NATIONAL ENGINEERING COLLEGE

(An Autonomous Institution – Affiliated to Anna University, Chennai)

K.R.NAGAR, KOVILPATTI – 628 503

www.nec.edu.in

REGULATIONS - 2015

DEPARTMENT OF

ELECTRONICS AND INSTRUMENTATION ENGINEERING

CURRICULUM AND SYLLABI OF

M.E. – CONTROL AND INSTRUMENTATION

SEMESTER - I

S. No.	Course Category	Course Code	Course Title	L	T	P	C	Question Pattern⊕
THEORY COURSES								
1.	CFC	15CI11C	Higher Engineering Mathematics@	3	2	0	4	B
2.	PCC	15CI12C	Transducers and Measurements	3	0	0	3	C
3	PCC	15CI13C	System Theory@	3	0	0	3	B
4.	PCC	15CI14C	Digital Control System	3	2	0	4	C
5.	PEC		Elective - I	3	0	0	3	
6.	PEC		Elective - II	3	0	0	3	
PRACTICAL COURSES								
7.	PCC	15CI15C	Digital Control and Instrumentation Laboratory - I	0	0	4	2	
			Total	**18**	**4**	**4**	**22**	

SEMESTER - II

S. No.	Course Category	Course Code	Course Title	L	T	P	C	Question Pattern⊕
THEORY COURSES								
1.	PEC	15CI21C	PC Based Instrumentation System Design@	3	0	0	3	B
2.	PCC	15CI22C	Process Dynamics and Control	3	0	0	3	C
3.	PCC	15CI23C	Soft Computing Techniques@	3	0	0	3	A
4.	OEC		Elective - III	3	0	0	3	
5.	PEC		Elective - IV	3	0	0	3	
PRACTICAL COURSES								
6.	PCC	15CI24C	Digital Control and Instrumentation Laboratory - II	0	0	4	2	
7.	PCC	15CI25C	Research Paper and Patent Review – Seminar	0	0	4	2	
			Total	**15**	**0**	**8**	**19**	

CFC – Common Foundation Course, PCC – Programme Core Course, PEC – Programme Elective Course, OEC – Open Elective Course
@ Common to M.E. – HVE, M.E. – C&I, # Common to M.E. – CS, M.E. – C&I, * Common to M.E. – HVE, M.E. – C&I, M.E. – CS

SEMESTER - III

S. No.	Course Category	Course Code	Course Title	L	T	P	C	Question Pattern⊕
THEORY COURSES								
1.	OEC		Elective - V	3	0	0	3	
2.	PEC		Elective - VI	3	0	0	3	
3.	PEC		Elective - VII	3	0	0	3	
4.	PEC		Elective - VIII	3	0	0	3	
PRACTICAL COURSES								
5.	PCC	15CI31C	Project Work Phase I	0	0	12	6	
			Total	**12**	**0**	**12**	**18**	

SEMESTER - IV

S. No.	Course Category	Course Code	Course Title	L	T	P	C	Question Pattern⊕
PRACTICAL COURSES								
1.	PCC	15CI41C	Project Work Phase II	0	0	24	12	
			TOTAL	**0**	**0**	**24**	**12**	

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE - 71

CFC – Common Foundation Course, PCC – Programme Core Course, PEC – Programme Elective Course, OEC – Open Elective Course
@ Common to M.E. – HVE, M.E. – C&I, # Common to M.E. – CS, M.E. – C&I, * Common to M.E. – HVE, M.E. – C&I, M.E. – CS

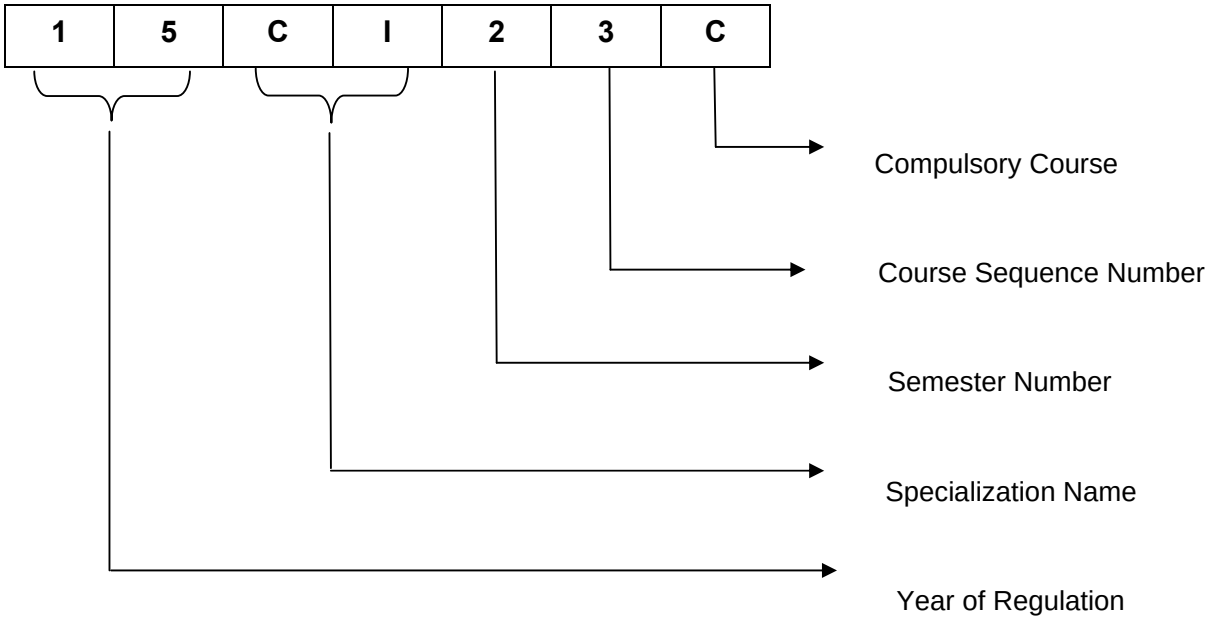
PROGRAMME ELECTIVE COURSES

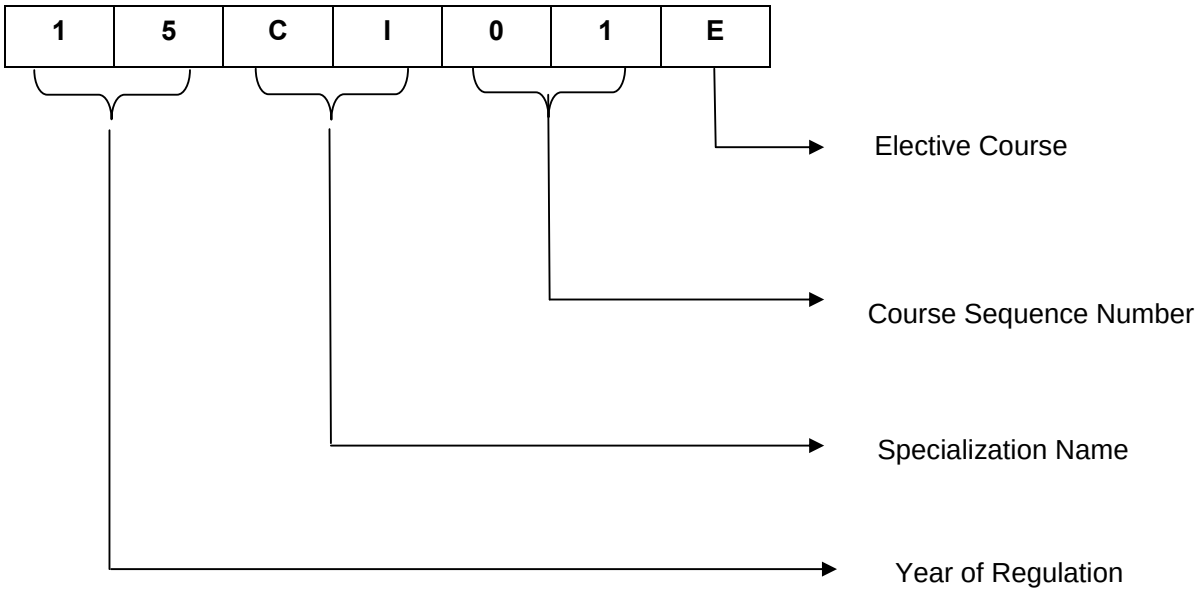
S. No.	Course Category	Course Code	Course Title	L	T	P	C	Question Pattern⊕
1.	PEC	15CI01E	Microcontroller based System Design	3	0	0	3	E
2.	PEC	15CI02E	Digital Instrumentation	3	0	0	3	B
3.	PEC	15CI03E	Smart Sensors	3	0	0	3	C
4.	PEC	15CI04E	Multi Sensor Data Fusion	3	0	0	3	B
5.	PEC	15CI05E	Micro Electro Mechanical Systems	3	0	0	3	B
6.	PEC	15CI06E	Medical Imaging Systems	3	0	0	3	B
7.	PEC	15CI07E	Wireless Sensor Networks#	3	0	0	3	B
8.	PEC	15CI08E	Nonlinear Control	3	0	0	3	B
9.	PEC	15CI09E	Optimal Control and Filtering	3	0	0	3	B
10.	PEC	15CI10E	System Identification and Adaptive control	3	0	0	3	B
11.	PEC	15CI11E	Biocontrol	3	0	0	3	B
12.	PEC	15CI12E	Advanced Process Control	3	0	0	3	B
13.	PEC	15CI13E	Industrial Automation	3	0	0	3	B
14.	PEC	15CI14E	Solar Photovoltaic Technologies and Applications	3	0	0	3	B
15.	PEC	15CI15E	Automobile Instrumentation	3	0	0	3	B
16.	PEC	15CI16E	Applied Industrial Instrumentation	3	0	0	3	C
17.	PEC	15CI17E	Modern Medical Instruments	3	0	0	3	C
18.	PEC	15C I18E	Advanced Digital System Design@	3	0	0	3	B
19.	PEC	15CI19E	Advanced Digital Signal Processing*	3	0	0	3	C
20.	PEC	15CI20E	Digital Image Processing Techniques	3	0	0	3	B
21.	PEC	15CI21E	Design of Embedded Systems@	3	0	0	3	B
22.	PEC	15CI22E	Power Plant Instrumentation	3	0	0	3	B
23.	PEC	15CI23E	Instrumentation for Non-Destructive Testing	3	0	0	3	C
24.	PEC	15CI24E	Instrumentation in Pulp and Paper Industries	3	0	0	3	B
25.	PEC	15CI25E	Robotics and Industrial Automation	3	0	0	3	B
26.	OEC		Courses Offered by other PG programmes					

