Lisa K Wells & Jeffrey Travels, 'Lab view for everyone', Prentice Hall, 1997.
   Sokoloff, 'Basic Concepts of lab view 4', Prentice Hall, 1998.

3. S. Gupta, J.P. Gupta, 'PC interfacing for Data Acquisition & Process Control', 2nd Ed., Instrument Society of America, 1994.

4. Kevin James, PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Newnes, 2000.

I. E - **2.3 COMPUTER CONTROL OF PROCESS**

Computer control – Introduction – Review of Z Transform, Modified Z Transform and Delta Transform. Relation between Discrete and Continuous Transfer function-Poles and Zeros of Sampled Data System (SDS) – Stability Analysis in Z domain.

Multivariable Systems – State Variable representation of multi-input, multi-output systems – Solutions to state equations – STM – Feed forward control, ratio control, cascade control – Interactive control systems – Controllability, observability – State-variable feedback.

Introduction to Computer Control Systems – Need for computer in a control system – Functional Block diagrams of Data Acquisition Systems, Supervisory Control, Direct Digital Control, Programmable logic control, Hierarchy Concept, Distributed Digital Control.

Digital Controller Algorithms – Functional block of a Computer Control System – Digital Controller Algorithms – Dead-beat, , Dahlin's, Kalman's 'Smith predictor and Internal Model Control algorithm with examples.

Adaptive Control: Introduction -Deterministic Self Tuning Regulator: Indirect and Direct self tuning regulator-Model reference Adaptive system: Design of MRAS using Liapnov and MIT Rule- Auto tuning and Gain scheduling adaptive control design with examples.

REFERENCE BOOKS

1. C.M. Houpis, G.B. Lamont, Digital Control Systems, Theory, Hardware, Software, International Student Edition, McGraw-Hill Book Company, 1985.

2. S.I Ashon, Microprocessors with Application in Process Control, Tata McGraw-Hill Publishing Company Ltd., 1984.

3. C.D. Johnson, Microprocessor based Process Control, Prentice Hall Inc., 1984.

4. C.L. Smith, Digital Computer Process Control, Intext Educational Publishers, 1972.

5. Astrom .K. J, Bjorn Wittenmark, Adaptive Control, Second Edition, Prentice Hall of India, New Delhi, 1994.

6. P. Deshpande and Ash, Computer Controlled System ISA Press, USA

I. E -2.4 POWER PLANT INSTRUMENTATION

Basics of power plant operation- major input variables, major control variables
Automation strategy: Distributed hierarchical system, software for data logging-
input/output variables- direct digital control, man- machine interface, communication

Automatic boiler control- basic boiler operation

Combustion controls; series-parallel operation, optimizing control for air-flow- oxygen trimming control

Drum level control: feed water control, drum level control, steam flow control, two-element control, and three-element control

Furnace pressure control, steam temperature control, super heater control

Digital electro hydraulic governor: basic functions, turbine speed control

Automatic startup systems- safety systems

Reference Books

1. D. Patranabis: Principles of process control, TMH, New Delhi, second edition.
2. Krishna Kant: Computer based industrial control, Prentice Hall India Pvt Ltd.
3. George Stephanopoulos: Chemical process control; Prentice Hall India Pvt Ltd.
4. Bela.G.Liptak: Instrumentation Engineers Hand book

I. E - **2.5Elective-III (a) INDUSTRIAL COMMUNICATION SYSTEMS**

Interface: Introduction, Principles of interface, serial interface and its standards. Parallel interfaces and buses.

Field bus Use of field buses in industrial plants, functions, international standards, performance, use of Ethernet networks, field bus advantages and disadvantages. Field bus design, installation, economics and documentation.

Instrumentation network design and upgrade: Instrumentation design goals, cost optimal and accurate sensor networks. Global system architectures, advantages and limitations of open networks, HART network and Foundation field bus network.

PROFIBUS-PA: Basics, architecture, model, network design and system configuration. Designing PROFIBUS-PA and Foundation Field bus segments: general considerations, network design.

REFERENCE BOOKS

1. Noltingk B.E., "*Instrumentation Reference Book*", 2nd Edition, Butterworth Heinemann, 1995.
2. B.G. Liptak, Process software and digital networks, 3rd Edition, CRC press, Florida.

