CURRICULUM AND SYLLABI

For

M.Tech. (Instrumentation Engineering) Programme

SUBMITTED
BY

THE DEPARTMENT
OF

ELECTRONICS & INSTRUMENTATION
ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY
SILCHAR

2019

PROGRAM OUTCOMES (POS)

M. Tech. Programme in Instrumentation Engineering

1. Students will demonstrate an ability to identify, formulate and solve problems in the area of Instrumentation and Control.
2. Students will demonstrate an ability to design a component, system or process, as per needs and specifications within realistic constraints.
3. Students will acquire qualities to become entrepreneur and leader in the Instrumentation and Control and allied fields.
4. Students will acquire ability of creative thinking, critical analysis and decision making for productive research and development.
5. Students will be able to find feasible and optimal solutions to the problems faced by the industry through innovative practices.
6. Students will acquire understanding of tools and techniques, and their usage in analysis and design of measurement, Instrumentation and control problems.
7. Students will be able to contribute in newly emerging areas through collaborative and multidisciplinary research.
8. Students will learn to communicate effectively.
9. Students will be sensitized towards the professional and ethical responsibilities.

Course Structure
(M. Tech in Instrumentation Engineering)

Semester I

S. N.	Code	Subject	L	T	P	Credits
1.	EI 5101	Advanced Sensing Technology	3	0	0	3
2.	EI 5102	Advanced Signal Processing	3	0	0	3
3.	EI 5103	Modern Control Systems	3	0	0	3
4.	EI 5104	Design, Simulation and Development Lab	0	0	3	2
5.	EI 51xx	Elective I	3	0	0	3
6.	EI 51xx	Elective II	3	0	0	3
		Total contact hours/credits	15	0	3	17

Semester II

S. N.	Code	Subjects	L	T	P	Credit
1.	EI 5111	Advanced Instrumentation	3	0	0	3
2.	EI 5112	Modern Biomedical Instrumentation	3	0	0	3
3.	EI 5113	Advanced Process Control and Industrial Automation	3	0	0	3
4.	EI 5114	Advanced Instrumentation and Process Control Lab	0	0	3	2
5.	EI 5115	Seminar and Technical Writing	0	0	3	2
6.	EI 51xx	Elective III	3	0	0	3
7.	EI 51xx	Elective IV	3	0	0	3
8.	EAA	Extra Academic Activities (Yoga)	0	0	2	0
		Total contact hours/credits	15	0	8	19

Semester III

S. N.	Code	Subjects	L	T	P	Credit
1.	EI 6198	Project Phase-I	0	0	6	6
		Total contact hours/credits	0	0	6	6

Semester IV

S. N.	Code	Subjects	L	T	P	Credit
1.	EI 6199	Project Phase-II	0	0	8	8
		Total contact hours/credits	0	0	8	8

Elective I

S. N.	Code	Subject	L	T	P	Credits
1.	EI 5141	Intelligent Control	3	0	0	3
2.	EI 5142	Smart Sensors	3	0	0	3
3.	EI 5143	Optimization Techniques	3	0	0	3
4.	EI 5144	Artificial Intelligence	3	0	0	3
5.	EI 5145	Microelectronics and VLSI Design	3	0	0	3
6.	EI 5146	Advanced Wireless Communication	3	0	0	3
7.	EI 5147	Fibre Optics and LASER Instrumentation	3	0	0	3
8.	EI 5148	Testing and Calibration of instruments	3	0	0	3
9.	EI 5149	Industrial Instrumentation	3	0	0	3

Elective II

S. N.	Code	Subject	L	T	P	Credits
1.	EI 5151	Robotics & Automation	3	0	0	3
2.	EI 5152	PC Based Instrumentation	3	0	0	3
3.	EI 5153	Information and Communication Theory	3	0	0	3
4.	EI 5154	Intelligent Instrumentation	3	0	0	3
5.	EI 5155	Computer Controlled Processes	3	0	0	3
6.	EI 5156	Biomedical Signal Processing	3	0	0	3
7.	EI 5157	IC Technology & Applications	3	0	0	3
8.	EI 5158	Data Acquisition and Signal Conditioning	3	0	0	3

Elective III

S. N.	Code	Subject	L	T	P	Credits
1.	EI 5161	MEMS	3	0	0	3
2.	EI 5162	Analog and Digital VLSI Design	3	0	0	3
3.	EI 5163	Logic & Distributed Control Systems	3	0	0	3
4.	EI 5164	Digital Control System	3	0	0	3
5.	EI 5165	Digital Image Processing	3	0	0	3
6.	EI 5166	Microcontroller & Embedded System	3	0	0	3
7.	EI 5167	Statistical Signal Processing	3	0	0	3
8.	EI 5168	Renewable Energy Sources	3	0	0	3
9.	EI 5169	Virtual Instrumentation	3	0	0	3
10.	EI 5170	Soft Computing	3	0	0	3

Elective IV

S. N.	Code	Subject	L	T	P	Credits
1.	EI 5171	Industrial Data Communication	3	0	0	3
2.	EI 5172	Environmental Pollution Control	3	0	0	3
3.	EI 5173	Identification and Estimation	3	0	0	3
4.	EI 5174	Precision Instrumentation	3	0	0	3
5.	EI 5175	Human Computer Interface and BCI	3	0	0	3
6.	EI 5176	Nanotechnology & Nano electronics	3	0	0	3
7.	EI 5177	Piping and Instrumentation	3	0	0	3
8.	EI 5178	System Identification and Adaptive Control	3	0	0	3
9.	EI 5179	Machine Learning Algorithm	3	0	0	3
10.	EI 5180	Power Plant Instrumentation	3	0	0	3

Detailed Syllabi

EI 5101	Advanced Sensing Technology	L	T	P	C
	First Semester	3	0	0	3

UNIT I: INTRODUCTION

Review of sensor technology and sensor applications. Basic sensors signal processing requirements and description. Basic elements of data acquisition, analog and digital DAS and signal conditioning.

UNIT II: CHEMICAL SENSORS
Physical Sensors – Surface Micro Machined Capacitive Pressure sensor, integrated flow sensor, Chemical and Biochemical Sensors – Conductivity sensor, Hydrogen Sensitive MOSFET, Tri-Oxide Sensors, Schottky diode type sensor, Solid Electrolyte, Electrochemical Sensors. Sensor Matrix for Two-dimensional measurement of concentrations

UNIT III: OPTICAL SENSORS
Holography, Echolocation and bio holography, Sensors used in space and environmental applications. Application in meteorology, natural resources application sensor used in Instrumentation methods.

UNIT IV: BIOMEDICAL SENSORS
Biological Sensors in Human Body – Different types of Transducer system – Physiological Monitoring – chemo receptors – Hot and cold receptors – sensors for smell, sound, vision taste ELECTRODES pH –EEG – ECG, EMG, Bio sensors – Plethysmography, Instruments based on knot of sound. Ultrasonic Transducers for Measurement and therapy – radiation detectors – NIR spectroscopy –NMR. MRI

UNIT V: ADVANCED SENSOR DESIGN
Sensor design, Sensor characteristic, Design of signal conditioning devices for sensors. Design of 2 & 4 wire transmitters with 4 – 20 mA output. Pressure Sensor using SiSi bonding, Catheter pressure sensors, TIP pressure sensors, High pressure sensors, Silicon accelerometers. Aerospace Sensor Gyroscope laser and fibre optic gyroscopes, accelerometers. Laser, Aerospace application of laser, Resolvers, Altimeters, Angle of attack sensors, servos.

UNIT VI: SMART SENSORS
Introduction, Basics of smart sensor, Micromachining Techniques, signal conditioning circuits.

TEXT BOOKS
1. Sabaree Soloman, Sensors Hand Book, McGraw Hill, 1998.
2. Carr and Brown, Introduction to Medical Equipment Technology, Addison Wesley, 1999.

REFERENCE BOOKS
1. Smith H. M. Principles of Holography, John Wiley & Sons, New York, 1975.
2. J. G. Webster, Medical instrumentation Application and Design, Houghton Mifilin Co.

COURSE OUTCOME:
After successful completion of the course, students will be able to:
CO1: Understand the application of different chemical sensors for chemical process industry.
CO2: Apply the principles of optic fiber system and mode of light transfer to the various applications.
CO3: Apply the different sensors to the various biomedical applications.
CO4: Understand the different type of electrodes and its usage.
CO5: Understand and design signal conditioning circuits.

EI 5102	**Advanced Signal Processing**	**L**	**T**	**P**	**C**
	First Semester	**3**	**0**	**0**	**3**

UNIT I: REVIEW OF DIGITAL SIGNAL PROCESSING
Discrete Time Signals & System: Review, Analysis of Discrete time LTI systems, Representation of Discrete Time systems by LTI systems, Z-Transform and inverse Z-transform, Frequency domain analysis of LTI systems, DFT: Properties and Applications, Radix-2 FFT algorithm and its implementation.

UNIT II: DESIGN OF DIGITAL FILTER
Design of FIR Filters: Symmetric and Anti-symmetric FIR filters, Design using windowing method and frequency sampling method, Design of IIR Filters from Analog Filters using Impulse invariance and Bilinear Transformation, Frequency Transformations.

UNIT III: MULTIRATE SIGNAL PROCESSING
Introduction to Multi-rate Digital Signal Processing, sample rate reduction, decimation by integer factors, sampling rate increase, interpolation by integer factor, Design of practical sampling rate converters, Filter Specification, filter requirement for individual stages, Determining the number of stages and decimation factors, Sampling rate conversion using poly-phase filter structure, poly-phase implementation of interpolators.

UNIT IV:
Bipolar operational amplifiers, MOS diode, active resistor and current mirrors, CMOS amplifier and operational amplifier. Logarithmic and exponential amplifiers, analog multipliers and divider, Voltage controlled oscillator, Phase locked loop. Waveform generator and Oscillator.

UNIT V:
Continuous time filter: Active filter; Second order filter: Single amplifier and multiple amplifier structures and filter parameter sensitivities. Cascade filter. Sampled data filter: Switched Capacitor filter; Switched capacitor integrator and filter. Filter transfer function in z-domain, Filter parameter sensitivities with respect to capacitor ratios.

TEXT BOOKS
1. Digital Signal Processing: principles, Algorithms, and Applications, J.G. Proakis and D.G. Manolakis, Pearson.
2. Digital Signal Processing, A.V. Oppenheim and R.W. Schafer, PHI Publications.
3. R. Gregorian and G.C. Temes, Analog MOS Integrated Circuits for Signal Processing; John Wiley and Sons, 2004.

4. Sedra and Smith, “Microelectronic Circuits”, Oxford University Press, 2003.

REFERENCE BOOKS

1. Thomas L. Floyd, “Electronics Fundamentals: Circuits, Devices and Applications”, 7th edition Prentice Hall.
2. Millman and Halkias, “Electronic Devices & Circuits”, McGraw-Hill.
3. Rybin, Yu. K., “Electronic Devices for Analog Signal Processing”, Springer Series in Advanced Microelectronics, Vol. 33, 2012.

COURSE OUTCOME:

After successful completion of the course, students will be able to:

CO1: Understand basics of digital signal processing to analyze Linear Time Invariant systems and various transforms.

CO2: Acquire the knowledge to design FIR and IIR filters for signal conditioning circuits.

CO3: Apply the knowledge of signal processing to design a multi-rate signal processing system.

CO4: Analyze different wave-shaping circuits and signal conditioning circuit for the sensor output.

CO5: Acquire knowledge to design and analyze active filters for analog signal processing.

EI 5103	Modern Control Systems	L	T	P	C
	First Semester	3	0	0	3

UNIT I: STATE VARIABLE ANALYSIS AND DESIGN

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

UNIT II: NON-LINEAR SYSTEMS

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

UNIT III: STABILITY ANALYSIS OF NON-LINEAR SYSTEM

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

UNIT IV: 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.

UNIT V: 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.

TEXT BOOKS

1. Nagrath I.J., and Gopal, M., Control system Engineering Wiley Eastern Reprint 1995.
2. Kirk D.E., “Optimal control theory-an introduction”, Prentice Hall, N.J. 1970.

REFERENCE BOOKS

1. Chalam V.V., Adaptive control systems Marcel Dekker, INC New York and Bassel, 1987.
2. Stanley M. Shinners, Modern Control System Theory and Design, John Wiley and Sons, 1998.

COURSE OUTCOME:

After successful completion of the course, students will be able to:
CO1: Understand the fundamental concepts of control system.
CO2: Analyze the mathematical modeling of the system.
CO3: Understand the concepts of stability of the system.
CO4: Understand the concept of time response and frequency response of the system.
CO5: Analyze the stability of the system.

EI 5104	Design, Simulation and Development Lab	L	T	P	C
	First Semester	0	0	3	2

List of Experiments:

1. Familiarization of signal processing commands used in MATLAB Software.
2. Developing elementary signal function modules (m-files) for unit impulse, step, and exponent and ramp sequence.
3. Generating continuous and discrete time sequences.
4. Carrying out mathematical operations on signals
5. Response of LTI system described by difference and differential equation
6. Developing a program for computing inverse Z-Transform.
7. Developing program for finding magnitude & phase response of LTI System
8. Developing program for computing DFT & IDFT
9. Developing a program for computing circular convolution.
10. Design of filter: FIR, IIR, ECG Signal filter.
11. Getting started with LabVIEW: Basic operations, controls, indicators, and simple Programming structures.
12. Debugging a VI and sub-VI.
13. Familiarization of DAQ card
14. PLC programming: familiarization of instruction set
15. PLC programming: simulation of process control
16. SCADA interface
17. Familiarization of Distributed Control System (DCS) with different process stations pressure, flow and level
18. Familiarization of MATLAB commands used in control system design
19. Representation of system in MATLAB: state space representation & transfer function representation
20. Stability analysis using Bode plot, root locus & their pole-zero-gain representation
21. Implementation of Ziegler- Nicholas/ Cohen-coon tuning method for 1^{st} order system

COURSE OUTCOME:

After successful completion of the course, students will be able to:

CO1: Apply several signal processing algorithms on digital signals using MATLAB and DSP boards.