⊕

Question pattern	1 mark	2 marks	4 marks	10 marks	12 marks	16 marks	20 marks	Total
A	-	-	-	-	--	-	1 Qn Compulsory & 4 Qns (either or type)	100
B	-	10	-	-	--	1 Qn Compulsory & 4 Qns (either or type)	--	100
C	10	-	10 out of 12	1 Qn Compulsory & 4 Qns (either or type)	--	--	--	100
D	10	10	5 out of 6	1 Qn Compulsory & 4 Qns (either or type)	--	--	--	100
E	-	10	5 out of 6	-	1 Qn Compulsory & 4 Qns (either or type)	--	--	100

FORMAT FOR COURSE CODE





15CI11C HIGHER ENGINEERING MATHEMATICS L T P C
(Common to C&I and HVE) **3 2 0 4**

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : learn the concepts of matrix theory. (K1)
CO 2 : understand simplex method, two phase method and graphical solution in linear programming. (K2)
CO 3 : learn moment generating functions and one dimensional random variables. (K1)
CO 4 : understand queueing models and computation methods in engineering. (K2)

UNIT I ADVANCED MATRIX THEORY 15

Eigen-values using QR transformations – Generalized eigen vectors – Canonical forms – Singular value decomposition and applications – Pseudo inverse – Least square approximations.

UNIT II LINEAR PROGRAMMING 15

Formulation – Graphical Solution – Simplex Method – Two Phase Method – Transportation and Assignment Problems.

UNIT III ONE DIMENSIONAL RANDOM VARIABLES 15

Random variables - Probability function – moments – moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions.

UNIT IV QUEUEING MODELS 15

Poisson Process – Markovian queues – Single and Multi Server Models – Little's formula – Steady State analysis – Self Service queue.

UNIT V COMPUTATIONAL METHODS IN ENGINEERING 15

Boundary value problems for ODE – Finite difference methods – Numerical solution of PDE – Solution of Laplace and Poisson equations – Liebmann's iteration process – Solution of heat conduction equation by Schmidt explicit formula and Crank - Nicolson implicit scheme – Solution of wave equation.

L: 45 T: 30 TOTAL: 75 PERIODS

REFERENCES

1. Bronson,R., "Matrix Operation, Schaum's outline series", McGraw Hill, New York, 1989.
2. Taha, H. A., "Operations Research: An Introduction", 7th Edition, Pearson Education Edition, Asia, New Delhi, 2002.
3. R. E. Walpole, R. H. Myers, S. L. Myers, and K. Ye, "Probability and Statistics for Engineers & Scientists", 8th Edition, Asia, 2007.
4. Donald Gross and Carl M. Harris, "Fundamentals of Queueing theory", 2nd Edition, John Wiley and Sons, New York 1985.
5. Grewal, B.S., "Numerical methods in Engineering and Science", 7th Edition, Khanna Publishers, 2009.

15CI12C TRANSDUCERS AND MEASUREMENTS L T P C
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : explain the characteristics of various sensors. (K2)
CO 2 : describe the operation of various measuring instruments. (K2)
CO 3 : illustrate the working of various optical Microstructure sensors and Miniature Sensors. (K2)

UNIT I RESISTIVE, INDUCTIVE AND CAPACITIVE ELEMENTS 9

Potentiometric, strain-gage and electrode elements – Inductive and Capacitive elements: structures, equivalent circuits and characteristics, single, differential and angle displacement elements, displacement to phase converters, and proximity elements, magnetostrictive elements, temperature instabilities and features.

UNIT II TRANSFORMER, ELECTRODYNAMIC, SERVO AND RESONANT ELEMENTS 9

Transformer elements: Single core, differential, rotating coil and synchro transformers, weak-field sensors - Electrodynamic elements: Moving-coil, variable-reluctance- - Resonant elements: vibrating strings, vibrating beams, vibrating cylinders, piezoelectric resonators, acoustical resonators, microwave cavity resonators.

UNIT III MECHANICAL, ACOUSTICAL AND FLOWMETERING ELEMENTS 9

Stresses state of diaphragm, dynamic characteristics of diaphragm, temperature drifts, sensitivity drifts, sensitivity to acceleration – Inertial mass elements: sensing and transduction elements of flowmeters, electromagnetic flowmeters, nanoelectrode electromagnetic flowmeters -ultrasonic elements – Acoustical elements: acoustical filters.

UNIT IV OPTICAL MICROSTRUCTURE SENSORS 9

Photo detectors: Thermal detectors, pneumatic detectors, pyroelectric detectors, photoemissive devices, photo conductive detectors, photo diodes, avalanche photo diodes, schottky photo diodes, photo transistors – Fiber optic sensors: Fibers as light guides, reflection sensors, Intrinsic multimode sensor, temperature sensor, phase modulated sensor, fiber optic gyroscopes and other fiber sensors.

UNIT V MISCELLANEOUS MINIATURE SENSORS 9

Magnetic sensors: Hall Effect sensors, magnetoresistors and other sensors – Solid state chemical sensors: Silicon based sensors, metal oxide sensors, solid electrolyte sensors, membranes – Electromechanical micro sensors and basic factors of design.

L: 45 TOTAL: 45 PERIODS

TEXT BOOK

1. Alexander D Khazan, “Transducers and their elements – Design and application”, PTR Prentice Hall, 1994.

REFERENCES

1. Pavel Ripka, Alois Tipek, “Modern sensors hand book”, Instrumentation and measurement series, ISTE Ltd., 2007.
2. David Fraden., “Hand book of Modern Sensors, Physics, Design and Applications”, 3rd Edition, PHI 2004, Springer India Private Limited, 2006.

15CI13C SYSTEM THEORY **L T P C**
(Common to C&I and HVE) **3 0 0 3**

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : explain the state space models for a linear system. (K2)
CO 2 : analyse the state space model with respect to observability and stabilizability. (K4)
CO 3 : apply state variable feedback to place system poles. (K3)
CO 4 : discuss state variable observers and controllers. (K2)
CO 5 : apply lyapunou stability methods to solve linear problems. (K3)

UNIT I MODERN CONTROL THEORY **9**

Limitations of conventional control theory - Concepts of State, State variables and State model – State model for linear time invariant systems: State space representation using physical-Phase and canonical variables.

UNIT II SYSTEM RESPONSE **9**

Transfer function from state model - Transfer matrix - Decomposition of transfer functions Direct, Cascade and Parallel decomposition techniques - Solution of state equation - State transition matrix computation.

UNIT III SYSTEM MODELS **9**

Characteristic equation - Eigen values and Eigen vectors - Invariance of Eigen values - Diagonalization - Jordan Canonical form - Concepts of Controllability and Observability - Kalman's and Gilbert's tests - Controllable and Observable phase variable forms - Effect of pole-zero cancellation on Controllability and Observability.

UNIT IV MODEL CONTROL **9**

Introduction – Stability improvement by State Feedback – Necessary and sufficient conditions for Arbitary Pole Placement - Pole Placement by State Feedback - Full-Order Observers - Reduced-Order Observers - Deadbeat Control by State Feedback - Deadbeat Observers.

UNIT V LIAPUNOV STABILITY **9**

Liapunov Stability analysis - Stability in the sense of Liapunov - Definiteness of Scalar Functions – Quadratic forms - Second method of Liapunov - Liapunov stability analysis of linear time invariant systems.

L: 45 TOTAL: 45 PERIODS

TEXT BOOKS

1. Gopal.M, “Modern Control System Theory”, 2nd Edition, New Age International Publisher, New Delhi, 2006.
2. Gopal M, “Digital Control and State Variable Methods”, 4th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, India, 2003.