I. E - **2.5Elective III (b) ROBOTICS AND AUTOMATION**

Introduction: Geometric configuration of robots – Manipulators – Drive systems – Internal and external sensors – End effectors – Control systems – Robot programming languages and applications – Introduction to robotic vision.

Robot arm kinematics : Direct and inverse kinematics – Rotation matrices – Composite rotation matrices – Euler angle representation – Homogenous transformation – Denavit Hattenberg representation and various arm configurations.

Robot arm dynamics**:** Lagrange – Euler formulation, joint velocities – Kinetic energy – Potential energy and motion equations –Generalised D'Alembert equations of motion.
Planning of manipulator trajectories**:** General consideration on trajectory planning- joint interpolation & Cartesian path trajectories.

Control of robot manipulators:PID control - Computed torque technique – Near minimum time control – Variable structure control – Non-linear decoupled feedback control – Resolved motion control and adaptive control.

Industrial robots: Industrial robots for welding, painting and assembling-Remote controlled robots-robots for nuclear, chemical and thermal plants- industrial automation-typical examples of automated industries.

REFERENCE BOOKS

1. Fu, K.S. Gonazlez, R.C. and Lee, C.S.G., "Robotics (Control, Sensing, Vision and Intelligence), McGraw-Hill, 1968 (II printing).
2. Wesley, E. Sryda, "Industrial Robots: Computer interfacing and Control" PHI, 1985.
3. Asada and Slotine, "Robot Analysis and Control", John Wiley and Sons, 1986.
4. Philippe Coiffet, "Robot Technology" Vol. II (Modelling and Control), Prentice Hall INC, 1981.
5. Groover M. P. Mitchell Wesis., 'Industrial Robotics Technology Programming and Applications', Tata McGraw-Hill, 1986.

I. E - 2.5Elective III (c) VLSI DESIGN

Introduction: Introduction to IC technology-MOS, PMOS, NMOS, CMOS, BiCMOS Technologies. Fabrication, Fabrication sequence - Oxidation, Lithography. Diffusion, Ion implantation, Metallisation, Encapsulations. Basic Electrical Properties of MOS and BiCMOS circuits -I_{ds}-V_{ds} relationships, MOS transistor Threshold voltages, figure of merit, NMOS inverter, and CMOS inverter analysis and design-BiCMOS inverters.

VLSI circuit Design Processes: VLSI design flow, MOS layers, Stick diagrams, Design rules and layout, 2μm CMOS Design rules for wires, contacts and transistors-Layout diagrams for NMOS and CMOS inverters and gates- Scaling of MOS circuits- Limitations of scaling.

Gate level Design: Logic gates and other complex gates, switching logic-alternate gate circuits-Basic circuit concepts-sheet resistance Rs and its concept to MOS- Area capacitance units- calculations-δ delays- Driving large capacitance loads- Wiring capacitive loads- wiring capacitances- Fan-in and fan-out- choice of layers.

Semi-custom Integrated circuit Design: Design approach of semi-custom and Full-custom ASICS,Standard Cell design, Programmable Logic Array, Programmable Array Logic, programmable gate arrays-CPLDs, FPGAs - etc.

VHDL Synthesis: Circuit Design flow- Circuit synthesis- Simulation-Layout-Design capture tools-Design verification tools- Test principles- Test vector generation, scan based techniques, Boundary scan test(BST), Built-in-self Test(BST) techniques, Testing and qualification.

REFERENCE BOOKS

1. Essentials of VLSI circuits and Systems: Kamran Eshraghian, Eshraghian Douglas and A.Pucknell—PHI-2005 Edition.

2. Principles of CMOS VLSI Design: Weste and Eshranghian—Pearson Education-1999.
3. Introduction to VLSI circuits and systems-John P.Uyemura-JohnWiley-2003

4. Modern VLSI Design- Wayne Wolf, Pearson Education, 3rd Edition, 1997.

5. Digital Integrated Circuits: A Design Perspective- J. Rabaey-Prentice Hall India, 1997.

I. E - 2.6Elective-IV (a) ADVANCED SENSORS

Chemical Sensors: Amperometry-Potentiometry-Conductivity sensors- Semi conductive sesors-MEMSsensors. Materials for sensors-Electrical conducting materials- Ionic conductors-zirconia-alumina-NASICON. Semiconductor materials-titania-tinoxide-zinc oxide. Insulating materials-Ferroelectric materials-Negative temperature ceramic thermistors.