CO2: Generate different test signals in time domain and demonstrate the same.

CO3: Write different programs in PLC.

CO4: Visualize the key concepts using MATLAB.

CO5: Design digital filters of different kinds in MATLAB.

EI 5111	Advanced Instrumentation	L	T	P	C
	Second Semester	3	0	0	3

UNIT I: INTRODUCTION

Introduction, Review of Sensors, applications and sensor signal processing, selected sensors-proximity sensors, Photoelectric Sensors, PMT etc.

UNIT II: NON-DESTRUCTIVE TESTING

NDT tools- Magnetic particle testing, Dye penetrants, Radiographic methods (X-rays, gamma rays), Ultrasonics, Ultrasonic Holography, Signature analysis etc. Pulse Echo method.

UNIT III: FIBER OPTIC SENSORS

Fibre optic instrumentation system -Different types of modulators – detectors -Interferometer method of measurement of length - moiré fringes - Applications of fibre-optic sensors - measurement of pressure, temperature, current, voltage, liquid level and strain - fibre optic gyroscope.

UNIT IV: LASER INSTRUMENTATION

Laser for measurement of distance, length, velocity, acceleration, current, voltage, atmospheric effect- material processing - laser heating, welding, melting and trimming of materials - removal and vaporization

UNIT V: MICROPROCESSOR BASED INSTRUMENTATION

Hardware and firmware components of a microprocessor system - micro controllers - multiple processors - An example application of a microprocessor system -calibration and correction – human interface - computer interface - software characteristics of the computer interface - numerical issues - Embedded programming issues

UNIT VI: SMART INSTRUMENTS

Smart/intelligent transducer-comparison with conventional transducers-self-diagnosis and remote

Calibration features-Smart transmitter with HART communicator-Measurement of strain, flow, and pH with smart transmitters

UNIT VII: VIRTUAL INSTRUMENTATION

Block diagram and architecture of the virtual instrumentation - VIs and sub VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O. Different applications of VI in instrumentation.

TEXT BOOKS
1. Chapman P., Smart Sensors, ISA Publications,1995
2. Jasprit Singh, Semiconductor Opto-electronics, McGraw Hill, 1995

REFERENCE BOOKS
1. Lisa K. Wells & Jeffrey Travels, Labview for everyone, Prentice Hall, 1999
2. Sokoloff, Basic concepts of Labview 4, Prentice Hall 1998.

COURSE OUTCOME:
After successful completion of the course, students will be able to:
CO1: Know the concept, types and general principles of Fibre optic instrumentation.
CO2: Study the concept of Laser technology and its usage in Instrumentation.
CO3: Understand the concept and application of microcontroller-based instrumentation.
CO4: Get an idea for the usage of smart instruments in process industries.
CO5: Utilize virtual instruments in industries.

EI 5112	Modern Biomedical Instrumentation	L	T	P	C
	Second Semester	3	0	0	3

UNIT I: VITAL ORGANS AND ITS SIGNALS IN HUMAN BODY
Electro physiology of Cardio Vascular system, Nervous System, Respiratory system, auditory system, Visual system and muscular system.

UNIT II: CLINICAL DIAGNOSTIC DEVICES
Thermometer, Stethoscope, BP apparatus, ECG, Echo Cardio Gram, EMG, EEG, Audiometer, Phoropter, Tonometer.

UNIT III: IMAGING SYSTEMS
X-ray, ultrasound, magnetic waves, radioactive elements and nuclear radiation.

UNIT IV: LABORATORY DEVICES
Blood Cell counters, Auto Analysers, Electrophoresis instrument.

UNIT V: THERAPEUTIC AND ASSISTING DEVICES
Pacemakers, Defibrillators, Heart Lung Machine, Anaesthesia Machine, Patient Controlled Analgesic Unit, Dialysers, Lithotripsy apparatus, Diathermy apparatus, Electrosurgical Unit, Hearing aids, Laser instruments for ophthalmology, Assisting devices for visually impaired persons, Automated Wheel Chairs and prosthetic devices.

UNIT VI: PATIENT MONITORING SYSTEM
Remote and Bedside and Introduction to Health Level 7 Protocol.

TEXT BOOKS
1. Medicine and Clinical Engineering by Jacobsons & Webster, PHI
2. Introduction to Biomedical Equipment Technology by Carr & Brown
3. Biomedical Instrumentation and Measurements by Cromwell, PHI
4. Handbook of Biomedical Instrumentation by R. S. Khandpur, TMH

REFERENCE BOOKS

1. The Biomedical Engineering Handbook, Bronzino, IEEE Press
2. Principles of Medical Imaging. By: K. Kirk Shung, Michael B. Smith, Benjamin Tsui.- Pub: Academic Press.
3. Medical Laser Applications -By Carruth.
4. Medical Lasers & their safe Use - By Sliney & Trokal.
5. Introduction to Biomedical Engineering, Edited by John D. Enderle and Joseph D. Bronzino, Elsevier Publication, 2012.
6. Introduction to Biomedical Engineering – 2nd Edition, Edited by John D. Enderle, Susan M. Blanchard and Joseph D. Bronzino, Elsevier Publication, 2005.
7. https://www.hl7.org/about/index.cfm?ref=footer

COURSE OUTCOME:

After successful completion of the course, students will be able to:

CO1: Outline the physiology of vital human systems.
CO2: Illustrate the measurement procedure of cardiovascular, brain, muscular parameters.
CO3: Classify the diagnostic and therapeutic devices.
CO4: Summarize the history, maths and science behind the medical instruments.
CO5: Explain the working of Clinical, laboratory, Imaging, rehabilitation and Operation Theatre Instruments.
CO6: Model a device to assist especially abled persons.

EI 5113	Advanced Process Control and Industrial Automation	L	T	P	C
	Second Semester	3	0	0	3

UNIT I: DYNAMICS

Introduction to process control - objective of modelling - models of industrial process – hydraulic tanks - fluid flow systems - mixing process - chemical reactions - thermal systems-heat exchangers - distillation column.

UNIT II: CONTROL ACTIONS AND CONTROLLER TUNING

Basic control actions-on/off – P - P+I - P+I+D - floating control - pneumatic - electronic controllers - controller tuning-time response - frequency response methods - non-linear controllers.

UNIT III: COMPLEX CONTROL TECHNIQUES

Feed forward-ratio – cascade - split range – inferential – predictive - adaptive - multivariable control.

UNIT IV: PROGRAMMABLE LOGIC CONTROLLERS

Evolution of PLC – Sequential - Programmable controllers – Architecture – Programming of PLC –Relay logic - Ladder logic – Functional blocks – Communication Networks for PLC.

UNIT V: DISTRIBUTED CONTROL SYSTEM

Evolution of DCS – Architecture – Local control unit – Operator interface – Engineering interface –Display – Case studies in DCS.

TEXT BOOKS

1. Dale E. Seborg, et al, Process dynamics and control, Wiley John and Sons, 1989
2. Norman A Anderson, Instrumentation for Process Measurement and Control, CRC Press LLC, Florida, 1998.

REFERENCE BOOKS:

1. George Stephanopoulos, Chemical Process Control, Prentice Hall India.
2. Harriot P., Process Control, Tata Mc Graw-Hill, New Delhi, 1991.
3. Marlin T. E., Process Control, Tata McGraw hill, New York, 2nd edition, 2000.
4. Balchan J. G., Mumme G., Process Control Structures and Applications, Van Nostrand Renhold Co., New York, 1988

COURSE OUTCOME:

After the successful completion of the course, the students will be able to:

CO1: Understand the mathematical modelling, controllers, final control elements and tuning processes.

CO2: Apply fundamental knowledge of mathematics to modelling and analysis of fluid flow, level, pressure, temperature problems.

CO3: Conduct experiments in pipe flows and open-channel flows and interpreting data from model studies to prototype cases. Documenting them in engineering reports.

CO4: Understand the possible disasters caused by an incorrect Design/Analysis in hydraulic, Pneumatic engineering system.

EI 5114	**Advanced Instrumentation and Process Control**	**L**	**T**	**P**	**C**
	Second Semester	**0**	**0**	**3**	**2**

List of Experiments:

1. Modelling of Temperature process
2. Modelling of flow process
3. Modelling of level process
4. Modelling of pressure process
5. PID Controller tuning for various process (Flow, Temperature, Pressure, Level)
6. Design of software PID controller
7. Design of Fuzzy logic controller
8. PID controller using PLC
9. Cascade Control
10. Ratio Control
11. Modelling and control of pH using distributed control system.
12. Modelling and control of concurrent heat exchanger using Distributed control system.
13. Modelling and control of counter current heat exchanger using Distributed control system.
14. Non-linear identification of pH process.

COURSE OUTCOME:

After the successful completion of the course, the students will be able to:

CO1: Apply the control system to industrial parameters like that- fluid flow, level, pressure, temperature problems.

CO2: Conduct experiments (in teams) in pipe flows and open-channel flows and interpreting data from model studies to prototype cases, as well as documenting them in engineering reports.

CO3: Understand disasters caused by incorrect design/analysis in hydraulic, pneumatic engineering system.

CO4: Identify optimal values for PID controller for any application.

EI 5115	**Seminar and Technical Writing**	**L**	**T**	**P**	**C**
	Second Semester	**0**	**0**	**3**	**2**

The objective of this course is to impart training to the students in collecting materials on a specific topic in the broad domain of Engineering/Science from books, journals and other sources, compressing and organizing them in a logical sequence, and presenting the matter effectively both orally and as a technical report. The topics should not be a replica of what is contained in the syllabi of various courses of the M. Tech program. The topics chosen by the student shall be approved by the Faculty-in-Charge. A seminar report duly certified by the Faculty-in-Charge of the seminar in the prescribed form shall be submitted to the department.

A tentative list of topics which may be covered is:
1. Fundamentals of Technical Communication
2. Forms/modes of Technical Communications
3. Technical Presentation: Strategies & Techniques
4. Technical Communication Skills
5. Kinesics & Voice Dynamics

The topics stated above are of suggestive nature and need not be limited to them.

REFERENCE BOOKS

1. Technical Communication – Principles and Practices by Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2007, New Delhi.

COURSE OUTCOME:

After successful completion of the course, students will be able to:

CO1: Survey the literature on new research areas and compile findings on a particular topic.

CO2: Organize and illustrate technical documentation with scientific rigor and adequate literal standards on the chosen topic strictly abiding by professional ethics while reporting results and stating claims.

CO3: Demonstrate communication skills in conveying the technical documentation via oral presentations using modern presentation tools.

EI 5198	**Project Phase-I**	**L**	**T**	**P**	**C**
	Third Semester	**0**	**0**	**6**	**6**

The major project in the third semester offers the opportunity to apply and extend knowledge acquired in the first year of the M. Tech. program. The major project can be analytical work, simulation, hardware design or a combination of these in the emerging areas of Instrumentation under the supervision of a faculty from the EIE Department. The specific project topic undertaken will reflect the common interests and expertise of the student(s) and supervisor. Students will be required to 1) perform a literature search to review current knowledge and developments in the chosen technical area; 2) undertake detailed technical work in the chosen area using one or more of the following:

- Analytical models
- Computer simulations
- Hardware implementation

The emphasis of major project shall be on facilitating student learning in technical, project management and presentation spheres. Project work will be carried out individually. The M. Tech. project evaluation committee of the department shall evaluate the project work during the third semester in two phases. The first evaluation shall be conducted in the middle of the semester. This should be followed by the end semester evaluation. By the time of the first evaluation, students are expected to complete the literature review, have a clear idea of the work to be done, and have learnt the analytical / software / hardware tools.

COURSE OUTCOME:

After successful completion of the course, students will be able to:

CO1: Develop aptitude for research and independent learning.

CO2: Demonstrate the ability to carry out literature survey and select unresolved problems in the domain of the selected project topic.

CO3: Gain the expertise to use new tools and techniques for the design and development.

CO4: Acquire the knowledge and awareness to carry out cost-effective and environment friendly designs.

CO5: Develop the ability to write good technical report, to make oral presentation of the work, and to publish the work in reputed conferences/journals.

EI 5199	Project Phase-II	L	T	P	C
	Third Semester	0	0	8	8

The major project in the fourth semester offers the opportunity to apply and extend knowledge acquired in the first year of the M. Tech. program. The M. Tech. project evaluation committee of the department shall evaluate the project work during the fourth semester in two phases. The first evaluation shall be conducted in the middle of the semester. This should be followed by the end semester evaluation. In the fourth semester, the students are expected to present the final results in the chosen topic, write thesis, and publish papers from their work.

COURSE OUTCOME:

After successful completion of the course, students will be able to:

CO1: Develop aptitude for research and independent learning.

CO2: Demonstrate the ability to carry out literature survey and select unresolved problems in the domain of the selected project topic.

CO3: Gain the expertise to use new tools and techniques for the design and development.

CO4: Acquire the knowledge and awareness to carry out cost-effective and environment friendly designs.

CO5: Develop the ability to write good technical report, to make oral presentation of the work, and to publish the work in reputed conferences/journals.

ELECTIVE-I

EI 5141	Intelligent Control	L	T	P	C
		3	0	0	3

UNIT I: INTRODUCTION
Definition – architecture – difference between conventional and expert system.

UNIT II: KNOWLEDGE ACQUISITION
Knowledge representation and formal logic-knowledge engineer – knowledge acquisition techniques –concept formalisation – knowledge representation development – knowledge acquisition for core problem knowledge acquisition without knowledge engineers.

UNIT III: EXPERT SYSTEM TOOLS
Problem solving start engines – languages for expert system development – expert system shells – LISP machines – PC-based expert system tools.

UNIT IV: FUZZY MODELLING AND CONTROL
Fuzzy sets – Fuzzy set operators – Fuzzy Reasoning – Fuzzy propositions – Linguistic variable –Decomposition and Defuzzification – Fuzzy systems- Case studies.

UNIT V: NEURAL CONTROLLERS
Introduction: Neural networks – supervised and unsupervised learning – neural network models – single and multilayers – back propagation – learning and training. Neural controllers case studies.