REFERENCES

1. Katsuhiko Ogata, "Modern Control Engineering", 3rd Edition, Prentice Hall of India Private Limited, New Delhi, 2002.
2. Nagrath I J and Gopal M, "Control Systems Engineering", New Age International Publisher, New Delhi, 2006.
3. Nise S Norman, “Control Systems Engineering”, 3rd Edition, John Wiley & Sons, Inc, Delhi, 2000.
4. Benjamin C Kuo, “Automatic Control Systems”, John Wiley & Sons, Inc., Delhi, 2002.

15CI14C DIGITAL CONTROL SYSTEM **LT P C**
3 2 0 4

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : estimate discrete time models, which approximate continuous time dynamics. (K2)
CO 2 : design a compensator for digital control system to achieve desired specification. (K3)
CO 3 : analyse the state variable concepts in digital control system. (K4)

UNIT I SIGNAL PROCESSING IN DIGITAL CONTROL **15**

Advantage of Digital Control – Principles of Signal Conversion – Basic Discrete Time Signal – Time Domain Models for Discrete Time Systems – Review of Z Transforms – Transfer Function Models –Sample and Hold System – Sampled Spectra and Aliasing – Reconstruction of Analog Signals – Selection of Sampling Rate –Principles of Discretization

UNIT II MODELS OF DIGITAL CONTROL DEVICES AND SYSTEMS **15**

Basic Digital Control Scheme – Z Domain Description of Sampled Continuous Time Plants – Z Domain Description of Systems with Dead Time – Implementation of Digital Controller – Digital PID controller – Digital Temperature Control System – Digital Position Control System – Stepping Motors and their Control

UNIT III DESIGN OF DIGITAL CONTROLLER **15**

Introduction - Z Plane Specifications of Control System Design – Digital Compensator Design Using Frequency Response Plots – Digital Compensator Design Using Root Locus Plots – Z Plane Synthesis – Stability on the Z Plane and Jury Stability Criterion

UNIT IV STATE VARIABLE ANALYSIS OF DIGITAL CONTROL SYSTEMS **15**

State Descriptions of Digital Processors – State Description of Sampled Continuous Time Plants - State Description of System with Dead Time – Solution of State Difference Equations – Controllability and Observability

UNIT V DIGITAL CONTROL SYSTEMS WITH STATE FEEDBACK **15**

State Regulator Design –State Observers – Separation Principle – State feedback with Integral control – Dead beat control by state feedback and dead beat observers - Pole Placement Design by State Feedback (Single Input) –Pole Placement Design by Output Feedback (Single Input)

L:45 T:30 Total : 75 PERIODS

TEXT BOOK

1. M.Gopal “Digital Control and State Variable Methods”, 4th Edition, Tata Mc-Graw Hill, 2012.

REFERENCES

1. Benjamin C. Kuo “Digital control systems”, Oxford University Press, 2004.
2. G. F. Franklin, J. D. Powell and M Workman, “Digital Control of Dynamic Systems”, PHI (Pearson), 2002.

15CI15C DIGITAL CONTROL AND INSTRUMENTATION LABORATORY – I L T PC
0 0 4 2

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : analyse the closed loop response of various real time process. (K3, S3)
CO 2 : compute the controller parameter using simulation software. (K2, S3)
CO 3 : implement the various compensator. (K3, S3)
CO 4 : distinguish the characteristics of different transducer for a particular measurement. (K3, S3)

DETAILED SYLLABUS

1. Characteristics of Control Valve with and without Positioner
2. Operation of ON-OFF controlled Thermal Process
3. Closed loop response of Flow Control Loop
4. Closed loop response of Level Control Loop
5. Closed loop response of Pressure Control Loop
6. Closed loop response of Temperature Control Loop
7. Study of complex control system (Ratio / Cascade)
8. Experimental study of following using matlab
   a) Response of different order processes with and without Transportation Lag
   b) Cohen-coon method
   c) Z-N method
9. Characteristics of Resistive Potentiometer, Strain Gauge, Load Cell and LVDT
10. Characteristics of RTD, Thermocouple and Thermistor
11. Experimental determination of coefficient of discharge for Orifice, Pitot and Venturi tube
12. Design of lead, lag, Compensator and Implementation using ELVIS.

P: 60 TOTAL: 60 PERIODS

15CI21C PC BASED INSTRUMENTATION SYSTEM DESIGN L T P C
(Common to C&I and HVE) **3 0 0 3**

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : describe the main functional units in a PC and the software used. (K2)
CO 2 : explain the architecture of PC expansion bus and USB. (K2)
CO 3 : differentiate PC expansion bus and USB. (K2)
CO 4 : select a Virtual Instrument for a particular application. (K3)
CO 5 : describe the functional units of a system for an application. (K2)

UNIT I PC AND ITS PROGRAMMING 9

Microcomputer systems - Data representation - Bus expansion - Microprocessor operation - Data transfer and control - Parallel versus serial I/O. PC memory - Memory operation -Memory organization - Data integrity - Memory terminology - Memory size -Memory speed - CMOS memory - BIOS ROM - PC memory allocation - BIOS data area - Disk drives. Choice of language - Software development - Control structures - Loops - Error checking and input validation - Event-driven programs - Testing.

UNIT II PC EXPANSION BUS SYSTEMS 9

Expansion methods - Development of PC expansion bus architectures - PC ISA/EISA expansion bus -PC expansion cards -Industry Standard Architecture (ISA) bus - The 62-way ISA (PC expansion bus) connector - The 36-way EISA (PC-AT expansion bus) connector - Electrical characteristics - Design of PC expansion cards - The PC/104 bus - Peripheral Component Interconnect/Interface (PCI) bus - Accelerated Graphics Port (AGP).

UNIT III THE UNIVERSAL SERIAL BUS 9

USB applications and principal features - USB implementation - Connection and disconnection of USB devices - USB bus topology and physical connections - Error detection and handling - USB data transfers - USB devices - USB data flow model - USB physical interface - Representative I/O cards - Measurement Computing Corporation PDISO-8 - Blue chip technology AIP-24 - Measurement Computing Corporation Dual-422 - Arcom APCI-ADADIO multifunction I/O card - The PMD-1208LS USB device.

UNIT IV VIRTUAL INSTRUMENTS 9

Selecting a virtual instrument - Instrument types - Instrument connection options - Digital storage oscilloscopes - Sampling rate and bandwidth - Resolution and accuracy - Low-cost DSO - High-speed DSO - High-resolution DSO - Choosing a computer-based DSO - Basic operation of a DSO - Waveform display - Parameter measurement - Spectrum analysis - Sound card oscilloscopes - Windows Oscilloscope -Software Oscilloscope - Waveform display - Parameter measurement - Spectrum analysis

UNIT V APPLICATIONS 9

Expansion cards - Approaches - PC instruments - Industrial PC systems - Backplane bus-based systems - Networked/distributed PC systems - Specifying hardware and software - Hardware design - Software design. Applications - Monitoring oscillator stability - Testing crystal filters - A speech enunciator - Strain measurement and display - Backup battery load test - Load sequencer - Environmental monitoring - Icing flow tunnel.

L: 45 TOTAL: 45 PERIODS

TEXT BOOK

1. Mike Tooley, 'PC Based Instrumentation and Control', 3rd Edition, Elsevier Publications, 2013.

REFERENCES

1. N. Mathivanan, "PC-Based Instrumentation: Concepts and Practice", PHI Learning Private Limited, 2007.
2. Jovitha Jerome, "Virtual Instrumentation using Labview", PHI Learning Private Limited, 2010.
3. MAPLE V programming guide.
4. MATLAB/SIMULINK user manual.
5. MATHCAD/VIS SIM user manual.
6. LABVIEW simulation user manual

15CI22C PROCESS DYNAMICS AND CONTROL **L T P C**
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : analyze the dynamics of process operations mathematically. (K4)
CO 2 : analyze the characteristics of various controller. (K4)
CO 3 : develop the controller and to obtain the controller parameter. (K3)
CO 4 : describes control schemes and analysis its performance. (K2)

UNIT I PROCESS DYNAMICS **9**

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

UNIT II CONTROL ACTIONS AND CONTROLLER TUNING **9**

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

UNIT III COMPLEX CONTROL TECHNIQUES **9**

Feed forward – ratio – cascade - selective control system – split range – inferential - predictive-adaptive and multivariable control – implementation of complex control techniques in distillation column and heat exchanger.

UNIT IV PROGRAMMABLE LOGIC CONTROLLERS **9**

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

UNIT V COMPUTER CONTROL OF PROCESS **9**

PLC based control of processes – Computer control of liquid level system – heat exchanger – Smart sensors and Field bus.

L: 45 TOTAL: 45 PERIODS

TEXT BOOKS

1. Chidambaram. M, “Computer control of processes”, Narosa Publications, 2002.
2. George Stephanopolus, “Chemical Process Control”, Prentice Hall India, 1984.