Thin and Thick film sensors: Thick film processes-Thin film processes- Thin film deposition methods-thin film characterization methods-thin film delineation techniques-compatibility issues- Longmuir-Blodgett films for sensor materials-film forming apparatus-dipping-ion sensors-gas sensors. Applications of thin and thick film sensors.

Biosesnors:Colorimetric- Optical- Potentiometic- Amperometic- Conductometric- Semiconductor-Mechanical and Molecular electronic based sensors. Chemiluminiscence based biosensors. Applications of biosensors in medical and health care- food and agricultural- Industrial process and environmental monitoring.

Integrated Magnetic Sensors: Overview of magnetic field sensor Technology-AMR-GMR-SQUIDS-Optoelectronic MFS- Semiconductor magnetic effects-materials and figure of merit-Standard MFS technologies-limitations and applications.

Sensor Applications: Automotive sensors-Environmental sensors-Sensors for Medical Diagnosis and patient monitoring-Aerospace sensors.

REFERENCE BOOKS

1. Sensors- A Comprehensive study-W.Gopal, J Hesse, J N Zemel –VHC Press, 1989.
2. Sensors Handbook-Sabree Soloman—McGraw Hill Publishers-1998
3. Electro Optical Instrumentation- Silvano Donati, Pearson Education 2005.
4. Introduction to Medical Equipment Technology: Carr and Brown- Addison Weseley-2001.

I. E - 2. 6Elective-IV (b)PIPING AND INSTRUMENTATION

Types of flow sheets, Flow sheet Presentation, Flow Sheet Symbols, Process flow diagram- Synthesis of steady state flow sheet - Flow sheeting software.

P & I D objectives, guide rules, Symbols, Line numbering, Line schedule, P & I D development, typical stages of P & I D.

P & I D for rotating equipment and static pressure vessels, Process vessels, absorber, evaporator.

Control System for Heater, Heat exchangers, reactors, dryers, Distillation column, Expander.

Applications of P & I D in design stage - Construction stage - Commissioning stage -Operating stage - Revamping stage - Applications of P & I D in HAZOPS and Risk analysis.

REFERENCEBOOKS

1. Applied Process Design for Chemical and Petrochemical Plants: Ernest E. Ludwig, Vol.-I Gulf Publishing Company, Houston, 1989.

2. Plant Design and Economics for Chemical Engineer: Max. S. Peters and K.D.Timmerhaus: McGraw Hill, Inc., New York, 1991.

3. Chemical Process Synthesis and Engineering Design: Anil Kumar, "", Tata Mc-GrawHill publishing Company Limited, New Delhi - 1981.

4. A. Process Flow sheeting: N. Westerberg, et al. Cambridge University Press, 1979.

I. E - 2. 5 Elective-IV (c) STEEL PLANT INSTRUMENTATION

Basics of steel production; mill zones: iron zone, steel zone, mill zone, utility zone
Automation strategy: different levels, input, output data.

Iron zone: supervisory control, direct digital control; instrumentation for-raw material handling, coke oven, sinter plant, Blast furnace; input/output data, control architecture.

Steel zone: Automation for- LD converters, continuous casting, soaking pit control, blooming mill controls.

Utility zone: instrumentation for-Gas distribution, liquid fuel distribution, power generation, steam generation, compressed air generation

Instrumentation for water management system. Pollution control and monitoring for steel plant environment.

REFERENCE BOOKS

1. D. Patranabis: Principles of process control., TMH, New Delhi, second edition.
2. Krishna Kant: Computer based industrial control, Prentice Hall India Pvt Ltd.
3. George Stephanopoulos: Chemical process control; Prentice Hall India Pvt Ltd.
4. Bela.G.Liptak: Instrumentation Engineers Hand book