TEXT BOOKS
1. Rolston, D.W., ‘Principles of Artificial and Expert Systems Development’, McGrawHill Book Company, International Edition, 1998.
2. Kosko, B, ‘Neural Networks and Fuzzy Systems’, Prentice Hall of India Pvt. Ltd., 1994.

REFERENCE BOOKS
1. Klir, G.J. and Folger, T.A., ‘Fuzzy Sets, and Information’, Prentice Hall, 1994.
2. James A. Freeman, David M. Skapura, ‘Neural Networks Algorithms’, Applications and programming Techniques’, Addison Wesley Publishing company 1992.

COURSE OUTCOME:
After successful completion of the course, students will be able to:
CO1: Understand the difference between conventional and expert system.
CO2: Understand the ideas of knowledge Acquisition.
CO3: Understand expert system tool.
CO4: Understand about Fuzzy modelling.
CO5: Understand about control with Neural Controllers.

EI 5142	Smart Sensors	L	T	P	C
		3	0	0	3

UNIT I: BASICS OF SMART SENSORS & MICROMACHINING
Introduction, Mechanical-Electronic transitions in sensing, nature of sensors, overview of smart sensing and control systems, integration of micromachining and microelectronics, introduction to micromachining, bulk micromachining, wafer bonding, surface micromachining, other micromachining techniques.

UNIT II: SENSOR INFORMATION TO MCU
Introduction, amplification and signal conditioning, separate versus integrated signal conditioning, digital conversion.

UNIT III: MCUS AND DSPS TO INCREASE SENSOR IQ
Introduction, MCU control, MCUs for sensor interface, DSP control, Software, tools and support, sensor integration.

UNIT IV: COMMUNICATIONS FOR SMART SENSORS
Introduction, definitions and background, sources and standards, automotive protocols, industrial networks, office & building automation, home automation, protocols in silicon, other aspects of network communications.

UNIT V: CONTROL TECHNIQUES
Introduction, state machines, fuzzy logic, neural networks, combined fuzzy logic and neural networks, adaptive control, other control areas.

UNIT VI: SENSOR COMMUNICATION & MEMS
Wireless zone sensing, surface acoustical wave devices, intelligent transportation system, RF-ID, Micro-optics, microgrippers, microprobes, micromirrors, FEDs.

UNIT VII: PACKAGING, TESTING AND RELIABILITY OF SMART SENSORS
Introduction, Semiconductor packaging applied to sensors, hybrid packaging, packaging for monolithic sensors, reliability implications, testing smart sensors. Unit Standards for Smart Sensors: Introduction, setting the standards for smart sensors and systems, IEEE 1451.1, IEEE 1451.2, IEEE P1451.3, IEEE 1451.4, extending the systems to network.

UNIT VIII: IMPLICATIONS OF SMART SENSOR STANDARDS AND RECENT TRENDS
Introduction, sensor plug-and- play, communicating sensor data via existing wiring, automated/remote sensing and web, process control over the internet, alternative standards, HVAC sensor chip, MCU with integrated pressure sensors, alternative views of smart sensing, smart loop.

TEXT BOOKS:
1.Smart Sensors and Sensing Technology, Daniel E. Suarez, Nova Science Publishers.

COURSE OUTCOME:
After successful completion of the course, students will be able to:

CO1: Understand the basics of micro-maching techniques, microelectronics and smart sensor.
CO2: Design basic amplification circuits, signal conditioning circuits and analog to digital converters.
CO3: Understand basics of office, building and home automation techniques.
CO4: Acquire the knowledge of Fuzzy Logics and Neural Networks.
CO5: Have basic knowledge of Internet of Things.

EI 5143	Optimization Techniques	L	T	P	C
		3	0	0	3

UNIT I: GENERAL
Engineering application of Optimization, Formulation of design Problems as mathematical programming problems, classification of optimization problems, Functions of single and multiple variables - optimality criteria, direct and indirect search methods.

UNIT II: LINEAR PROGRAMMING
Graphical method, Simplex method, revised simplex method, Duality in linear programming (LP), Sensitivity analysis, other algorithms for solving LP problems, Transportation, assignment and other applications.

UNIT III: NON-LINEAR PROGRAMMING
Unconstrained optimization techniques, Direct search methods, Descent methods, Constrained optimization, Direct and indirect methods, Optimization with calculus, Khun- Tucker conditions.

UNIT IV: DYNAMIC PROGRAMMING
Introduction, Sequential optimization, computational procedure, curse of dimensionality, Applications in control system and instrumentation.
Advanced Techniques of Optimization: Genetic algorithms for optimization and search. Artificial intelligence in optimization.

TEXT BOOKS
1. D. Bertsimas and J.N. Tsitsiklis, Introduction to Linear Optimization, Athena, Scientific, Belmont, Massachusetts, 1999.
2. S.S. Rao, “Engineering Optimization: Theory and Practice”, New Age International (P) Ltd., New Delhi, 2000.
3. K. Deb, “Optimization for Engineering Design – Algorithms and Examples”, Prentice-Hall of India Pvt. Ltd., New Delhi, 1995.

COURSE OUTCOME:
After successful completion of the course, students will be able to:
CO1: Learn efficient computational procedures to solve optimization problems.
CO2: Cast engineering minima/maxima problems into optimization framework.
CO3: Use Matlab to implement important optimization methods.

EI 5144	Artificial Intelligence	L	T	P	C

		3	**0**	**0**	**3**

UNIT I: INTRODUCTION TO ARTIFICIAL INTELLIGENCE
Overview of Al-general concepts-problem spaces and search –search techniques – BFS, DFS-Heuristic search techniques.

UNIT II: KNOWLEDGE REPRESENTATION
Knowledge –general concepts- predicate logic-representing simple fact- instance and ISA relationships – resolution –natural deduction.

UNIT III: KNOWLEDGE ORGANISATION AND MANIPULATION
Procedural Vs declaration knowledge – forward Vs backward reasoning – matching techniques – control knowledge/strategies – symbol reasoning under uncertainty – introduction to non – monotonic reasoning –logic for monotonic reasoning.

UNIT IV: ERCEPTION – COMMUNICATION AND EXPERT SYSTEMS
Natural language processing – pattern recognition – visual image understanding – expert system
Architecture

UNIT V: KNOWLEDGE ACQUISITION
Knowledge acquisition – general concepts – learning – learning by induction – explanation-based learning

TEXT BOOKS
1. Elaine Rich and Kelvin Knight, Artificial Intelligence, Tata McGraw-Hill, New Delhi, 1991.
2. Stuart Russell and Peter Norvig, Artificial Intelligence: A modern approach Prentice Hal, 1995.

REFERENCE BOOKS
1. Nelson N.J. Principles of Artificial Intelligence, Springer Verlag, Berlin, 1980.
2. Patterson, Introduction to Artificial Intelligence and Expert systems, Prentice Hall of India, New Delhi, 1990.

COURSE OUTCOME:
After successful completion of the course, students will be able to:
CO1: Represent the concept of intelligent agents, search technique, knowledge, reasoning and planning.
CO2: Give ideas of intelligent agents and search method.
CO3: Understand knowledge representation
CO4: Understand about planning and learning methodologies.
CO5: Understand implementation of plans and method for designing controllers.

EI 5145	**Microelectronics and VLSI Design**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

UNIT I:

Introduction to functional verification - HDL and HVL languages - Functional verification approaches verification technologies – code coverage – functional coverage - requirements specification and the verification plan – levels of verification – directed testbench – coverage driven random based approach.

UNIT II:

Introduction to System Verilog - data types, arrays, structures and unions – procedural blocks, tasks and functions – procedural statements – design hierarchy – interfaces.

UNIT III:

High level modeling – data abstraction – OOPS – parallel simulation – race condition – simple and complex stimulus and response – bus functional models – response monitors – transaction level interface self checking testbenches – reference models – transfer function – scoreboarding – monitors -randomization in System Verilog – constrained random verification – random device configuration.

UNIT IV:

Functional coverage in System Verilog – Covergroup/Coverpoint – coverage monitoring – Verification methodology - OVM/UVM basics – System on chip verification – system level and block level verification. Introduction to formal verification – basics of equivalence checking and model checking – Boolean satisfiability (SAT) – assertion-based verification – System Verilog assertions.

REFERENCE BOOKS

1. Sutherland, Stuart, Davidmann, Simon, Flake, Peter, SystemVerilog for Design: A Guide to Using SystemVerilog for Hardware Design and Modeling", Second Edition, Springer Science & Business Media, 2006.
2. Chris Spear, Greg Tumbush, SystemVerilog for Verification: A Guide to Learning the Testbench Language Features, 3rd Edition, Springer Science & Business Media, 2012.
3. Bergeron, J., Writing Testbenches using SystemVerilog, Springer, USA, 2006.
4. Rashinkar P, Paterson P, Singh L., System-on-a-chip verification: methodology and techniques, Springer Science & Business Media; 2007
5. Erik Seligman, Tom Schubert, M V Achutha Kiran Kumar, Formal Verification: An Essential Toolkit for Modern VLSI Design, Morgan Kaufmann, 2015

COURSE OUTCOME:

After successful completion of the course, students will be able to:

CO1: Estimate the effort required for verification and formulate a verification plan for complex IC designs.

CO2: Develop HVL based self-checking test benches both directed and random.

CO3: Apply techniques to assess the verification efficiency and identify the methods to improve it.

CO4: Select suitable formal verification methods for exhaustive verification of a design.

EI 5146	**Advanced Wireless Communication**	L	T	P	C
		3	0	0	3

UNIT I:
Introduction to Wireless Systems: Types, History, Modern Wireless Communication system, Cellular Concept: Design issues, cell capacity, reuse, interference, system capacity, coverage.

UNIT II:
Beyond 3G: HSPA and LTE, Architecture, Radio interface and channels, Resource mapping Session, mobility and security procedures, LTE Advanced, Heterogeneous Networks, Internetworking, IP based coupling Architecture, Multimode terminals and intersystem handover.

UNIT III:
MIMO Wireless communication: Wireless channels, Error/Outage probability over fading channels, Diversity techniques, Channel coding as a means of time diversity, Multiple antennas in wireless communications, Capacity and Information rates of noisy, AWGN and fading channels, Capacity of MIMO channels, Capacity of non-coherent MIMO channels, Constrained signaling for MIMO communications.

UNIT IV:
Ultrawideband communication: Introduction, Power spectral density, Pulse shape, UWB modulation methods, UWB transmitter/receiver, Multiple access techniques in UWB, Capacity of UWB systems, Comparison of UWB with other wideband communication systems, Interference and coexistence of UWB with other systems, Applications of UWB communication systems.

TEXT BOOKS:
1. Iti Saha Misra, “Wireless Communication and Networks – 3G and Beyond”, Mc Graw Hill Education, Second Edition, 2013.
2. Jochen Schiller, “Mobile Communications”, Pearson Education, Second Edition, 2012.
3. E.Dahlman et. al., “3G Evolution: HSPA and LTE for Mobile Broadband”, Elsevier, Second Edition, 2008.
4. Tolga M. Duman and Ali Ghrayeb, “Coding for MIMO Communication systems”, John Wiley & Sons, West Sussex, England, 2007.
5. M. Ghavami, L. B. Michael and R. Kohno, “Ultra Wideband signals and systems in Communication Engineering”, 2nd Edition, John Wiley & Sons, NY, USA, 2007.
6. T.S. Rappaport, “Wireless communication, Principles and Practice”, Pearson Publications.

COURSE OUTCOME:
After successful completion of the course, students will be able to:
CO1: Develop a comprehensive overview of UWB system design that spans pulse shape, modulation schemes, multiple access techniques and applications.
CO2: Identify the Capacity and information rates of MIMO channels.
CO3: Describe the concepts of cellular communication.
C04: Classify the mobility and security procedures for LTE communication.

EI 5147	Fibre Optics and LASER Instrumentation	L	T	P	C
		3	0	0	3

UNIT I: OPTICAL FIBRES AND THEIR PROPERTIES

Principles of light propagation through a fibre - Different types of fibres and their properties, fibre characteristics – Absorption losses – Scattering losses – Dispersion – Connectors and splicers – Fibre termination – Optical sources – Optical detectors.

UNIT II: INDUSTRIAL APPLICATION OF OPTICAL FIBRES

Fibre optic sensors – Fibre optic instrumentation system – Different types of modulators – Interferometric method of measurement of length – Moire fringes – Measurement of pressure, temperature, current, voltage, liquid level and strain.

UNIT III: LASER FUNDAMENTALS

Fundamental characteristics of lasers – Three level and four level lasers – Properties of laser – Laser modes – Resonator configuration – Q-switching and mode locking – Cavity damping – Types of lasers – Gas lasers, solid lasers, liquid lasers, semiconductor lasers.

UNIT IV: INDUSTRIAL APPLICATION OF LASERS

Laser for measurement of distance, length, velocity, acceleration, current, voltage and Atmospheric effect – Material processing – Laser heating, welding, melting and trimming of material – Removal and vaporization.

UNIT V: HOLOGRAM AND MEDICAL APPLICATIONS

Holography – Basic principle - Methods – Holographic interferometry and application, Holography for non-destructive testing – Holographic components – Medical applications of lasers, laser and tissue interactive – Laser instruments for surgery, removal of tumors of vocal cards, brain surgery, plastic surgery, gynaecology and oncology.

TEXT BOOKS

1. J.M. Senior, ‘Optical Fibre Communication – Principles and Practice’, Prentice Hall of India, 1985.
2. J. Wilson and J.F.B. Hawkes, ‘Introduction to Opto Electronics’, Prentice Hall of India, 2001.

REFERENCE BOOKS

1. G. Keiser, ‘Optical Fibre Communication’, McGraw Hill, 1995.
2. M. Arumugam, ‘Optical Fibre Communication and Sensors’, Anuradha Agencies, 2002.
3. John F. Read, ‘Industrial Applications of Lasers’, Academic Press, 1978.
4. Monte Ross, ‘Laser Applications’, McGraw Hill, 1968.