REFERENCES

1. K.Krishna Swamy, “Process Control”, New Age International, 2007.
2. Marlin T.E., “Process Control”, 2nd Edition, McGraw-Hill, New York, 2000.
3. Norman A Anderson, “Instrumentation for Process Measurement and Control” CRC Press LLC, Florida, 1998.
4. Harriot P, “Process Control”, Tata McGraw-Hill, New Delhi, 1991.
5. Pertrezeulla, “Programmable Controllers”, McGraw-Hill, 1989.
6. Balchan J.G. and Mumme G, “Process Control Structures and Applications”, Van Nostrand Renhold Co., New York, 1988.
7. Lucas M.P, “Distributed Control System”, Van Nostrand Reinhold Co., New York, 1986.

15CI23C SOFT COMPUTING TECHNIQUES **L T P C**
(Common to HVE and C&I) **3 0 0 3**

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : outline the concepts of intelligent expert system. (K2)
CO 2 : explain the components of fuzzy logic system. (K5)
CO 3 : distinguish various structures of ANN. (K4)
CO 4 : describe the basic concepts of genetic algorithms. (K6)
CO 5 : apply ANN, FLC and GA to various electrical applications. (K3)

UNIT I INTRODUCTION **9**

Approaches to intelligent control - Architecture for intelligent control - Symbolic reasoning system-rule-based systems - AI approach - Knowledge representation - Expert systems.

UNIT II ARTIFICIAL NEURAL NETWORKS **9**

Concept of Artificial Neural Networks and its basic mathematical model, McCulloch-Pitts neuron model - simple perceptron - Adaline and Madaline - Feed-forward Multilayer Perceptron. Learning and Training the neural network - Data Processing: Scaling, Fourier transformation, principal-component analysis and wavelet transformations - Hopfield network, Self-organizing network and Recurrent network - Neural Network based controller.

UNIT III FUZZY LOGIC SYSTEM **9**

Introduction to crisp sets and fuzzy sets - basic fuzzy set operation and approximate reasoning - Introduction to fuzzy logic modeling and control - Fuzzification, inferencing and defuzzification - Fuzzy knowledge and rule bases. Fuzzy modeling and control schemes for nonlinear systems - Self-organizing fuzzy logic control - Fuzzy logic control for nonlinear time-delay system.

UNIT IV GENETIC ALGORITHM **9**

Basic concept of Genetic algorithm and detail algorithmic steps - adjustment of free parameters - Solution of typical control problems using genetic algorithm - Concept on some other search techniques like tabu search and ant-colony search techniques for solving optimization problems.

UNIT V APPLICATIONS **9**

GA application to power system optimization problem - Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab - Neural Network toolbox - Stability analysis of Neural-Network interconnection systems - Implementation of fuzzy logic controller using Matlab fuzzy - Logic toolbox - Stability analysis of fuzzy control systems.

L: 45 Total: 45 Periods

REFERENCES

1. Jacek M Zurada, "Introduction to Artificial Neural Systems", Jaico Publishing House, 1999.
2. Kosko.B, "Neural Networks And Fuzzy Systems", Prentice-Hall of India Pvt Ltd., 1994.
3. Klir G.J. and Folger T.A., "Fuzzy sets, Uncertainty and Information", Prentice-Hall of India Pvt. Ltd., 1993.
4. Zimmerman H.J., "Fuzzy set theory-and its Applications"-Kluwer Academic Publishers, 1994.
5. Driankov and Hellendroon, "Introduction to Fuzzy Control", Narosa Publishers, 2001.

15CI24C DIGITAL CONTROL AND INSTRUMENTATION LABORATORY – II L T P C
0 0 4 2

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : examine the system's controllability and observability. (S3)

CO 2 : develop system to acquire data from Real World into PC for analysis purpose using LabVIEW. (K3, S4)

CO 3 : design linear and nonlinear controller. (S4)

DETAILED SYLLABUS

1. Developing voltmeter and signal generator using DAQ cards.
2. Simulating Reactor Control using Virtual Instrumentation
3. Real time Temperature Control using Virtual Instrumentation
4. Linear and Nonlinear PID controller using Virtual Instrumentation
5. Design of Instrumentation Amplifier and Implementation using ELVIS
6. Design of Low pass, High pass, Band pass filter for different order systems and implementation using ELVIS
7. Study of PLC and Programming
8. Develop and Implement a ladder diagram for Bottle Filling Plant and Mixing Process using PLC
9. Study of DCS – Process Field Control Station and Human Interface System
10. Develop a project using DCS for controlling Flow, Level, Pressure and Temperature processes
11. Develop a project using DCS for implementing logical sequence of a typical plant
12. Experimental study of following using Matlab
    a. Check the Controllability and Observability of Systems
    b. Design a Dead Beat Algorithm.

P: 60 TOTAL: 60 PERIODS

15CI25C RESEARCH PAPER AND PATENT REVIEW – SEMINAR L T P C
0 0 4 2

The student will make at least two technical presentations on recent research publication and patent related to their specialization. The presentation will be assessed by a committee constituted by the head of the department. The students also expected to submit a report at the end of the semester.

P: 60 TOTAL: 60 PERIODS

15CI01E MICROCONTROLLER BASED SYSTEM DESIGN L T P C
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: Describe common features and architecture of 8051 and PIC micro controller. (K2)

CO 2: Write programmes for serial communication, Timer and Interrupts blocks in micro controller. (K3)

CO 3: explain digital multi meter, frequency counter and DC motor control using PIC micro controller. (K3)

UNIT I 8051 ARCHITECTURE 9

Architecture – memory organization – Addressing modes – Instruction set – Timers - Interrupts - I/O ports, Interfacing I/O Devices – Serial Communication - Arithmetic Instructions – Logical Instructions – Single bit Instructions.

UNIT II 8051 PROGRAMMING 9

Assembly language programming – Timer Counter Programming – Serial Communication Programming Interrupt Programming – RTOS for 8051 – RTOSLite – FullRTOS –Task creation and run – LCD digital clock/thermometer using FullRTOS.

UNIT III PIC MICROCONTROLLER 9

Architecture – memory organization, RAM & ROM Allocation –Timers – Interrupts, I/O ports- I2C bus-A/D converter-UART - Addressing modes – Instruction set.

UNIT IV PIC MICROCONTROLLER PROGRAMMING 9

PIC programming in Assembly & C Languages –I/O port, Data Conversion, Timer programming - CCP modules -ADC, DAC and Sensor Interfacing –Flash and EEPROM memories.

UNIT V SYSTEM DESIGN – CASE STUDY 9

Interfacing LCD Display – Keypad Interfacing - Generation of Gate signals for converters and Inverters - Motor Control – Controlling AC appliances – Measurement of frequency - Stand alone Data Acquisition System.

L: 45 TOTAL: 45 PERIODS

TEXT BOOKS

1. Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey, “PIC Microcontroller and Embedded Systems using Assembly and C for PIC18”, Pearson Education, 2008.
2. Kenneth J.Ayala “The 8051 Microcontroller Architecture, Programming & Applications”, 2nd Edition, Penram International Publishing (India), 2000.

REFERENCE

1. Myke Predko, “Programming and customizing the 8051 microcontroller”, Tata McGraw Hill 2001.

15CI02E DIGITAL INSTRUMENTATION L T P C
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : identify the various data acquisition systems. (K2)
CO 2 : explain the different peripheral interfaces and data transmission. (K2)
CO 3 : select the appropriate instrumentation bus. (K3)
CO 4 : differentiate the various parallel port busses. (K2)
CO 5 : explain various PC based measurement. (K2)

UNIT I DATA ACQUISITION SYSTEMS 9

Overview of A/D converter, types and characteristics – Sampling Objective – Building blocks of Automation systems –Counters – Modes of operation: Frequency, Period, Time interval measurements, Prescaler, Heterodyne converter for frequency measurement. Single and Multi channel Data Acquisition systems.

UNIT II INTERFACING AND DATA TRANSMISSION 9

Data transmission systems – 8086 Microprocessor based system design – Peripheral Interfaces – Time Division Multiplexing (TDM) – Digital Modulation – Pulse Modulation – Pulse Code Format – Interface systems and standards – Communications.

UNIT III INSTRUMENTATION BUS 9

Introduction - Modem standards - Basic requirements of Instrument Bus standards - Bus communication - interrupt and data handshaking - Interoperability - Interchangeability - RS-232, USB, RS-422, RS-485.

UNIT IV PARALLEL PORT BUSES 9

Field bus, Mod bus, GPIB, IEEE-488, VME, VXI, Network buses – Ethernet – TCP/IP protocols; CAN bus- basics, Message transfer, Fault confinement.

UNIT V CASE STUDIES 9

PC based DAS, Data loggers, PC based industrial process measurements like flow, temperature, pressure and level development system, CRT interface and controller with monochrome and colour video display.

L: 45 TOTAL: 45 PERIODS

TEXT BOOKS

1. A.J. Bouwens, “Digital Instrumentation”, TATA McGraw - Hill, 1998.
2. N. Mathivanan, “Microprocessors, PC Hardware and Interfacing”, Prentice-Hall India, 2005.