SUGGESTED READINGS

1. John and Harry, **Industrial Lasers and their Applications**, McGraw Hill, 1974.
2. Senior J.M., **Optical Fiber Communication Principles and Practice**, Prentice Hall, 1985.

3. John F Read, **Industrial Applications of Lasers**, Academic Press, 1978.
4. MonteRoss, **Laser Applications**, McGraw Hill, 1968.
5. Keiser G., **Optical Fiber Communication**, McGraw Hill, 1991.
6. Jasprit Singh, **Semiconductor Optoelectronics**, McGraw Hill, 1995.
7. Ghatak A.K and Thiagarajar K, Optical Electronics Foundation Book, TMH, New Delhi, 1999.

COURSE OUTCOME:
After successful completion of the course, students will be able to:
CO1: Calculate attenuation constant, numerical aperture, acceptance angle and multipath time dispersion of single and multi-mode optical fiber if refractive indices of core, cladding and medium are given.
CO2: Explain the methods of fabrication of optical fibers, LASERs and light emitting diodes.
CO3: Calculate quantum efficiency and responsivity of PIN and Avalanche photodiodes if operating wavelength and obtained photocurrent is given.
CO4: Design Laser based systems for measurement of distance and velocity.
CO5: Investigate medical applications of Lasers.

EI 5148	Testing and Calibration of instruments	L	T	P	C
		3	0	0	3

UNIT I: INTRODUCTION TO TESTING AND CALIBRATION
The Signal Flow of Electronic Instruments, The Instrument Block Diagram, Measurement Systems, Types of instrument, Traceability, Calibration Types, Calibration Requirements, Calibration Methodology, Instrument Specifications and Calibration Tests, Calibration Standard Requirements.

UNIT II: TEST MEASUREMENT INSTRUMENTATION
Test Measurement Instrumentation, Process Instrumentation, Test Objective Requirements and limitations, Test Data - Format and Analysis.

UNIT III: TESTING OF INSTRUMENTS
Voltage-Voltmeter, Current - Ammeter and Resistance - Ohmmeter, Temperature - Thermocouple, Pressure - Primary pressure sensing elements-Diaphragm, Bourdon tube.

UNIT IV: CALIBRATION REQUIREMENTS
Calibration procedure, calibration procedure content, calibration datasheet, Instrument Specification Forms, Project Specifications, Manufacturer‘s Specifications, Calibration Intervals, Safety Considerations, Calibration Status Labels.

UNIT V: CALIBRATION STANDARDS
National Measurement Standard Laboratories, Commercial Calibration Services, standards in different National Laboratories and Bureaus, calibration management and maintenance.

TEXT BOOKS
1. Mike Cable, ―Calibration - A technician‘s guide, ISA, 2005.
2. Vaisala Oyj, ―Calibration Book, Calibration book project team, 2006.

REFERENCES
1. Clyde F.Coombs Jr, ―Electronic Instrument Handbook, 3rd Edition, 2008.
2. M/s. Beamex OYED, Fram in Vaasa, Finland, 2nd Edition, 2012.
3. http://www.iceweb.com.au/Test&Calibration/Test%20and%20Calibration.htm

COURSE OUTCOME:
After successful completion of the course, students will be able to:
CO1: Explain key terms related to testing and calibration.
CO2: Illustrate the test measurement instrumentation system.
CO3: Explain the testing procedures for industrial instruments.
CO4: Prepare calibration data sheet for an instrument of interest.
CO5: Carryout the calibration management process based on types of instrument and with relevant standards.

EI 5149	**Industrial Instrumentation**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

UNIT I: LEVEL MEASUREMENT
Sight Glass, Float, Displacer type and Bubbler system – Electrical level gauge:- Resistance and Capacitance – Nuclear radiation - Ultrasonic level transmitters - Guided Wave Radar Level Transmitters – vibration and microwave level switches- – Boiler drum level measurement. Leading manufacturers of flow and level instruments with specifications. (Non-descriptive).

UNIT II: PRESSURE MEASUREMENT
Units of pressure, Manometers - different types, Elastic type pressure gauges - Bourdon tube, bellows and diaphragms, Electrical methods - Elastic elements with LVDT and strain gauges, Capacitive type pressure gauge, Piezo resistive pressure sensor, Resonator pressure sensor, Measurement of vacuum-McLeod gauge, Thermal conductivity gauge, lonization gauges, Cold cathode type and hot cathode type, calibration of pressure gauges, Dead weight tester.

UNIT III: FLOW MEASUREMENT
Variable Head Type Flow Meters: Variable head type flow meters: Orifice plate, Venturi tube, Flow nozzle and Dall tube – Installation of head flow meters – Conditioning Orifice Plates- Pitot tube.

UNIT IV: METERS
Quantity Meters, Area Flow Meters and Mass Flow Meters: Positive displacement flow meters: Nutating disc, Reciprocating piston, Oval gear and Helix type flow meters – Inferential meter – Turbine flow meter – Area flow meter: Rotameter – Theory and installation – Mass flow meters: Thermal and Coriolis – Temperature/pressure compensation in mass flow meters - Calibration of flow meters: Dynamic weighing methods.

UNIT V: FLOW METERS
Principle and constructional details of Electromagnetic flow meter – Ultrasonic flow meters – Laser Doppler anemometer – Vortex shedding flow meter – Target flow meter – Open channel flow measurement – Solid flow rate measurement – guidelines for selection of flow meter.

UNIT VI: INDUSTRIAL SAFETY

Safety: Introduction, electrical hazards, hazardous areas and classification, Non-hazardous areas, enclosures – NEMA types, fuses and circuit breakers, protection methods: purging, explosion proofing and Intrinsic safety. Specification of instruments, preparation of project documentation, process flow sheet, Instrument index sheet, Instrument specification sheet, panel drawing and specifications.

TEXT BOOKS:

1. Ernest O.Doebelin, "Measurement systems Application and Design", International Student Edition, IV Edition, McGraw Hill Book Company.
2. R.K. Jain, "Mechanical and Industrial Measurements", Khanna Publishers, New Delhi.
3. C. D. Johnson, "Process Control Instrumentation Technology", PHI.
4. S.K. Singh, "Industrial Instrumentation and Control", Tata McGraw Hill Publishing Ltd., New Delhi.
5. D. Patranabis, "Principles of Industrial Instrumentation", Tata McGraw Hill Publishing Ltd., New Delhi,
6. Andrew W.G, "Applied Instrumentation in Process Industries – A survey", Vol. 1 & Vol.2, Gulf Publishing Company, Houston.
7. James W. Dailly, William F. Riley, Kenneth G. Mc. Connel, ―Instruments for Engineering Measurements, Wiley Edition.
8. A.K. Sawhney, ―A course in Electrical and Electronic Measurement and Instrumentation‖ Dhanpat Rai and Sons, New Delhi, 2014.
9. Liptak B.G., ―Instrumentation Engineers Handbook (Measurement)‖, CRC Press, 2005.
10. Lessons in Industrial Instrumentation: www.ibiblio.org/ kuphaldt/ socratic/ sinst/ book/ liii.pdf
11. Industrial Flow measurement: http://eprints.hud.ac.uk/5098/1/macrabtreefinalthesis.

COURSE OUTCOME:

After successful completion of the course, students will be able to:

CO1: Illustrate the working principle of instruments involved in level and pressure measurement.

CO2: Explain the theory, operation and installation of variable head type and mass flow meters.

CO3: Describe the construction and principle of operation of electrical type flow meters.

CO4: Select appropriate method to measure level, pressure and flow for different applications.

CO5: Provide customized solution for specific level, pressure and flow measurement problems.

CO6: Explain the safety precautions/guidelines while being in Industrial area during installation, commissioning and operation.

ELECTIVE II

EI 5151	Robotics & Automation	L	T	P	C
		3	0	0	3

UNIT I: INTRODUCTION

Robotics – Basic components – Classification – Performance characteristics – Actuators- Electric actuator-DC motor horse power calculation, magneto strictive hydraulic and pneumatic actuators. Sensors and vision systems: Different types of robot transducers and sensors – Tactile sensors – Proximity and range sensors–ultrasonic sensor-touch sensors-slip sensors-sensor calibration- vision systems – Image processing and analysis – image data reduction – segmentation feature extraction – Object recognition.

UNIT II: ROBOT CONTROL

Control of robot manipulators- state equations-constant solutions-linear feedback systems-single axis PID control- PD gravity control- computed torque control- variable structure control- Impedance control.

UNIT III: END EFFECTORS

End effectors and tools– types – Mechanical grippers – Vacuum cups – Magnetic grippers – Robot end effectors interface, work space analysis work envelope-workspace fixtures-pick and place operation-continuous path motion-interpolated motion-straight line motion.

UNIT IV: ROBOT MOTION ANALYSIS

Robot motion analysis and control: Manipulator kinematics –forward and inverse kinematics-arm equation-link coordinates-Homogeneous transformations and rotations and Robot dynamics.

UNIT V: ROBOT APPLICATIONS/AUTOMATION

Industrial and Non industrial robots, Robots for welding, painting and assembly – Remote Controlled robots– Robots for nuclear, thermal and chemical plants – Industrial automation – Typical examples of automated industries.

TEXT BOOKS

1. Mikel P. Grover,et. Al. “Industrial Robots – Technology Programming and Applications”, McGraw Hill.

2. Robert J.Schilling, Fundamentals of Robotics-Analysis and Control, PHI. (Unit-II and Unit-III).

REFERENCE BOOKS

1. K.S. Fu, R.C. Gonzalez, C.S.G. Lee, Robotics, control sensing vision and Intelligence, Tata McGraw-Hill.

COURSE OUTCOME:

After successful completion of the course, students will be able to:

CO1: Demonstrate knowledge of the relationship between mechanical structures of industrial robots and their operational workspace characteristics.

CO2: Demonstrate an ability to apply spatial transformation to obtain forward kinematics equation of robot manipulators.

CO3: Demonstrate an ability to solve inverse kinematics of simple robot manipulators.

CO4: Demonstrate an ability to obtain the Jacobian matrix and use it to identify singularities.

CO5: Demonstrate an ability to generate joint trajectory for motion planning.

EI 5152	**PC Based Instrumentation**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

UNIT I:
Introduction, Necessity and functions of computers. Level of automation and economy of computer control. Centralized computer control Vs distributed computer control.

UNIT II:
Computer architecture, Micro and mini-computer, functional models of I.O. system, interfacing, Sampling.

UNIT III:
Multiplexing; A/D and D/A converters, interfacing with different types of transducers - Analog/Digital, Electrical and non-electrical selection of sensors; Micro-computer interfacing standard buses Serial buses; Serial data communication protocols.

UNIT IV:
Study of automatic process control, Fundamental of automatic process control, building block of automatic system, direct and distributed digital control system, Programmable controllers.

UNIT V:
Personal computer in real life environment, Introduction, personal computer: system and facility, PC bus and signals, interrupts, interfacing P C with outer world, PC in RTE, Real time application of IBM PC, PC based distributed control system, Programming and application, Modelling and simulation for plant automation, PLC Architecture and programming of PLC, industrial control application: cement plant, thermal power plant, water treatment plant, steel plant.

TEXT BOOKS
1. Computer based industrial control: Krishan Kant, PHI.
2. PC-based Instrumentation: Concepts and Practice (Paperback), N. Mathivanan, PHI

COURSE OUTCOME:
After successful completion of the course, students will be able to:
CO1: Understand the main functional units in a PC and be able to explain how they interact. They should know different bus types, and on this basis be able to distinguish account for different generations of PCs.
CO2: Understand an operating system and their importance such as multitasking, privilege levels and drivers.
CO3: Solve simple instrumentation tasks using both PC and microcontroller. They shall also master programming in C and LabVIEW on a level that enables them to solve such tasks.
CO4: At the end of each chapter, review question, problems given to reinforce their understanding of the concepts to re-in force their command and over the aspect to implement in projects.

EI 5153	Information and Communication Theory	L	T	P	C
		3	0	0	3

UNIT I:
Introduction to detection and estimation problem in communication, The meaning and axioms of probability; Random variables, Examples of commonly used random variables and their density and distribution functions, Moments and characteristic functions, Bivariate distributions and functions of two random variables, joint moments and characteristic functions, conditional distributions and expected values.

UNIT II:
Binary hypothesis testing: Bayes, Neyman-Pearson, maximum likelihood, MAP and minimum probability of error criteria; Bayes, ML and MAP estimation.

UNIT III:
Information, entropy, source coding theorem, Mutual information, Data compression, Huffman coding, Markov sources; Channel capacity theorems for discrete and continuous ensembles; Introduction to rate distortion function, Shannon Hartley Law, Trade-off between bandwidth and SNR.

UNIT IV:
Correlation matrix and characteristic functions of sequences of random variables, jointly normal random variables; Mean square estimation, stochastic convergence and limit theorems, Random number generation.

UNIT V:
Random processes, correlation function and power spectrum, random process through linear systems, KLT, ergodicity.

TEXT BOOKS
1. Papoulis, A. and Pillai, S.U., "Probability, Random Variables and Stochastic Processes", Tata McGraw-Hill.
2. Cover, T.M. and Thomas, J.A., "Elements of Information Theory", 2nd Ed., Wiley Interscience.
3. Van Trees, H.L., "Detection, Estimation and Modulation Theory", Part I, Wiley Interscience.
4. Bose, R., "Information Theory, Coding and Cryptography", Tata McGraw-Hill.

COURSE OUTCOME:
After successful completion of the course, students will be able to:
CO1: Understand the concepts of probability to analyse detection and estimation problem in communication.
CO2: Acquire the knowledge of binary hypothesis testing for control, instrumentation and communication system.
CO3: Design the channel performance using Information theory.
CO4: Apply the concepts of random process in control and communication system.

EI 5154	Intelligent Instrumentation	L	T	P	C
		3	0	0	3

UNIT I: INTRODUCTION
Intelligence, features characterizing intelligence, intelligent instrumentation system; features of intelligent instrumentation; components of intelligent instrumentation system. Block diagram of an intelligent instrumentation system.