REFERENCES

1. H S Kalsi, “Electronic Instrumentation” 2nd Edition, Tata McGraw- Hill, 2006.
2. Joseph J. Carr, “Elements of Electronic Instrumentation and Measurement” 3rd Edition, Pearson Education, 2003.
3. Buchanan, “Computer busses”, Arnold, London, 2000.
4. Jonathan W Valvano, “Embedded Microcomputer systems”, Asia Private Limited., Brooks/Cole, Thomson, 2001.

15CI03E SMART SENSORS **L T P C**
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : recall the fundamental concepts of micro sensors and actuators. (K1)
CO 2 : explain the various types of sensors used in industries. (K2)
CO 3: infer different sensor interfaces for different applications.(K3)

UNIT I OVERVIEW OF SMART SENSOR SYSTEMS 9

Definitions for Several Kinds of Sensors- Automated Production Machines - Automated Consumer Products. Interface Electronics and Measurement Techniques for Smart Sensor Systems: Object-oriented Design of Sensor Systems - Sensing Elements and their Parasitic Effects - Analog-to-Digital Conversion - A Universal Transducer Interface.

UNIT II SILICON SENSORS, OPTICAL SENSORS AND PHYSICAL CHEMOSENSORS 9

Silicon Sensors: Introduction- Measurement and Control Systems- Transducers.
Optical Sensors: Introduction - Photon Absorption in Silicon – Interfacing of Photon Transmission into Silicon - Photon Detection in Silicon Photoconductors - Photon Detection in Silicon PN Junctions.
Physical Chemosensors: Introduction - Physical Chemosensing - Energy Domains - Examples and Applications.

UNIT III SMART TEMPERATURE SENSORS, CAPACITIVE SENSORS AND HALL MAGNETIC SENSORS 9

Smart Temperature Sensors - Sensor Systems: Introduction - Resistive Temperature-sensing Elements - Temperature-sensor Features of Transistors - Smart Temperature Sensors and Systems.
Capacitive Sensors: Basics of Capacitive Sensors - The Design of Electrode Configurations - Selectivity for Electrical Signals and Electrical Parameters.
Integrated Hall Magnetic Sensors: Hall Effect and Hall Elements - Integrated Hall Sensor Systems.

UNIT IV UNIVERSAL ASYNCHRONOUS SENSOR INTERFACES AND DAQ 9

Universal Sensor Interfaces - Asynchronous Converters - Dealing with Problems of Low-cost Design of Universal Interface ICs - Front-end Circuits.
Data Acquisition for Frequency- and Time-domain Sensors: DAQ Boards - Design for Quasi-digital Sensors - Universal Frequency-to-Digital Converters (UFDC).

UNIT V MICROCONTROLLERS AND DIGITAL SIGNAL PROCESSORS FOR SMART SENSOR SYSTEMS 9

Introduction - MCU and DSP Architectures, Organization, Structures, and Peripherals - Choosing a Low-Power MCU or DSP - Timer Modules - Analog Comparators, ADCs, and DACs as Modules of Microcontrollers - Embedded Networks and LCD Interfacing - Development Tools and Support.

L: 45 TOTAL: 45 PERIODS

REFERENCES

1. Gerard C.M. Meijer, “Smart Sensor System”, A John Wiley and Sons Ltd, 2008.
2. Sergey Y. Yurish, Maria T.S.R. Gomes and Maria Teresa S.R. Gomes, “Smart Sensors and MEMS”, Klumer Academic Publishers, 2004.

15CI04E MULTI SENSOR DATA FUSION **L T P C**
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : recall the fundamental concepts of multisensor Data Fusion. (K1)
CO 2 : describe the various types of Algorithm for Data fusion. (K2)
CO 3 : summarize the advanced filtering techniques and estimation analysis. (K2)
CO 4 : select the suitable algorithm for a specific application. (K3)

UNIT I MULTISENSOR DATA FUSION INTRODUCTION **9**

Sensors and sensor data, Use of multiple sensors, Fusion applications. The inference hierarchy: output data. Data fusion model. Architectural concepts and issues. Benefits of data fusion, Mathematical tools used:Algorithms, co-ordinate transformations, rigid body motion. Dependability and Markov chains, Meta – heuristics.

UNIT II ALGORITHMS FOR DATA FUSION **9**

Taxonomy of algorithms for multisensor data fusion - Data association - Identity declaration.

UNIT III ESTIMATION **9**

Kalman filtering, practical aspects of Kalman filtering, extended Kalman filters. Decision levels identify fusion. Knowledge based approaches.

UNIT IV ADVANCED FILTERING **9**

Data information filter, extended information filter. Decentralized and scalable decentralized estimation. Sensor fusion and approximate agreement. Optimal sensor fusion using range trees recursively. Distributed dynamic sensor fusion.

UNIT V HIGH PERFORMANCE DATA STRUCTURES **9**

Tessellated, trees, graphs and function. Representing ranges and uncertainty in data structures. Designing optimal sensor systems with in dependability bounds. Implementing data fusion system.

L: 45 TOTAL: 45 PERIODS

TEXT BOOK

1. David L. Hall, “Mathematical techniques in Multisensor data fusion”, Artech House, Boston, 2004.

REFERENCES

1. R.R. Brooks and S.S. Iyengar, “Multisensor Fusion: Fundamentals and Applications with Software”, Prentice Hall Inc., New Jersey, 1998.
2. Arthur Gelb, “Applied Optimal Estimation”, The M.I.T. Press, 1999.
3. James V. Candy, “Signal Processing: The Model Based Approach”, McGraw –Hill Book Company, 1987.

15CI05E MICRO ELECTRO MECHANICAL SYSTEMS **L T P C**
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : describe various Microsystems and MEMS technologies and their applications. (K2)
CO 2 : explain various semiconductor processes, micro fabrication, techniques and water – level packaging technologies. (K2)
CO 3 : describe different sensing and actuating mechanisms in Microsystems. (K2)
CO 4 : apply the MEMS techniques in developing the modern digital gadget models. (K3)

UNIT I OVERVIEW OF MEMS **9**

History of MEMS, MEMS and Microsystems, Scaling laws in Miniaturization. Materials for MEMS and Microsystems.

UNIT II MICRO FABRICATIONS AND MICROMACHINING **9**

Microsystem Design and Fabrication, Microsystem fabrication processes- Photolithography, Ion Implantation, Diffusion, Oxidation, Chemical and Physical Vapour deposition, Deposition by Epitaxy, Etching. Bulk Micro manufacturing, Surface micromachining, LIGA process.

UNIT III PHYSICAL MICROSENSORS **9**

Design of Acoustic wave sensors, resonant sensor, Vibratory gyroscope, Capacitive and Piezo Resistive Pressure sensors- engineering mechanics behind these Microsensors.

UNIT IV MICROACTUATORS **9**

Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces (Parallel plate, Torsion bar, Comb drive actuators), Micromechanical Motors and pumps.

UNIT V CASE STUDIES **9**

Ink jet pointer heads, Micro mirror TV Projector, DNA chip, Micro arrays, and RF electronic devices.

L: 45 TOTAL: 45 PERIODS

TEXT BOOKS

1. Marc Madou, “Fundamentals of Microfabrication”, 2nd Edition, CRC press, 2002.
2. Stephen D. Senturia, “Micro system Design”, Kluwer Academic Publishers, 2001.

REFERENCES

1. B.H. Bao, “Analysis and design principles of MEMS Devices”, Elsevier, 2005.
2. Tai Ran Hsu, “MEMS and Microsystems Design and Manufacture”, Tata Mc-Graw Hill, 2002.
3. Chang Liu, “Foundations of MEMS”, Pearson Education India limited, 2006.

15CI06E MEDICAL IMAGING SYSTEMS **L T P C**
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : explain the imaging modalities using the knowledge on human physiology. (K2)
CO 2 : demonstrate the various imaging instruments. (K2)
CO 3 : describe the principles of Ultrasound and Magnetic resonance Imaging.(K2)
CO 4 ; explain the fundamentals of Nuclear Medicine Imaging.(K2)

UNIT I HUMAN PHYSIOLOGY **9**

Cell and its structure – Skeletal system – Muscular system – Nervous system- Cardiovascular system – respiratory system – Basic components of a biomedical system – Transducers for physiological measurement – selection criteria for transducers.

UNIT II IMAGING PRINCIPLES AND RADIOGRAPHIC IMAGING **9**

Imaging modalities – Image quality – Contrast, Resolution, Noise, SNR, Nonrandom effects, Accuracy – Physics of Radiography – Attenuation of EM radiation – Narrow beam, Broad beam – Radiation dosimetry – Exposure, Dose and Kerma, f-factor, Dose equivalent, effective dose.

UNIT III PROJECTION RADIOGRAPHY AND COMPUTED TOMOGRAPHY **9**

Projection Radiography – Instrumentation – X-Ray tubes, Filtration, grids, image intensifiers – Image formation – Basic Imaging equation, Geometric effects, Blurring effects, Film characteristics, SNR.

Computed Tomography – Instrumentation – X-Ray source and collimation, CT detectors, Gantry and slip ring – Image formation – Parallel Ray reconstruction, Fan Beam reconstruction – Artifacts.