UNIT II: SIGNAL PROCESSING, MANIPULATION AND TRANSMISSION
Signal amplification & attenuation (OP-AMP based); Instrumentation Amplifier (circuit diagram, high CMRR& other features); Signal Linearization (different types such as Diode resistor combination, OP-AMP based, etc.(; Bias Removal, Signal filtering (outputs from ideal filters, outputs form constant-k filters, matching of filter sections, active analog filters);OP-AMP based Voltage-to-current converter, Current-to-voltage conversions, Signal integration, Voltage follower (pre amplifier); voltage comparator, Phase –Locked loop, Signal addition, Signal multiplication, Signal Transmission (Signal amplification, Shielding , Current loop transmission, Voltage-to-frequency conversion, Fiber optic transmission).

UNIT III: SMART SENSORS
Primary sensors; Excitation; Compensation (Nonlinearity: look up table method, polygon interpolation, polynomial interpolation, cubic spline interpolation, Approximation & regression: Noise & interference; Response time: Drift; Cross-sensitivity); information coding/Processing; Data Communication; Standards for smart sensor interface.

UNIT IV: INTERFACING INSTRUMENTS
Address decoding; Data transfer control; A/D converter; D/A converter; Sample & hold circuit; others interface considerations.

UNIT V: RECENT TRENDS IN SENSOR TECHNOLOGIES
Introduction; Film sensors (Thick film sensors, this film sensor) Semiconductor IC Technology- Standard methods; Micro electro- mechanical systems (Micro-machining, some application examples); Nano-Sensors.

TEXT BOOKS
1. Barney, G.C., Intelligent instruments, Hemel Hempsteao: Prentice Hall.
2. Alan S. Morris, Principles of Measurement s Instrumentation. New Delhi, PHI Pvt. Ltd.
3. D. Patranabis, Sensors s Transducers, New Delhi, PHI.
4. Roman Kuc, Introduction to Digital Signal Processing, New York: McGraw-Hill Pub. Co.

COURSE OUTCOME:
After successful completion of the course, students will be able to:
CO1: Understand the concept of Intelligent instrumentation.
CO2: Identify the optimized protocol selection according to the application area.
CO3: Design complete automatic process control system.
CO4: Analyze the PLC systems in industry.

EI 5155	Computer Controlled Processes	L	T	P	C
		3	0	0	3

UNIT I: ANALYSIS OF SAMPLED DATA CONTROL SYSTEM

Continuous and discrete systems sample data system- Z transform –inverse Z transform-selection of sampling period – mathematical representation of sampler- transfer function of zero order hold and first order hold device-Pulse transfer function – –open loop and closed response of linear sample data control system for step input – stability analysis: Jury's test and bilinear transformation-State space representation of sample data systems.

UNIT II: DIGITAL CONTROL ALGORITHMS

– Deadbeat Algorithm – Dahlin's method – ringing – Kalman's approach – discrete equivalent to an analog controller – design for load changes. PID Algorithms – tuning techniques. Selection of sampling time. Dead time Compensation – Smith Predictor Algorithm.

UNIT III: SYSTEM MODELING AND IDENTIFICATION

– Mathematical model for processes – first order. Second order processes without and with pure delay higher order systems –process modeling form step test data – pulse testing for process identification – time – domain identification – linear least square algorithm. Robust Control, Intelligent Controllers, Optimal Control.

UNIT IV: ADAPTIVE CONTROL

Introduction- types- MFA control- single loop MFA control-multivariable MFA control-model reference adaptive control.

UNIT V: MODEL PREDICTIVE CONTROL

Introduction- optimization problems- dynamic matrix control-DMC for first order process – quadratic DMC.

TEXT BOOKS

1. P.B. Deshpande and R.H. Ash, "Elements of Computer Process Control", Instrument Society of America,1981.
2. B.W. Bequette. "Process control", Prentice Hall Inc. 2006.
3. C.L. Smith, "Digital Computer Process Control", Intext Educational Publishers, 1972.
4. Vance Vandoren, "Techniques for Adaptive Control" BH publishers., 2003.

COURSE OUTCOME:

After successful completion of the course, students will be able to:

CO1: Analyze control systems using different transforms.
CO2: Understand various PID Algorithms.
CO3: Model and identify different process control systems.
CO4: Understand and analyze adaptive control systems.

EI 5156	Biomedical Signal Processing	L	T	P	C
		3	0	0	3

UNIT I: DISCRETE – TIME SIGNALS AND SYSTEMS
Sampling of Analogue signals – aliasing – standard discrete time signals – classification – discrete time systems – Linear time invariant stable casual discrete time systems – classification methods – linear and circular convolution – difference equation representation – DFS, DTFT, DFT – FFT computations using DIT and DIF algorithms.

UNIT II: INFINITE IMPULSE RESPONSE DIGITAL FILTERS
Review of design of analogue Butterworth and Chebyshev Filters, Frequency transformation in analogue domain – Design of IIR digital filters using impulse invariance technique – Design of digital filters using bilinear transform – pre warping – Frequency transformation in digital domain – Realization using direct, cascade and parallel forms.

UNIT III: FINITE IMPULSE RESPONSE DIGITAL FILTERS
Symmetric and Antisymmetric FIR filters – Linear phase FIR filters – Design using Frequency sampling technique – Window design using Hamming, Hanning and Blackmann Windows – Concept of optimum equiripple approximation – Realisation of FIR filters – Transversal, Linear phase and Polyphase Realization structures.

UNIT IV: ANALYSIS OF BIO –SIGNALS
Removal of artifacts-ECG, Event detection –ECG, P wave, QRS Complex, T wave, correlation analysis of ECG signals, Averaging of signals-PCG, ECG and EMG.

UNIT V: SPECIAL TOPICS IN BIOMEDICAL SIGNAL PROCESSING
Heart rate variability Analysis. Analysis of PCG signals, Analysis of Time variant systems, Fixed segmentation –STFT, ACF, SEM and GLR.

TEXT BOOKS
1. John G. Proakis and Dimitris G. Manolakis, Digital Signal Processing, Algorithms and Applications, PHI of India Ltd., New Delhi, 3rd Edition, 2000. Rangaraj. M. Rangayyan, Biomedical signal processing,

REFERENCE BOOKS
1. S.K. Mitra 'Digital Signal Processing', A Computer Based Approach, Tata McGraw-Hill, New Delhi, 1998.

COURSE OUTCOME:
After successful completion of the course, students will be able to:
CO1: Understand DFT and its computation.

CO2: Analyze the design techniques involved for digital filters.
CO3: Identify the bio-signals.
CO4: Understand special techniques like Heart rate variability Analysis.

EI 5157	IC Technology & Applications	L	T	P	C
		3	0	0	3

UNIT I: INTRODUCTION TO IC TECHNOLOGY
Historical perspective, design methodologies & styles, VLSI Design flow, Design hierarchy Custom Circuit design, Cell based and Array based design implementations.

UNIT II: IC FABRICATION
MOSFET fabrication, CMOS n-well, p-well, twin tub process, layout design rules, full custom mask layout design, Power dissipation, Designing combinational logic circuits.

UNIT III: DEVICE PHYSICS
Analysis of MOSFET, Calculation of threshold voltage, Static I-V characteristics of MOSFETs, MOSFET capacitances, C-V characteristics, Channel length modulation, body bias effect and short channel effects, MOS switch, MOSFET models for calculation.

UNIT IV: CMOS INVERTER
Static and Dynamic Characteristics of CMOS inverter, switching characteristics and interconnect.

UNIT V: MEMORY DESIGN
Read-Only Memories, ROM cells, Read-write memories (RAM), dynamic memory design, 4 transistor SRAM cell, 6 transistor SRAM cell, Sense amplifiers.

TEXT BOOKS
1. Sung-Mo (Steve) Kang (Author), Yusuf Leblebici "CMOS Digital Integrated Circuits Analysis & Design (3/e)" TMH, 2002.
2. J.Rabey, M. Pedram, "Digital Integrated circuits (2/e)", PHI, 2003.

REFERENCE BOOKS
1. Pucknell & Eshraghian, "Basic VLSI Design", (3/e), PHI, 1996.

COURSE OUTCOME:
After successful completion of the course, students will be able to:
CO1: Understand the rapid advances in CMOS technology.
CO2: Learn the basic terminology of VLSI.
CO3: Know the steps involved in IC fabrication.
CO4: Understand MOSFET device related issues and their impact on circuits.
CO5: Appriciate CMOS Inverter its VTC and the parameters affecting it.

EI 5158	Data Acquisition and Signal Conditioning	L	T	P	C
		3	0	0	3

UNIT I: DATA ACQUISITION TECHNIQUES
Analog and digital data acquisition, Sensor/Transducer interfacing, unipolar and bipolar transducers, Sample and hold circuits, Interference, Grounding and Shielding.

UNIT II: DATA ACQUISITION USING OP-AMPS
Operational Amplifiers, CMRR, Slew Rate, Gain, Bandwidth. Zero crossing detector, Peak detector, Window detector. Difference Amplifier, Instrumentation Amplifier AD 620, Interfacing of IA with sensors and transducer, Basic Bridge amplifier and its use with strain gauge and temperature sensors, Filters in instrumentation circuits.

UNIT III: DATA TRANSFER TECHNIQUES
Serial data transmission methods and standards RS 232-C: specifications connection and timing, 4-20 mA current loop, GPIB/IEEE-488, LAN, Universal serial bus, HART protocol, Foundation-Fieldbus, ModBus, Zigbee and Bluetooth.

UNIT IV: DATA ACQUISITION SYSTEM (DAS):
Single channel and multichannel, Graphical Interface (GUI) Software for DAS, RTUs, PC-Based data acquisition system.

Laboratory Work: Op-amp as a comparator and its application, Integrator and differentiator, Active filters, Simulation of the above applications using ORCAD, Instrumentation Amplifier/AD 620, Interfacing of sensors and transducers using DAQ cards.

TEXT BOOKS
1. Coughlin, R.F., Operational Amplifiers and Linear Integrated Circuits, Pearson Education (2006).
2. Kalsi, H.S., Electronic Instrumentation, Tata McGraw Hill (2002).
3. Gayakwad, R.A., Op-Amp and Linear Integrated Circuits, Pearson Education (2002).
4. Mathivanan, N., Microprocessor PC Hardware and Interfacing, Prentice Hall of India Private Limited (2007).

REFERENCE BOOKS
1. Anand, M.M.S., Electronic Instruments and Instrumentation Technology, Prentice Hall of India Private Limited (2004).
2. Murthy, D.V.S., Transducers and Instrumentation, Prentice Hall of India Private Limited (2006).

COURSE OUTCOME:
After successful completion of the course, students will be able to:
CO1: Elucidate the elements of data acquisition techniques.
CO2: Design and simulate signal conditioning circuits.
CO3: Explain various data transfer techniques.
CO4: Explain the components of data acquisition system.
CO5: Differentiate between single and multi-channel.

ELECTIVE- III

EI 5161	MEMS	L	T	P	C
		3	0	0	3

UNIT I:
Introduction to MEMS, Lithography and Soft Lithography, Materials and Material Properties.

UNIT II:
Basic Micro/Nanofabrication Techniques, Bulk Micromachining, a. Dry Bulk Micromachining, b. Wet Bulk Micromachining, Surface Micromachining, Wafer Bonding and Packaging.

UNIT III:
MEMS Design and High-Volume Manufacturing.

UNIT IV:
Fundamentals: a. Electronics, b. Structures and Elasticity, c. Fluids and Mass Transport in Liquids.

UNIT V:
Structures and Devices: a. Mechanical Sensors, b. Mechanical Actuators, c. Microfluidic Devices, d. Optical/Photonic Microsystems, e. Biological Transducers.

COURSE OUTCOME:
After successful completion of the course, students will be able to:
CO1: Introduce to the field of micro/nanosystems.
CO2: Gain knowledge of basic approaches for micro/nanosystem design.
CO3: Gain knowledge of state-of-the-art lithography techniques for micro/nanosystems.
CO4: Learn new materials, science and technology for micro/nanosystem applications.
CO5: Understand materials science for micro/nanosystem applications.

EI 5162	Analog and Digital VLSI Design	L	T	P	C
		3	0	0	3

UNIT I:

CMOS Amplifiers & CMOS Operation Amplifiers: Basic concepts, Performance Parameters, One state OPAMP, Two stage OPAMP, Stability and Phase compensation, Cascode OPAMP, Design of two-stage and Cascode OPAMP.

UNIT II:

Switch Capacitor circuits: General considerations, Switched capacitor integrators, First and second order switched capacitor filter circuits, Ideal D/A converters, Ideal A/D converter, Serial and Flash D/A converters and A/D converters, Special Circuits: CMOS voltage controlled oscillators, Ring oscillators.

UNIT III:

Differential Amplifiers: The Source Coupled pair, the Source Cross-Coupled pair, cascode loads, Wide-Swing Differential Amplifiers, Operational Amplifiers: Basic CMOS Op-Amp Design, Operational Trans conductance Amplifiers, Differential Output Op-Amp.

REFERENCE BOOKS

1. Allen Phillip E and Holberg Douglas R, CMOS Analog Circuit Design, 3rd Edition, Oxford University Press, 2012. (TK7874.A428 2012).
2. Weste Neil H E and Harris David Money, CMOS VLSI Design: A Circuit and Systems Perspective, 4th Edition, Addison Wesley, 2011. (TK7874.W525 2011).
3. Rabaey Jan M, Chandrakasan Anantha P and Nikolic Borivoje, Digital Integrated Circuits: A Design Perspective, 2nd Edition, Pearson Education, 2003. (TK7874.65.R112 2003).
4. Lin Ming-Bo, Introduction to VLSI Systems: A Logic, Circuit and System Perspective, CRC Press, 2012 (TK7874.75.L735).
5. Sansen Wiley M C, Analog Design Essentials, Springer, 2006. (TK7874.654.S229).
6. Tony Chan Carusone, David Jones and Ken Martins, Analog Integrated Circuit Design, 2nd Edition, John Wiley & Sons, 2013. (TK7874.J65 2013).