UNIT IV ULTRASOUND IMAGING AND MAGNETIC RESONANCE IMAGING **9**

Ultrasound imaging – Wave propagation – Instrumentation – Pulse-Echo imaging – Transducer motion – Ultrasound imaging modes – Depth of penetration, Pulse repetition rate – Steering and Focusing – Transmit type, Beam forming and Dynamic Focusing.

MRI – Precession and Larmor Frequency – Instrumentation – MRI Data acquisition – Encoding spatial position, Slice selection, Frequency and Phase encoding, Gradient Echoes – Image reconstruction – Rectilinear data, Polar data – Image quality – Sampling, Resolution, SNR.

UNIT V NUCLEAR MEDICINE IMAGING **9**

Radioactive decay and modes of decay – Planar Scintigraphy – Instrumentation – Collimators, crystal, PMT, PHA, Gating circuit – Image formation – Event position estimation, Acquisition modes, Anger camera imaging equation – Image quality in Planar Scintigraphy – SPECT Image formation – PET Image formation – Image quality in SPECT and PET.

L: 45 TOTAL: 45 PERIODS

TEXT BOOKS

1. Jerry L. Prince, Jonathan M. Links, “Medical Imaging – Signals and Systems” Pearson Prentice Hall, New Jersey, 2006.
2. B H Brown, P V Lawford , R H Smallwood, D R Hose, D C Barber, “Medical Physics and Biomedical Engineering”, IOP publishers, 1999.

REFERENCES

1. Arthur C.Guyton and John Edward Hall, “Textbook of Medical Physiology”, 12th Edition, Elsevier Publication, 2010.
2. Jacobson B. and Webster J.G. “Medicine and Clinical Engineering”, Prentice Hall India, New Delhi, 1999.
3. Steve Webb, “The Physics of Medical Imaging”, Institute of Physics Publishing; 2 Rev. Edition, 2008.
4. R.S.Khandpur, “Hand Book of Bio-Medical instrumentation”, Tata McGraw Hill Publishing Company Limited, 2003.

15CI07E WIRELESS SENSOR NETWORKS L T P C
(Common to CS and C&I) **3 0 0 3**

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: Discuss the design issues in sensor networks. (K1-K2)
CO 2: Explain the different types of MAC protocols. (K1-K2)
CO 3: Discuss the different types of routing protocols. (K1-K2)
CO 4: Expose to the protocol stack issues in sensor networks. (K1-K3)
CO 5: Describe the architecture and protocols of wireless sensor networks. (K1-K2)

UNIT I INTRODUCTION 9

Fundamentals of Wireless Communication Technology – The Electromagnetic Spectrum – Radio propagation Mechanisms – Characteristics of the Wireless Channel- Difference between mobile ad hoc networks (MANETs) and wireless sensor networks (WSNs) - Applications of Ad Hoc and Sensor Networks.

UNIT II ARCHITECTURES 9

Single node architecture – Hardware components – Energy consumption of sensor nodes – Network architecture – Sensor network scenarios – Design challenges in wireless sensor networks – Optimization goals and Figure of merit – Gateway concepts.

UNIT III NETWORKING OF SENSORS 9

Physical layer and Transceiver design considerations – MAC protocols for wireless sensor networks – Low duty cycle protocols and wake up radio concepts – Schedule based protocols – Contention based protocols.

UNIT IV INFRASTRUCTURE ESTABLISHMENT 9

Topology control – Clustering – Time synchronization – Localization and Positioning – Sensor tasking and control.

UNIT V SENSOR NETWORK PLATFORMS AND TOOLS 9

Operating systems for wireless sensor networks – Tiny OS – Programming challenges – Sensor node examples: EYES, Berkeley and Mica Motes – Case study: Forest fire detection, Habitat monitoring and Medical applications.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Holger Karl & Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, John Wiley, 2008.
2. C. Siva Ram Murthy, and B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols", Prentice Hall Professional Technical Reference, 2008.
3. Wayne Tomasi, “Introduction to data communication and Networking”, Pearson Education, 2007.

15CI08E NONLINEAR CONTROL **L T P C**
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : apply the describing function method to non linear feedback systems. (K3)
CO 2 : summarize phase plane analysis of linear and nonlinear systems. (K2)
CO 3 : discuss the nonlinear problems using lyapenov methods and feedback linearization. (K2)

UNIT I DESCRIBING FUNCTION **9**

Common Nonlinear behavior, Common Nonlinearities - Definitions – Computing Describing Functions - Common Nonlinearities and its Describing Functions - Nyquist Criterion and its Extension - Existence of Limit Cycles - Stability of Limit Cycles.

UNIT II PHASE PLANE ANALYSIS **9**

Concepts of phase plane analysis- Phase portraits- Singular points- Symmetry in Phase Plane Portraits-Constructing Phase Portraits- Phase plane Analysis of Linear and Nonlinear Systems.

UNIT III LYAPUNOV THEORY **9**

Nonlinear Systems and Equilibrium Points - Concepts of Stability - Linearization and Local Stability - Lyapunov's Direct Method - Positive definite Functions and Lyapunov Functions - LTI System Analysis based on Lyapunov's Direct Method - Krasovski's Method - Variable Gradient Method - Popov method - Control Design based on Lyapunov's Direct Method.

UNIT IV FEEDBACK LINEARIZATION **9**

Feedback Linearization and the Canonical Form-Mathematical Tools-Input-State Linearization of SISO Systems- Input-Output Linearization of SISO Systems-Generating a Linear Input-Output Relation-Inverse Dynamics and Non-Minimum-Phase Systems-Feedback Linearization of MIMO Systems, Zero-Dynamics and Control Design.

UNIT V SLIDING MODE CONTROL **9**

Sliding Surfaces - Continuous approximations of Switching Control laws - Variable Structure Systems - Sliding modes in Variable Structure System conditions for existence of sliding regions - MIMO Systems.

L: 45 TOTAL : 45 PERIODS

TEXT BOOKS

1. J A E Slotine and W Li, "Applied Nonlinear control", PHI, 1991.
2. M Gopal, Digital Control and State Variable Methods: Conventional and Intelligent Control Systems, 3rd Edition, 2009.

REFERENCES

1. Hasan Khalil, "Nonlinear systems and control", Prentice Hall, 2002.
2. Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall Inc., 1997.
3. G. J. Thaler, "Automatic control systems", Jaico publishers, 1993.

15CI09E OPTIMAL CONTROL AND FILTERING **L T P C**
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : explain the classification of optimal control problem. (K2)
CO 2 : solve the optimal control problems. (K3)
CO 3 : explain the numerical techniques for optimal control. (K2)
CO 4 : analyse the kalmon filter properties. (K3)

UNIT I INTRODUCTION **9**

Statement of optimal control problem – Problem formulation and forms of optimal Control – Selection of performance measures. Necessary conditions for optimal control – Pontryagin's minimum principle – State inequality constraints – Minimum time problem.

UNIT II LQ CONTROL PROBLEMS AND DYNAMIC PROGRAMMING **9**

Linear optimal regulator problem – Matrix Riccatti equation and solution method – Choice of weighting matrices – Steady state properties of optimal regulator – Linear tracking problem – LQG problem – Computational procedure for solving optimal control problems – Characteristics of dynamic programming solution – Dynamic programming application to discrete and continuous systems – Hamilton Jacobi Bellman equation.

UNIT III NUMERICAL TECHNIQUES FOR OPTIMAL CONTROL **9**

Numerical solution of 2-point boundary value problem by steepest descent and Fletcher Powell method solution of Ricatti equation by negative exponential and interactive Methods.

UNIT IV FILTERING AND ESTIMATION **9**

Filtering – Linear system and estimation – System noise smoothing and prediction –Gauss Markov discrete time model – Estimation criteria – Minimum variance estimation – Least square estimation – Recursive estimation.

UNIT V KALMAN FILTER AND PROPERTIES **9**

Filter problem and properties – Linear estimator property of Kalman Filter – Time invariance and asymptotic stability of filters – Time filtered estimates and signal to noise ratio improvement – Extended Kalman filter.

L : 45 TOTAL : 45 PERIODS

TEXT BOOKS

1. Kirk.D.E., "Optimal Control Theory – An introduction", Dover Publication,2001.
2. Anderson, BD.O. And Moore J.B., "Optimal Filtering", 2nd Edition, Prentice hall Inc., 2005.

REFERENCES

1. S.M. Bozic, "Digital and Kalman Filtering", 2nd edition Edward Arnold, London, 1994.
2. David G.Hull., "Optimal control theory for Applications", Springer Publishing Company, 2001.
3. D. Subbaram Naidu, "Optimal control systems", CRC Press, Aug 2002.

15CI10E SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL L T P C
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : explain the concepts of system modeling for various control system. (K2)
CO 2 : describe the various parametric system identification methods. (K2)
CO 3 : analyse various state estimation techniques. (K3)
CO 4 : apply the various adaptive control scheme for real time problems. (K3)

UNIT I MODELS FOR IDENTIFICATION 9

Basic approaches to System Identification, Models of LTI systems: Linear Models-State space Models - Model sets, Structures and Identifiability-Models for Time-varying and Non-linear systems: Models with Nonlinearities – Non-linear state-space models-Black box models, Fuzzy models.