COURSE OUTCOME:

After successful completion of the course, students will be able to:

CO1: Apply knowledge of mathematics, science, and engineering to design and analysis of analog integrated circuits.

CO2: Acquire knowledge to identify, formulates, and solves engineering problems in the area of analog integrated circuits.

CO3: Design methodologies using practical integrated circuits.

CO4: Know the fabrication process of CMOS technology and its layout design rules

EI 5163	Logic & Distributed Control Systems	L	T	P	C
		3	0	0	3

UNIT I:
Review of computers in process control: Data loggers, Data Acquisition Systems (DAS), Direct Digital Control (DDC). Supervisory Control and Data Acquisition Systems (SCADA), sampling considerations. Functional block diagram of computer control systems. alarms, interrupts. Characteristics of digital data, controller software Linearization. Digital controller modes: Error, proportional, derivative and composite controller modes.

UNIT II:
Programmable logic controller (PLC) basics: Definition, overview of PLC systems, input/output modules, power supplies, isolators. General PLC programming procedures, programming on-off inputs/ outputs. Auxiliary commands and functions: PLC Basic Functions: Register basics, timer functions, counter functions.

UNIT III:
PLC intermediate functions: Arithmetic functions, number comparison functions, Skip and MCR functions, data move systems. PLC Advanced intermediate functions: Utilizing digital bits, sequencer functions, matrix functions. PLC Advanced functions: Alternate programming languages, analog PLC operation, networking of PLC, PLC-PID functions, PLC installation, troubleshooting and maintenance, design of interlocks and alarms using PLC. Creating ladder diagrams from process control descriptions.

UNIT IV:
Distributed control systems (DCS): Definition, Local Control (LCU) architecture, LCU languages, LCU - Process interfacing issues, communication facilities, configuration of DCS, displays, redundancy concept case studies in DCS.

UNIT V: Supervisory Control and Data Acquisition (SCADA): Objectives and features of HMI and SCADA, Building blocks for mimic diagrams, Building blocks for data entry and reports, Introducing animation and alarms, Selection criteria of SCADA /HMI, Making a SCADA for Sample application and communication.

TEXT BOOKS

1. John. W.Webb Ronald A Reis , Programmable Logic Controllers - Principles and Applications, Third edition, Prentice Hall Inc., New Jersey, 1995.
2. Lukcas M.P Distributed Control Systems, Van Nostrand Reinhold Co., New York, 1986.
3. Deshpande P.B and Ash R.H, Elements of Process Control Applications, ISA Press, New York, 1995.
4. Curtis D. Johnson, Process Control Instrumentation Technology, Fourth edition, Prentice

Hall of India, New Delhi, 1999.

COURSE OUTCOME:

After successful completion of the course, students will be able to:

CO1: Understand the application of computers in industrial process systems.

CO2: Understand the overview of PLC's architectures, programs, logic & their functional blocks.

CO3: Do Communications in PLC's and case study of bottle filling plant.

CO4: Understand the application of DCS in industrial.

CO5: Design a logic control system using SCADA.

EI 5164	Digital Control System	L	T	P	C
		3	0	0	3

UNIT I: INTRODUCTION

Sampling and holding – Sample and hold devices – D/A and A/D conversion – Reconstruction – Z transform – Inverse Z transform – Properties – Pulse transfer function - state variable approach –Review of controllability – observability.

UNIT II: DESIGN USING TRANSFORM TECHNIQUES

Methods of discretisation – Comparison – Direct design – Frequency response methods.

UNIT III: DESIGN USING STATE SPACE TECHNIQUES

State space design – Pole assignment – Optimal control – State estimation in the presence of noise –Effect of delays.

UNIT IV: COMPUTER BASED CONTROL

Selection of processors – Mechanization of control algorithms – PID control laws predictor merits and demerits – Application to temperature control – Control of electric drives – Data communication for control.

UNIT V: QUANTIZATION EFFECTS AND SAMPLE RATE SELECTION

Analysis of round off error – Parameter round off – Limit cycles and dither – Sampling theorem limit – Time response and smoothness – Sensitivity to parameter variations – Measurement noise and anti-aliasing filter – Multi-rate sampling.

TEXT BOOKS

1. Gopal. M., "Digital control Engineering", Wiley Eastern Ltd.1989.

REFERENCE BOOKS

1. G. F. Franklin, J. David Powell, Michael Workman, "Digital control of Dynamic Systems", 3rd Edition, Addison Wesley, 2000.

2. Paul Katz, "Digital control using Microprocessors", Prentice Hall, 1981.

3. Forsytheand. W. Goodall. R. N., "Digital Control", McMillan,1991.

4. Chesmond, Wilson, Lepla, "Advanced Control System Technology", Viva – low price edition, 1998.

COURSE OUTCOME:

After successful completion of the course, students will be able to:
CO1: Have the basic knowledge of A/D and D/A conversion.
CO2: Have the knowledge of Z- Transform.
CO3: Have knowledge of digital process control design.
CO4: Design and compensate the digital control system.

EI 5165	Digital Image Processing	L	T	P	C
		3	0	0	3

UNIT I: DIGITAL IMAGE FUNDAMENTALS AND TRANSFORMS
Elements of visual perception – Image sampling and quantization Basic relationship between pixels – Basic geometric transformations-Introduction to Fourier Transform and DFT – Properties of 2D Fourier Transform – FFT – Separable Image Transforms -Walsh – Hadamard – Discrete Cosine Transform, Haar, Slant – Karhunen – Loeve transforms.

UNIT II: IMAGE ENHANCEMENT TECHNIQUES:
Spatial Domain methods: Basic grey level transformation, Histogram equalization, Image subtraction, Image averaging, Spatial filtering: Smoothing, sharpening filters, Laplacian filters, Frequency domain filters: Smoothing, Sharpening filters, Homomorphic filtering.

UNIT III: IMAGE RESTORATION
Model of Image Degradation/restoration process, Noise models, Inverse filtering, Least mean square filtering, Constrained least mean square filtering, Blind image restoration, Pseudo inverse, Singular value decomposition.

UNIT IV: IMAGE COMPRESSION
Lossless compression: Variable length coding, LZW coding, Bit plane coding, predictive coding-DPCM. Lossy Compression: Transform coding, Wavelet coding, Basics of Image compression standards: JPEG, MPEG, Basics of Vector quantization.

UNIT V: IMAGE SEGMENTATION AND REPRESENTATION
Edge detection, Thresholding, Region Based segmentation, Boundary representation: chair codes, Polygonal approximation, Boundary segments, boundary descriptors: Simple descriptors, Fourier descriptors, Regional descriptors, Simple descriptors, Texture.

TEXT BOOKS
1. Rafael C Gonzalez, Richard E Woods 2nd Edition, Digital Image Processing - Pearson Education 2003.
2. William K Pratt, Digital Image Processing John Willey (2001).
3. Image Processing Analysis and Machine Vision – Millman Sonka, Vaclav, Roger Boyle, Broos/colic, Thompson Learniy (1999).
4. A.K. Jain, PHI, New Delhi (1995)-Fundamentals of Digital Image Processing.
5. Chanda Dutta Majundar – Digital Image Processing and Applications, Prentice Hall of India, 2000.

COURSE OUTCOME:

After successful completion of the course, students will be able to:

CO1: Understand the basic theory and algorithms that are widely used in digital image processing.

CO2: Get exposure to current technologies and issues that are specific to image processing systems.

CO3: Develop hands-on experience in using computers to process image.

CO4: Familiarized with MATLAB Image Processing Toolbox.

CO5: Develop critical thinking about shortcomings of the state of the art in image processing.

EI 5166	Microcontroller & Embedded System	L	T	P	C
		3	0	0	3

UNIT I: INTRODUCTION TO EMBEDDED SYSTEM

Overview of Embedded Systems, Processor Embedded into a system, Embedded Hardware Units and Devices in system, Embedded Software, Complex System Design, Design Process in Embedded System, Formalization of System Design, Classification of Embedded Systems.

UNIT II: MICROCONTROLEERS AND PROCESSOR ARCHITECTURE & INTERFACING

8051 Architecture, Input/Output Ports and Circuits, External Memory, Counters and Timers, PIC Controllers. Interfacing Processor (8051, PIC), Memory Interfacing, I/O Devices, Memory Controller and Memory arbitration Schemes.

UNIT III: EMBEDDED RISC PROCESSORS & EMBEDDED SYSTEM ON-CHIP PROCESSOR

PSOC (Programmable System-on-Chip) architectures, Continuous Timer blocks, Switched Capacitor blocks, I/O blocks, Digital blocks, Programming of PSOC, Embedded RISC Processor architecture – ARM Processor architecture, Register Set, Modes of operation and overview of Instructions.

UNIT IV: INTERRUPTS AND DEVICE DRIVERS

Exceptions and Interrupt handling Schemes – Context & Periods for Context Switching, Deadline & interrupt latency. Device driver using Interrupt Service Routine, Serial port Device Driver, Device drivers for Internal Programmable timing devices.

UNIT V: NETWORK PROTOCOLS

Serial communication protocols, Ethernet Protocol, SDMA, Channel & IDMA, External Bus Interface.

TEXT BOOKS

1. Embedded Systems - Architecture Programming and Design – Raj Kamal, 2nded., 2008, TMH.

2. PIC Microcontroller and Embedded Systems – Muhammad Ali Mazidi, Rolin D. Mckinaly, Danny Causy – PE. 3. Designers Guide to the Cypress PSOC – Robert Ashpy, 2005, Elsevier.

3. Embedded Microcomputer Systems, Real Time Interfacing – Jonathan W. Valvano – Brookes / Cole,1999, Thomas Learning.

4. ARM Systems Developers Guides- Design & Optimizing System Software - Andrew N. Sloss, Dominic Symes, Chris Wright, 2004, Elsevier.
5. Designing with PIC Microcontrollers- John B. Peatman, 1998, PH Inc.

COURSE OUTCOME:
After successful completion of the course, students will be able to:
CO1: Familiarize with operation of microprocessor and microcontroller, machine language programming and interfacing techniques.
CO2: Acquire the knowledge on internal organization of some popular microprocessor and microcontroller.
CO3 Capable of understanding the hardware and software interaction and integration
CO4 Understand the design of microprocessor and microcontroller based system
CO5 Understand the applications of microcontroller.

EI 5167	**Statistical Signal Processing**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

UNIT I: DISCRETE RANDOM PROCESS
Random Process- Ensemble Average, Gaussian Process, Stationary Process, The Autocorrelation and Autocovariance Matrix, Ergodicity, White Noise, The Power Spectrom, Filtering Random Process, Special Types of Random Process-ARMV Process, AR Process, MA Process, Harmonic Process. Signal Modeling Introduction, Stochastic Models- ARMA Models, AR Models, MA Models, Application: Power Spectrum Estimation.

UNIT II: WEINER FILTERING
Introduction, The FIR Wiener Filter- Filtering, Linear Prediction, Noise Cancellation, IIR Wiener Filter- Noncausal IIR Wiener Filter, The Causal IIR Wiener Filter, Causal Wiener Filtering, Causal Linear Prediction, Wiener Deconvolution, Discrete Kalman Filter.

UNIT III: SPECTRUM ESTIMATION
Introduction, Nonparametric Method- The Periodogram, Performance of Periodogram. Parametric Methods- AR Spectrum Estimation, MA Spectrum Estimation, ARMA Spectrum Estimation. Frequency Estimation- Eigen decomposition of the Autocorrelation Matrix, MUSIC.

UNIT IV: ADAPTIVE FILTERING
Introduction, FIR Adaptive Filters- The Steepest Descent Adaptive Filter, The LMS Algorithm, Convergence of LMS Algorithm, NLMS, Noise Cancellation, LMS Based Adaptive Filter, Channel Equalization, Adaptive Recursive Filter, RLS- Exponentially Weighted RLS, Sliding Window RLS.

TEXT BOOKS
1. Monson H. Hayes, Statistical Digital Signal Processing &Modeling, John Wiley & Sons
2. Steven M. Kay, Fundamentals of Statistical Signal Processing: Estimation Theory, Prentice Hall.

COURSE OUTCOME:
After successful completion of the course, students will be able to:

CO1: Analyse the implications at system level of the use of statistical signal processing techniques.
CO2: Apply advanced mathematical methods for the resolution of problems related to statistical signal processing.
CO3: Acquire critical reasoning and thought as means for originality in the generation, development and/or application of ideas in a research or professional context.
CO4: Develop and evaluate signal detection techniques with applications in positioning and radar systems.
CO5: Develop statistical filtering systems aimed at synchronisation, equalisation and detection in communications receivers.

EI 5168	Renewable Energy Sources	L	T	P	C
		3	0	0	3

UNIT I: INTRODUCTION TO ENERGY SOURCES
Renewable and non-renewable energy sources, energy consumption as a measure of Nation's development; strategy for meeting the future energy requirements Global and National scenarios, Prospects of renewable energy sources.

UNIT II: SOLAR ENERGY
Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solar radiation, local solar time, derived solar angles, sunrise, sunset and day length. flat plate collectors, concentrating collectors, Solar air heaters-types, solar driers, storage of solar energy- thermal storage, solar pond, solar water heaters, solar distillation, solar still, solar cooker, solar heating & cooling of buildings, photo voltaics - solar cells & its applications.

UNIT III: WIND ENERGY
Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations.

UNIT IV: ENERGY FROM BIOMASS
Biomass conversion technologies, Biogas generation plants, classification, advantages and disadvantages, constructional details, site selection, digester design consideration, filling a digester for starting, maintaining biogas production, Fuel properties of biogas, utilization of biogas.

UNIT V: GEOTHERMAL ENERGY
Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo- pressured hot dry rock, magma. advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India.

UNIT VI: ENERGY FROM THE OCEAN
Ocean Thermal Electric Conversion (OTEC) systems like open cycle, closed cycle, Hybrid cycle, prospects of OTEC in India. Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy.

Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy.

UNIT VII: FUEL CELLS
Introduction, Design principle and operation of fuel cell, Types of fuel cells, conversion efficiency of fuel cell, application of fuel cells.

UNIT VIII: HYDROGEN ENERGY
Introduction, Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles.

UNIT IX: ENERGY MANAGEMENT
Energy economics, energy conservation, energy audit, general concept of total energy system, scope of alternative energy system in India.

TEXT BOOKS

1. Non-conventional energy sources by B.H. Khan, 2nd edition, Tata McGraw Hill

REFERENCE BOOKS

1. Non-conventional energy sources by G.D. Rai, Khanna Publishers.
2. Solar Energy: Fundamentals and Applications by H.P. Garg & Jai Prakash, Tata McGraw Hill.
3. Solar Energy: Principles of Thermal Collection and Storage by S,P. Sukhatme, Tata McGraw Hill.
4. Alternative Energy Sources by B.L. Singhal Tech Max Publication.
5. Non-Conventional Energy Resources by S. Hasan Saeed and D.K. Sharma.
6. Fuel Cells by Bockris and Srinivasan; McGraw Hill.
7. Magneto Hydrodynamics by Kuliovsky and Lyubimov, Addison.
8. Solar Engineering of Thermal Processes by Duffic and Beckman, John Wiley.

COURSE OUTCOME:
After successful completion of the course, students will be able to:
CO1: Know the need of renewable energy resources, historical and latest developments.
CO2: Describe the use of solar energy and the various components used in the energy production with respect to applications like - heating, cooling, desalination, power generation, drying, cooking etc.
CO3: Understand the concepts & working of solar PV cells.
CO4: Appreciate the need of Wind Energy and the various components used in energy generation and know the classifications.
CO5: Appreciate the energy audit methods for both domestics and industrial applications.

EI 5169	**Virtual Instrumentation**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

UNIT I: VIRTUAL INSTRUMENTATION
Historical perspective, advantages, block diagram and architecture of a virtual instrument, data-flow techniques, graphical programming in data flow, comparison with conventional

programming. Development of Virtual Instrument using GUI, Real-time systems, Embedded Controller, OPC, HMI / SCADA software, Active X programming.

UNIT II: VI PROGRAMMING TECHNIQUES
VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O, Instrument Drivers, Publishing measurement data in the web.

UNIT III: DATA ACQUISITION BASICS
Introduction to data acquisition on PC, Sampling fundamentals, Input/Output techniques and buses. ADC, DAC, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements.

UNIT IV: CHASSIS REQUIREMENTS
Common Instrument Interfaces: Current loop, RS 232C/ RS 485, GPIB. Bus Interfaces: USB, PCMCIA, VXI, SCSI, PCI, PXI, Firewire. PXI system controllers, Ethernet control of PXI. Networking basics for office & Industrial applications, VISA and IVI.

UNIT V: VI TOOL SETS
Distributed I/O modules. Application of Virtual Instrumentation: Instrument Control, Development of process data base management system, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control.

Additional topics: FPGA, Motion Control, Real Time Systems with LabVIEW.

(for proper understanding & practice in LabVIEW, laboratory class room may be used for teaching where necessary)

TEXT BOOKS
1. Gary Johnson, "LabVIEW Graphical Programming", 2nd Edition, McGraw Hill, New York.
2. Lisa K. wells & Jeffrey Travis, "LabVIEW for everyone", Prentice Hall, New Jersey.
3. Jane W. S. Liu, "Real-time Systems", Pearson Education India.
4. Jean J. Labrosse, "Embedded Systems Building Blocks: Complete and Ready-to-use Modules in C", 2nd Edition, CMP Books.

REFERENCE BOOKS
1. Kevin James, "PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control", Newnes.
2. Jean J. Labrosse, "MicroC/OS-II. The Real-time Kernal", CMP Books.

WEB RESOURCES
1. www.ni.com
2. www.ltrpub.co

COURSE OUTCOME:
After successful completion of the course, students will be able to:
CO1: Understand the fundamental of virtual instrumentation.
CO2: Understand the programming and data flow in virtual instrumentation.
CO3: Understand the overview about the interfacing of external instruments to pc and detailed

information about the different protocols
CO4: Provide graphical programming environment in virtual instrumentation.
CO5: Analyse tools and simple applications used in virtual instrumentation.

EI 5170	Soft Computing	L	T	P	C
		3	0	0	3

UNIT I: INTRODUCTION
What is soft computing? Differences between soft computing and hard computing, Soft Computing constituents, Methods in soft computing, Applications of Soft Computing.

UNIT II:
Introduction to Genetic Algorithms Introduction to Genetic Algorithms (GA), Representation, Operators in GA, Fitness function, population, building block hypothesis and schema theorem.; Genetic algorithms operators- methods of selection, crossover and mutation, simple GA(SGA), other types of GA, generation gap, steady state GA, Applications of GA.

UNIT III:
Neural Networks Concept, biological neural system. Evolution of neural network, McCulloch Pitts neuron model, activation functions, feedforward networks, feedback networks, learning rules – Hebbian, Delta, Perceptron learning and Windrow Hoff, winner-take-all.

UNIT IV:
Supervised learning Perceptron learning, single l layer/multilayer perceptron, linear separability, hidden layers, back propagation algorithm, Radial Basis Function network; Unsupervised learning - Kohonen, SOM, Counter-propagation, ART, Reinforcement learning, adaptive resonance architecture, applications of neural networks to pattern recognition systems such as character recognition, face recognition, application of neural networks in image processing.

UNIT V:
Fuzzy systems Basic definition and terminology, set-theoretic operations, Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations, Membership Functions, Fuzzy Rules & Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making; Neuro-fuzzy modeling- Adaptive Neuro-Fuzzy Inference Systems, Coactive Neuro-Fuzzy Modeling, Classification and Regression Trees, Data Clustering Algorithms, Rulebase Structure Identification and Neuro-Fuzzy Control, Applications of neuro-fuzzy modelling.

COURSE OUTCOME:
After successful completion of the course, students will be able to:
CO1: Identify and describe soft computing techniques and their roles in building intelligent machines.
CO2: Recognize the feasibility of applying a soft computing methodology for a particular problem.
CO3: Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems.
CO4: Apply genetic algorithms to combinatorial optimization problems.
CO5: Apply neural networks to pattern classification and regression problems.

ELECTIVE- IV

EI 5171	Industrial Data Communication	L	T	P	C
		3	0	0	3

UNIT I: DATA NETWORK FUNDAMENTALS
Networks hierarchy and switching – Open System Interconnection model of ISO – Data link control protocol – Media access protocol – Command / response – Token passing -CSMA/CD, TCP/IP.

UNIT II: INTERNET WORKING
Bridges – Routers – Gateways – Standard ETHERNET and ARCNET configuration special requirement for networks used for control – RS 232, RS 485 configuration Actuator Sensor (AS) – interface, Device net.

UNIT III: HART AND FIELD BUS
Introduction – Evolution of signal standard – HART communication protocol – HART networks -HART commands – HART applications – Fieldbus – Introduction – General Fieldbus architecture Basic requirements of Fieldbus standard – Fieldbus topology – Interoperability – Interchangeability – Introduction to OLE for process control (OPC).

UNIT IV: MODBUS AND PROFIBUS PA/DP/FMS AND FF
MODBUS protocol structure – function codes – troubleshooting Profibus, Introduction, Profibus protocol stack, Profibus communication model – communication objects – system operation – troubleshooting – review of foundation fieldbus – Data Highway

UNIT V: INDUSTRIAL ETHERNET AND WIRELESS COMMUNICATION
Industrial Ethernet, Introduction, 10 Mbps Ethernet, 100 Mbps Ethernet – Radio and wireless communication, Introduction, components of radio link – radio spectrum and frequency allocation – radio MODEMs-Introduction to wireless HART and ISA100.

TEXT BOOKS
1. Steve Mackay, Edwin Wrijut, Deon Reynders, John Park, Practical Industrial Data Networks Design, Installation and Troubleshooting' Newnes Publication, Elsevier First Edition, 2004.
2. William Buchanan, Computer Buses, CRC Press, 2000.
3. Behrouz Forouzan, Data Communications & Networking, 3rd edition, Tata McGraw Hill, 2006.

REFERENCE BOOKS
1. Andrew S. Tanenbaum, David J. Wetherall, Computer Networks, Prentice Hall of India Pvt. Ltd., 5th Edition. 2011.

2. Theodore S Rappaport, Wireless Communication: Principles and Practice, Prentice Hall of India 2nd Edition, 2001.

COURSE OUTCOME:

After successful completion of the course, students will be able to:

CO1: Define basic concepts of data communication and its importance.

CO2: Explain the various internetworking devices involved in industrial networks

CO3: Explain the various serial communication used in process industries.

CO4: Illustrate, compare & explain the working of HART and Field bus used in process digital communication

CO5: Summarize the operation of MODBUS, PROFIBUS protocol & its applications.

EI 5172	**Environmental Pollution Control**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

UNIT I: INTRODUCTION

Global atmospheric change – greenhouse effect – Ozone depletion - natural cycles -mass and energy transfer – material balance – environmental chemistry and biology –impacts – environmental. Legislations.

UNIT II: AIR POLLUTION

Pollutants - sources and effect – air pollution meteorology – atmospheric dispersion –indoor air quality - control methods and equipments - issues in air pollution control – air sampling and measurement.

UNIT III: WATER POLLUTION

Water resources - water pollutants - characteristics – quality - water treatment systems – waste water treatment - treatment, utilization and disposal of sludge – monitoring compliance with standards.

UNIT IV: WASTE MANAGEMENT

Sources and Classification – Solid waste– Hazardous waste- Characteristics–Collection and Transportation - Disposal – Processing and Energy Recovery – Waste minimization.

UNIT V: OTHER TYPES OF POLLUTION FROM INDUSTRIES

Noise pollution and its impact - oil pollution - pesticides - instrumentation for pollution control - water pollution from tanneries and other industries and their control – environment impact assessment for various projects – case studies.

TEXT BOOKS

1. G. Masters (2003): Introduction to Environmental Engineering and Science Prentice Hall of India Pvt Ltd, New Delhi.

2. H.S. Peavy, D.R. Rowe, G. Tchobanoglous (1985): Environmental Engineering McGraw-Hill Book Company, NewYork.

3 H. Ludwig, W. Evans (1991): Manual of Environmental Technology in Developing Countries. International Book Company, Absecon Highlands, N.J.

4. Arcadio P. Sincero and G. A. Sincero, (2002): Environmental Engineering – A Design

Approach, Prentice Hall of India Pvt Ltd, New Delhi.

COURSE OUTCOME:

After successful completion of the course, students will be able to:

CO1: Describe Acid Rain, Ozone layer depletion, Green House effect.

CO2: Describe remedial measures to control Air pollution.

CO3: Describe remedial measures to control water pollution.

CO4: Measure pollutants – sampling, Physical characteristics, chemical characteristics, biological characteristics.

CO5: Evaluate the quality of environmental impact assessment.

EI 5173	Identification and Estimation	L	T	P	C
		3	0	0	3

UNIT I: ESTIMATION

Introduction, development of parameter estimators, estimation of stochastic Processes, applications. Least – square estimation. Linear least squares problem, generalized least square problem. Sequential least squares, non-linear least squares theory. Maximum a posteriori and maximum likelihood estimators. Numerical solution of least- squares and maximum likelihood estimation problems. Sequential estimators and some asymptotic properties.

UNIT II: NON-PARAMETRIC METHODS

A parametric method- Bias, consistency and model approximation, A degenerate experimental condition- the influence of feedback, Transient analysis-frequency analysis- Correlation analysis-spectral analysis. The least squares method revisited-description of prediction error methods-optimal prediction - relationships between prediction error methods and other identification methods theoretical analysis. The recursive least squares method-real time identification-the recursive instrumental variable method- the recursive prediction error method.

UNIT III: DESCRIPTION OF INSTRUMENT VARIABLE METHODS

Theoretical analysis-covariance matrix of VI estimates - comparison of optimal IV and prediction error estimates.

TEXT BOOKS

1. Ljung .L, System Identification: Theory for the user, Prentice Hall, Englewood Cliffs, 1987

2. Ljung, L. and Soderstorm, T., Theory and Practice of Recursive Identification, MIT Press, Cambridge, 1987.

3. Childers, Probability and random processes, The McGraw-Hill companies Inc., 1997.

4. Harold W. Sorenson, Parameter Estimation, Principles and Problems, Marcel Dekker Inc., 1980.

COURSE OUTCOME:

After successful completion of the course, students will be able to:

CO1: Understand theoretical and practical knowledge on methods to develop mathematical models from experimental data, adaptive control system.

CO2: Design and implement system identification experiments.

CO3: Design methods of adaptive control.
CO4: Use input/output experimental data for identification of mathematical dynamical models
CO5: Design various methods of adaptive control.

EI 5174	Precision Instrumentation	L	T	P	C
		3	0	0	3

UNIT I:
Introduction, Instrument characteristics-accuracy, precision, repeatability, reproducibility, constituent elements in instrumentation; precession measurements, errors, calibration of instruments.

UNIT II:
Standard cell, standard resistors, cylindrical cross capacitors; Transformer double bridge

UNIT III:
Ultrasonics-principle-instrumentation; NDT tools, Magnetic particles, dye penetrants, pulse-echo method, signature analysis, US holography.

UNIT IV:
Fibre-optic sensors-instrumentation; LASER-introduction, principle, types, sources, instrumentation; sensors for manufacturing-distance sensing.

UNIT V:
Digital Instruments in precision measurements: Digital multimeter, DSO, MDO, Arbitrary function generators, Intelligent instrumentation-definition, basic elements, working-application-case studies.

UNIT VI:
Smart sensor-introduction-primary sensors-excitation-amplification-filters-converters-ompensation- nonlinearity approximation & regression-noise & interference-response time-cross sensitivity- information coding/processing-data communication-the automation.

TEXT BOOKS

1. D. Patranabis, Sensors and Transducers, PHI, New Delhi
2. Barney, G.C., Intelligent instruments, Hemel Hempsteao: Prentice Hall.
3. ALAN S. Morris, Principles of Measurement s Instrumentation. New Delhi, PHI Pvt. Ltd.