UNIT II NON-PARAMETRIC AND PARAMETRIC IDENTIFICATON 9

Transient response and Correlation Analysis – Frequency response analysis – Spectral Analysis – Least Square – Recursive Least Square –Forgetting factor- Maximum Likelihood – Instrumental Variable methods.

UNIT III NON-LINEAR IDENTIFICATION AND MODEL VALIDATION 9

Open and closed loop identification: Approaches – Direct and indirect identification – Joint input-output identification – Non-linear system identification – Wiener models – Power series expansions - State estimation techniques – Model Validation**.**

UNIT IV ADAPTIVE COTROL AND ADAPTATION TECHNIQUES 9

Introduction – Uses – Auto tuning – Self Tuning Regulators (STR) – Model Reference Adaptive Control (MRAC) – Types of STR and MRAC – Different approaches to self tuning regulators – Stochastic Adaptive control – Gain Scheduling.

UNIT V CASE STUDIES 9

Inverted Pendulum, Aircraft Flight Control, process control application: heat exchanger, Distillation column, Wind mill application, Ship steering control.

L : 45 TOTAL : 45 PERIODS

TEXT BOOKS

1. Ljung, “System Identification Theory for the User”, PHI, 1999.
2. Astrom and Wittenmark, “Adaptive Control”, Pearson Education, 2009.

REFERENCES

1. Torsten Soderstrom, Petre Stoica, “System Identification”, Prentice Hall International (UK) Limited, 1994.
2. Narendra and Annasamy, “Stable Adaptive Control Systems”, Prentice Hall, Dover Edition 2005.

15CI11E BIOCONTROL **L T P C**
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : explain the system concepts and different mathematical techniques applied in analyzing any given system. (K2)
CO 2 : illustrate the techniques of plotting the responses in both domain analysis. (K2)
CO 3 : apply frequency domain analysis to study biological systems. (K3)

UNIT I CONTROL SYSTEM MODELLING **9**

Dynamic Systems and their Control - Modelling and Block Diagrams - Open and Closed loop Systems - Closed Loop Dynamics of First Order and Second Order - System Stability and Compensation - Frequency Response and Techniques - Root Locus Method - Introduction to Non-linear Control.

UNIT II PHYSIOLOGICAL CONTROL SYSTEMS **9**

Block diagram representation of the muscle stretch reflex – Difference between engineering and physiological control – generalized system properties – models with combination of system elements – introduction to simulation.

UNIT III BIOLOGICAL CONTROL SYSTEMS **9**

Pupil Control System - Visual Fixation System –- Oculo-motor System - Skeletal Muscle Servomechanism - Thermo Regulation - Prosthetic control.

UNIT IV PHYSIOLOGICAL SYSTEM MODELLING **9**

Westheimer Saccadic Eye Movement Model - Respiration Models and Controls - Cardiovascular Control Systems - Sugar Level Control Mechanism - Endocrine Control System -Excretion Control.

UNIT V TRANSFER FUNCTIONS **9**

Human Operator Tracking Characteristics - Biological Receptors - Receptor Characteristics - Transfer Function Models of Receptors.

L : 45 TOTAL : 45 PERIODS

TEXT BOOKS

1. Ogata Katsuhika, “Modern Control Engineering”, 2nd Edition, Prentice Hall of India, 2010.
2. John Enderle, Susan Blanchard, Joseph Bronzino, “Introduction to Biomedical Engineering”, 3rd Edition, Academic Press, 2012.

REFERENCES

1. Milsum John H., “Biological Control Systems Analysis”, McGraw-Hill, 2007.
2. Richard C. Dorf, Robert H. Bishop, “Modern Control Systems”, Pearson, 2004.
3. Michel C Khoo, “Physiological Control Systems – Analysis, simulation and Estimation”, Prentice Hall of India, 2001.

15CI12E ADVANCED PROCESS CONTROL **L T P C**
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : describe the various linear model identification. (K2)
CO 2 : analyze the Internal Model Control. (K4)
CO 3 : express the elements of computer process control. (K2)
CO 4 : develop the advanced control schemes for real time processes. (K4)

UNIT I ADVANCED PROCESS MODELLING AND IDENTIFICATION 9

Process Time Constant – Domain Transformation – Common Elements in Control - Model application – Types of Models – Empirical (linear) Dynamic Model – Model Structure Considerations – Model Identification – Identification of Parametric Model – Identification of Non-Parametric Model.

UNIT II INTERNAL MODEL CONTROL 9

Introduction to Model-Based Control – Practical Open –Loop Controller – Model Uncertainty and Disturbances – Development of the IMC Structures – IMC Design procedure – Effect of Model Uncertainty and Disturbances – Improved Disturbance Rejection Design – Manipulated Variable Saturation.

UNIT III ELEMENTS OF COMPUTER PROCESS CONTROL 9

Review of Conventional Process Control: Introduction to Process Control - Process Dynamics and Mathematical Models-Types of Dynamic Processes - Basic Feedback Control - Stability of Conventional Control Systems - Problem Control Situations - Computer - Control Hardware and Software: Conventional Control versus Computer Control - Basic Concepts of Computers-Computer System Hardware Concepts - Computer System Software Concepts - Configurable Digital Systems and Networks - Single - Loop Computer Control: The Present System - Switchover to Computer Control.

UNIT IV DESIGN OF ADVANCED CONTROL SCHEMES 9

Modified Z Transforms: Definitions and Evaluation of Modified Z Transforms - Application of Modified Z Transforms to Systems with Dead Time - Application of Modified Z Transforms to Determine Output Between Sampling Instants - Design and Application of Advanced Control Concepts: Process Modeling from Step - Test Data - Pulse Testing for Process Identification - Time Domain Process Identification - Algorithms for Processes with Dead Time : Smith Predictor Algorithm - Analytical Predictor Algorithm - Algorithm of Gautam and Mutharasan.

UNIT V MULTIPLE LOOP CONTROL SCHEMES 9

Feed forward control: Introduction and Design Fundamentals - Cascade Control: Controller Design of Cascade Systems - An Industrial Application of Cascade - Control Technique - Use of Cascade Control - Multivariable Control Systems : The Interaction Measure - Interaction and Decoupling.

L : 45 TOTAL : 45 PERIODS

TEXT BOOKS

1. PradeepB.Deshpande and Raymond H.Ash, “Elements of Computer Process Control with Advanced Control Applications”, Prentice Hall 2004.
2. B.Roffel and B.H.L. Betlem, “Advanced Practical Process Control”, Springer , 2004

REFERENCES

1. B.Wayne Beqyett, “Process Control Modeling, Design and Simulation”, PHI Learning Private Limited, 2010
2. Astrom, K. J. and B. Wittenmark, “Computer Controlled Systems”, Prentice Hall, 2005.

15CI13E INDUSTRIAL AUTOMATION **L T P C**
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : explain the various exploration techniques employed in petroleum. (K2)
CO 2 : discuss the different types of dryers, evaporators and heat exchangers used in chemical reactors. (K2)
CO 3 : summarize modern trends in iron making blast furnace. (K2)
CO 4 : explain about the working and construction of pumps. (K2)

UNIT I PETROCHEMICAL INTRODUCTION **9**

Petroleum Exploration, Production and Refining - Constituents of Crude Oil. P & I diagram of petroleum refinery – Atmospheric and Vacuum Distillation of Crude oil Thermal Conversion process – Control of Distillation Column – Temperature and Pressure Control – Feed control, Reflux Control, Reboiler Control.

UNIT II CONTROLS OF CHEMICAL REACTORS **9**

Temperature and Pressure Control in reactors – Control of Dryers – Batch and Continuous Dryers. Control of Heat Exchangers and Evaporators – variables and Degrees of freedom – Liquid to Liquid Heat Exchangers – Steam Heaters – Condensers – Reboilers and Vaporizers – Cascade Control – Feed forward Control. Evaporators: Types of Evaporators. Control of Pumps: Centrifugal pump: On-Off level control – Pressure control – Flow control – Throttling control. Reciprocating Pumps: On-Off control and Throttling control.

UNIT III IRON AND STEEL **9**

The need for iron and steel in the civilised world; history of steel making – Process description in diagrammatic and functional block details; raw materials reparation; operation of Blast Furnace (BF) and auxiliary units including stoves; Basic oxygen Furnace (BOF); Electric Furnace (EF); Open Hearth Furnace (OHF); relative merits of various steel making furnaces.

UNIT IV QUALITY OF STEEL **9**

Impurities present and allowed limits for usable steel; waste recycling casting of steel; primary and secondary rolling, cold rolling; steel finishing operations. Identification of various process parameters in the industry; weighing and proportioning; special gauges for measurement of thickness and shape.

UNIT V SPECIAL APPLICATIONS FOR CONTROLS **9**

Blast Furnace, Stove combustion control system; gas and water control system in Basic Oxygen Furnace; Mould Level control system in Sand Casting operations. Evolution of computer applications in the industry; Practices for model calculating and data logging; steel rolling mill control; annealing process control; utilities management with computer system.

L: 45 TOTAL: 45 PERIODS

TEXT BOOKS

1. Dr.Ram Prasad, “Petroleum Refining Technology”, 1st Edition, Khanna Publisher, 2000.
2. Considine D. M., “Process/Industrial Instruments and control Handbook”, 5th Edition McGraw Hill, 2009.