COURSE OUTCOME:
After successful completion of the course, students will be able to:
CO1: Analyze the performance characteristics of each instrument.
CO2: Illustrate basic meters such as voltmeters and ammeters.
CO3: Explain about holography.
CO4: Explain the basic features of Fibre-optic sensors-instrumentation.

CO5: Apply the complete knowledge of various Digital electronics instruments/transducers to measure the physical quantities in the field of science, engineering and technology.

EI 5175	Human Computer Interface and BCI	L	T	P	C
		3	0	0	3

UNIT I: **INTRODUCTION**
Importance of user Interface – Definition, Importance of good design, Benefits of good design, A brief history of Screen design.

UNIT II: THE GRAPHICAL USER INTERFACE
Popularity of graphics, The concept of direct manipulation, Graphical system, Characteristics, Web user – Interface popularity, characteristics- Principles of user interface.

UNIT III: DESIGN PROCESS
Human interaction with computers, Importance of human characteristics human consideration, Human interaction speeds, Understanding business junctions.

UNIT IV: SCREEN DESIGNING
Design goals – Screen planning and purpose, organizing screen elements, ordering of screen data and content – screen navigation and flow – Visually pleasing composition – amount of information – focus and emphasis – presentation information simply and meaningfully – information retrieval on web – statistical graphics – Technological consideration in interface design.

UNIT V: WINDOWS
New and Navigation schemes selection of window, selection of devices based and screen based controls.

COMPONENTS
Text and messages, Icons and increases – Multimedia, colors, uses problems, choosing colors.

SOFTWARE TOOLS:
Specification methods, interface – Building Tools.

INTERACITON:
Keyboard and function keys – pointing devices – speech recognition digitization and generation – image and video displays – drivers- BCI and its applications.

TEXT BOOKS
1. The essential guide to user interface design Wilbert O Galitz Wiley DreamTech
2. Designing the user interface. 3rd Edition Ben Shneidermann Pearson Education, Asia
3. Human – Computer Interaction. Alan Dix, Janet Fincay, GreGoryd, Abowd, Russell Bealg, Pearson Education.

4. Interaction Design Prece, Rogers, Sharps. Wiley Dreamtech.
5. User Interface Design, Soren Lauesen Pearson Education.

COURSE OUTCOME:

After successful completion of the course, students will be able to:

CO1: Understand the Computer and Human-Computer Interaction.

CO2: Acquire the knowledge of GUI.

CO3: Design basic processes by interacting human with computers.

CO4: Understand Windows Concepts and Interfaces.

CO5: Do Quantitative Analysis – Evaluation – Redesign.

EI 5176	Nanotechnology & Nano electronics	L	T	P	C
		3	0	0	3

UNIT I: NANO TECHNOLOGY

Overview: Nanotechnology; Nano devices, Nano materials, Nano characterization, Synthesis of Nanomaterials: CVD, Nucleation and Growth, ALD, Epitaxy, MBE.

Emerging nano materials: Nanotubes, nanorods and other nano structures, LB technique, Soft lithography etc. Microwave assisted synthesis, Self-assembly etc. Characterization techniques for nanomaterials: FTIR, XRD, AFM, SEM, TEM, EDAX etc. Applications and interpretation of results.

Compound semiconductor hetero-structure growth and characterization: Quantum wells; Thickness measurement techniques: Contact - step height, Optical - reflectance and ellipsometry. AFM.

Introduction – Scaling of physical systems – Geometric scaling & Electrical system scaling. The Single-Electron Transistor: The Single- Electron Transistor Single-Electron Transistor Logic, Other SET and FET Structures, Carbon Nanotube Transistors (FETs and SETs), Semiconductor Nanowire FETs and SETs, Coulomb Blockade in a Nanocapacitor, Molecular SETs and Molecular Electronics.

UNIT II: NANO ELECTRONCS

Introduction: Recent past, the present and its challenges, Future, Overview of basic Nano-electronics. Nano Electronics Architectures: Nanofabrication, Nano-patterning of Metallic/Semiconducting nanostructures (e-beam/X ray, Optical lithography, STM/AFM- SEM & Soft-lithography), Nano phase materials, Self-assembled Inorganic/Organic layers.

Spintronics: Introduction, Overview, History & Background, Generation of Spin Polarization Theories of spin Injection, spin relaxation and spin dephasing, Spintronic devices and applications, spin filters, spin diodes, spin transistors.

Memory Devices: Memory devices and sensors – Nano ferroelectrics – Ferroelectric random access memory –Fe-RAM circuit design –ferroelectric thin film properties and integration – calorimetric, electrochemical cells – surface and bulk acoustic devices – gas sensitive FETs.

Sensors: Sensors –– resistive semiconductor gas sensors –electronic noses – identification of hazardous solvents and gases – semiconductor sensor array.

TEXT BOOKS

1. Stephen D. Sentaria, Microsystem Design, Kluwer Academic Press.
2. Marc Madou, Fundamentals of microfabrication & Nanofabrication.
3. T. Fukada & W.Mens, Micro Mechanical system Principle & Technology, Elsevier, 1998.
4. Julian W.Gardnes, Vijay K. Varda, Micro sensors MEMS & Smart Devices, 2001.
5. Concepts in Spintronics – Sadamichi Maekawa, oxford science publication,2006 edition
6. Spin Electronics – David Awschalom, springer-science Business Media,2006 or new Edition.

HYPERLINKS

1. http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-701-introduction-to-nanoelectronics-spring-2010/readings/
2. http://nptel.ac.in/courses/118102003/

REFERENCE BOOKS

1. Nano Terchnology and Nano Electronics – Materials, devices and measurement Techniques by WR Fahrner – Springer.
2. Nano: The Essentials – Understanding Nano Scinece and Nanotechnology by T.Pradeep; Tata Mc.Graw Hill.
3. Spin Electronics by M. Ziese and M.J. Thornton.
4. Nanoelectronics and Nanosystems – From Transistor to Molecular and Quantum Devices by Karl Goser, Peter Glosekotter, Jan Dienstuhl
5. Silicon Nanoelectronics by Shunri Odo and David Feny, CRC Press, Taylor & Franicd Group.
6. Nanotubes and nanowires by C.N.R. Rao and A. Govindaraj, RSC Publishing
7. Quantum-Based Electronic Devices and Systems by M. Dutta and M.A. Stroscio, World Scientific.
8. James R Sheats and Bruce w.Smith, “Microlithography Science and Technology”, Marcel Dekker Inc., New York, 1998.
9. J.P. Hirth and G.M.Pound “Evaporation: Nucleation and Growth Kinetics” Pergamon Press, Oxford, 1963.

COURSE OUTCOME:

After successful completion of the course, students will be able to:
CO1: Understand basics of nanotechnology.
CO2: Fabricate and analyze different nano-devices for optoelectronic applications such as solar cells, supercapacitors etc.
CO3: Characterize nanomaterials and nano-devices using modern analytical instruments.
CO4: Describe the phenomenon behind nano-devices.
CO5: Understand basic and advanced concepts of nanoelectronic devices, sensors.
CO6: Design new applications of nanotechnology and nanoelectronics.
CO7: Develop nano-sensors for different sensing applications.

EI 5177	**Piping and Instrumentation**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

UNIT I:

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

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

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

UNIT IV:
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.

TEXT BOOKS:
1. Ernest E. Ludwig, "Applied Process Design for Chemical and Petrochemical Plants", Vol.-I Gulf Publishing Company, Houston, 1989.
2. Max. S. Peters and K.D. Timmerhaus, "Plant Design and Economics for Chemical Engineers", McGraw Hill, Inc., New York, 1991.

REFERENCE BOOKS
1. Anil Kumar, "Chemical Process Synthesis and Engineering Design", Tata McGraw Hill publishing Company Limited, New Delhi - 1981.
2. A.N. Westerberg, et al., "Process Flowsheeting", Cambridge University Press, 1979.

COURSE OUTCOME:
After successful completion of the course, students will be able to:
CO1: Analyze about variable head type flow meters, quantity meters.
CO2: Analyze about air flow meters and mass flow meters.
CO3: Analyze electrical type flow meters.
CO4: Acquire knowledge on various level measurement techniques.
CO5: Understand the properties of Viscosity, Humidity and Moisture content.

EI 5178	System Identification and Adaptive Control	L	T	P	C
		3	0	0	3

UNIT I: SYSTEMS AND MODELS
Models of LTI systems - Linear Models - State space Models - Model sets - Structures and Identifiability - Models for Time-varying - Non-linear systems - Models with Nonlinearities – Nonlinear state - space models - Black box models - Fuzzy models - Model approximation – validation - Random Process Modeling.

UNIT II: PARAMETRIC AND NON-PARAMETRIC ESTIMATION METHODS
Transient response - Correlation Analysis – Frequency response analysis – Spectral Analysis – Least Square – Recursive Least Square – Maximum Likelihood – Instrumental Variable methods – Pseudo Linear Regression.

UNIT III: LINEAR AND NON-LINEAR ESTIMATION TECHNIQUES
Open - Closed loop identification - Approaches – Direct - indirect identification – Joint input – output identification – Non-linear system identification – Wiener models – Power series expansions -Multidimensional Identification – State estimation techniques – FFT based - Model based Spectral estimation techniques.

UNIT IV: CLASSIFICATION OF ADAPTIVE CONTROL
Introduction – Uses – Auto tuning – Self Tuning Regulators (STR) – Model Reference Adaptive Control (MRAC) – Types of STR - MRAC – Different approaches to self-tuning regulators –Stochastic Adaptive control – Gain Scheduling.

UNIT V: APPLICATIONS OF ADAPTIVE CONTROL
Recent trends in self – tuning – Stability, Convergence and Robustness studies - Model Updating –General purpose Adaptive regulator – Applications to process control.

TEXT BOOKS
1. Narendra, Annasamy, Stable Adaptive Control Systems, Prentice Hall, 1989.

REFERENCE BOOKS
1. Ljung, System Identification Theory for the User, PHI, 1987.
2. Astrom, Wittenmark, Adaptive Control, PHI.

COURSE OUTCOME:
After successful completion of the course, students will be able to:
CO1: Develop mathematical models for industrial systems.
CO2: Develop models from first principles.
CO3: Develop data driven models.

EI 5179	**Machine Learning Algorithm**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

UNIT I:
Introduction to methods for Machine Learning, Python notebook, data visualisation.

UNIT II:
Numpy and scipy basics: common linear algebra and statistical routines, numerical optimization.

UNIT III:
Introduction to scikit-learn. Common classification, regression and clustering methods.

UNIT IV:
Meta-learning in scikit-learn: ensembling, hyper-parameter optimization, feature extraction.

UNIT V:
Introduction to dataflow computational model, distributed programming. Apache Spark basics.

TEXT BOOKS

1. Jure Leskovec, Anand Rajaraman, and Jeffrey David Ullman. Mining of massive datasets. Cambridge University Press, 2014.
2. Peter Flach. Machine Learning: The Art and Science of Algorithms that Make Sense of Data, Cambridge University Press, 2012.

REFERENCE BOOKS

1. Christopher M Bishop. Pattern recognition and machine learning. Springer, 2006.
2. Trevor J. Hastie, Robert John Tibshirani, and Jerome H Friedman. The elements of statistical learning: data mining, inference, and prediction. Springer, 2009.
3. Witten, E. Frank, M. Hall. Data Mining: Practical Machine Learning Tools and Techniques, 2011, Morgan Kaufmann Publishers.

COURSE OUTCOME:

After successful completion of the course, students will be able to:

CO1: Understand complexity of Machine Learning algorithms and their limitations.

CO2: Understand modern notions in data analysis-oriented computing.

CO3: Confidently apply common Machine Learning algorithms in practice and implementing their own.

CO4: Perform distributed computations;

CO5: Perform experiments in Machine Learning using real-world data.

EI 5180	**Power Plant Instrumentation**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

UNIT I: INTRODUCTION

Piping and instrumentation diagram of a thermal power plant, basic process on a boiler, Fuel measurement- review of pressure and temperature measurement steam and water flow measurement – instrument applications in power stations: review of indicating and recording instrument applications in power stations: review of indicating and recording instruments, water level gauge for boiler drums, closed circuit television instrument, gas analysis meters, smoke instruments, dust monitor-measurement of impurities in feed water and steam generator coolant controls and instrument-instrument maintenance aspects.

UNIT II: BOILER CONTROL-I

Boiler control objectives-combustion of fuels (gaseous, liquid and solid), excess air, combustion chemistry and products of combustion, requirement for excess combustion, air-circulation of efficiency of boiler: input/output method-stream temperature control systems super heaters and de- superheaters.

UNIT III: BOILER CONTROL-II

Feed water supply and boiler water circulation system-drum level control systems- boiler draft systems-measurement and control of furnace draft-measurement and control of combustion-draft and air flow control related functions.

UNIT IV: FLUE GAS ANALYSIS TRIMMING OF COMBUSTION CONTROL

SYSTEMS

Combustion control for liquid and gaseous fuel boilers coal or solid fuel strokes-combustion control for stoker-fired boilers- pulverised coal-fired boilers. Turbine monitoring and control: speed, vibration, shell temperature monitoring.

UNIT V: NUCLEAR POWER PLANT INSTRUMENTATION

Piping and instrumentation diagram of different types of nuclear power plants-radiation detection instruments-process sensors for nuclear power plants- spectrum analyzers-nuclear reactor control systems and allied instrumentation.

TEXT BOOKS:

1. B.G. Liptak, Instrumentation in process industries, Vol. I and II, Chilton books co, 1973.
2. Sam G. Dukelow. The control of boilers, Instrument Society of America press.
3. A. Sherryet. Al. (Editors), Modern power station practice, Vol. 6 (Instrumentation controls and testing), Pergamon Press, 1971.

COURSE OUTCOME:

After successful completion of the course, students will be able to:

CO1: Understand the power generation through various methods.

CO2 Acquires knowledge on the various types of power plants and the measurement devices.

CO3: Understand the basic and advanced boiler control techniques.

CO4: Get knowledge about different analyzers in power plant.

CO5: Understand different control loops used in boilers.