REFERENCES

1. Liptak B.G., “Instrument Engineers Handbook”, Volume II, 2005.
2. Robert H. Perry, D.W. Green and J.O. Maloney, Perry’s, “Chemical Engineers, Handbook”, 8th Edition, McGraw Hill Inc, New York, 2007.
3. Serope Kalpakjian, “Manufacturing Engineering and Technology”, 4th Edition, Addison Wesley Publishing Company, Massachusetts, 2009.

15CI14E SOLAR PHOTOVOLTAIC TECHNOLOGIES AND APPLICATIONS L T P C
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : infer fundamental concepts of Solar Energy. (K2)
CO 2 : interpret different design concepts of solar cells. (K2)
CO 3 : outline different Power Electronic converters. (K2)
CO 4 : summarize various PV system design. (K2)
CO 5 : discuss applications on Solar Energy. (K2)

UNIT I FUNDAMENTALS OF SOLAR ENERGY AND ELECTRONICS 9

Need for sustainable Energy Sources, Sustainable Sun's Energy, Current status of Renewable Energy. Fundamentals of Semiconductor-Semiconductor as Solar cell material, Arrangements of Atoms, Atom model, Formation of Energy band, Charge carriers in semiconductor, carrier motion in semiconductor, Generation and Recombination of carriers.PN Junction under Illumination-Generation of Photovoltage – Light generated I-V Equation of Solar Cells-Solar Cell Characteristics.

UNIT II DESIGN OF SOLAR CELLS 9

Solar cell-Introduction, Generation of Electric Current using Solar Cell-Factors affecting Electricity generated by Solar Cell-Upper limits of Solar Cell Parameters-Losses in Solar Cell-Solar Cell Design-Design for High Isc, Design of High Voc, Design for High FF.

UNIT III SOLAR POWER ELECTRONICS 9

DC to DC Converters Types: Buck, Boost, Buck-Boost-Charge Controllers-DC to AC Converters Types: Single phase, 3 phase, Inverter with PWM-MPPT design and Algorithm-Perturb & Observence, Hill Climbing.

UNIT IV PV SYSTEM DESIGN 9

Introduction-Stand alone PV System Configuration, Types-Stand alone system with DC Load(Type A, Type B)-Stand alone system with Battery, DC Load-Stand alone system with AC/DC load with Battery-Design Methodology –Hybrid PV Systems-Grid Connected PV Systems.

UNIT V APPLICATIONS 9

Solar Water heaters - Solar Air heaters - Solar Crop Drying - Solar Distillation - Solar thermal power generation - Solar thermoelectric refrigeration.

L : 45 TOTAL : 45 PERIODS

TEXT BOOKS

1. Chetan Singh Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Applications", 2nd Edition, PHI Learning Private Limited, 2012.
2. Chetan Singh Solanki, "Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers, PHI Learning Private Limited, 2013.

REFERENCE

1. Rai.G.D., "Solar Energy utilization", 5th Edition, Khanna Publishers, 2010.

15CI15E AUTOMOBILE INSTRUMENTATION **L T P C**
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : recall the fundamentals of automotive electronics. (K1)
CO 2 : identify basic electric and electronic components. (K3)
CO 3 : describe the principles of magnetism and magnetic fields. (K2)
CO 4 : identify types of electrical test meters and equipment. (K3)

UNIT I FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS 9

Open loop and closed loop system components for electronic engine management, vehicle motion control, Current trends in modern Automobiles.

UNIT II ELECTRONIC FUEL INJECTION AND IGNITION SYSTEMS 9

Introduction, Carburettor control system,throttle body ignition and multi port or point fuel injection, Advantages of electronic ignition system, Types of solid state ignition systems and their principle of operation, electronic spark timing control system.

UNIT III ENGINE CONTROL SYSTEM 9

Engine cranking and warm up control, Acceleration enrichment –Deacceleration leaning and idle speed control, integrated engine control system, exhaust emission control system, Engine performance testing.

UNIT IV AUTOMOBILE CHASSIS ELECTRONIC CONTROL SYSTEM 9

Principle of electronic braking, automatic transmission electronic control circuit, cruise control circuit, the electronic steering control theory, Antilock Braking System(ABS), Anti Slip Regulation(ASR), Electronic Stability Program(ESP) and other electronic control method.

UNIT V AUTO BODY ELECTRONIC CONTROL TECHNOLOGY 9

Automotive central locking and anti-theft system control technology, electronically controlled windows and doors and airbag technology, principle of control circuit components and characteristics.

L : 45 TOTAL : 45 PERIODS

TEXTS BOOKS

1. Robert Bosch, “Automotive Hand Book”, 5th ed., SAE, 2000.
2. William B. Riddens, “Understanding Automotive Electronics”, 5th Edition, (Butterworth Heinemann Woburn), 1998.

REFERENCES

1. Jiri Marek, Hans Peter trah, “Sensors Applications, Sensors for Automotive Technology” 1st Edition, Wiley, 2003.
2. T. Mellard, “Automotive Electronic Systems”, Heinenmann Professional, 1987.

15CI16E APPLIED INDUSTRIAL INSTRUMENTATION LT P C
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : outline the measurement procedure of different industrial parameters. (K2)
CO 2 : explain the measurement procedure of different parameters in thermal power plant. (K2)
CO 3 : illustrate the measurement procedures for measurement of process parameters in Petrochemical Industry. (K2)
CO 4 : describe the various types of pulp and paper properties and measurement techniques. (K2)
CO 5 : explain the measurement principles for measuring the industrial parameters for different applications. (K2)

UNIT I REVIEW OF INDUSTRIAL INSTRUMENTATION 9

Measurement of Force, Torque, Velocity, Acceleration, Pressure, Temperature, Flow, Level, Viscosity, Humidity & Moisture (Qualitative Treatment Only).

UNIT II MEASUREMENT IN THERMAL POWER PLANT 9

Selection, Installation and maintenance of Instruments used for the measurement of fuel flow, Air flow, Drum level, Steam pressure, Steam temperature and other parameters in thermal power plant – Analyzers-Dissolved Oxygen Analyzers- Flue gas Oxygen Analyzers-pH measurement-Coal/Oil Analyzer – Pollution Controlling Instruments.

UNIT III MEASUREMENT IN PETROCHEMICAL INDUSTRY 9

Parameters to be measured in refinery and petrochemical industry-Temperature, Flow and Pressure measurements in Pyrolysis, catalytic cracking, reforming processes- Selection and maintenance of measuring instruments – Intrinsic safety.

UNIT IV INSTRUMENTATION FOR PULP AND PAPER INDUSTRIES 9

Definition of consistency — Techniques for head box consistency measurement -Functioning of Paper making machine — Quality parameters — moisture, basic weight, caliper, brightness, colour, ash content, strength, gloss and tensile strength - parameters monitoring Instrumentation.

UNIT V SPECIAL PURPOSE INSTRUMENTATION 9

Toxic gas monitoring- Detection of Nuclear radiation – Water quality monitoring- Monitor measurement by neutron-Thermo-luminescent detectors – Measurement of length, mass, thickness, flow, level using nuclear radiation.

L : 45 TOTAL : 45 PERIODS

TEXT BOOK

1. B.G.Liptak, “Instrument Engineers Hand Book”, 4th Edition, CRC press, 2012.

REFERENCES

1. D.Patranabis, “Principles of Industrial Instrumentation”, Tata McGraw Hill Publishing Company Limited., New Delhi, 2010.
2. John G Webster, “Measurement, Instrumentation and Sensors Handbook”,2nd Edition CRC press, 2014.

15CI17E MODERN MEDICAL INSTRUMENTS **L T P C**
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : explain the human physiology. (K2)
CO 2 : model and experiment with the medical equipments. (K3)
CO 3 : explain the procedure to test the safety of medical equipment. (K6)

UNIT I HUMAN PHYSIOLOGY AND SIGNALS **9**

Overview of Cell - Cardio Vascular System - Nervous System - Respiratory system - musculo skeletal system. Bio-potential: generation and propagation. Electrodes: Micro – Skin – surface – needle electrodes

UNIT II DIAGNOSTIC AND IMAGING DEVICES **9**

Block diagram, operation, advancements in X-ray imaging – Tomogram – computerized Axial tomography - Ultrasonic imaging techniques - Echo cardiograph – Angiogram - CT scanner - Magnetic Resonance Imaging - Electrical Impedance Tomography - Endoscope, Proton Beam Radiotherapy - Medical Infrared Imaging.

UNIT III THERAPEUTIC AND ASSISTIVE DEVICES **9**

Working principle, types and advancements in Pacemakers – defibrillators - heart valves - heart-lung machines - ventilators –incubators - dialyzers.

UNIT IV PATIENT MONITORING SYSTEM AND TELEMETRY **9**

ECG – Respiration – BP – Temperature - O_2 and CO_2 measurement - Blood Gas Analyzer - Drug Dosage calculator - Drug Management System - RFID in PMS - Real Time Patient Location System - Wearable PMS.

UNIT V MEDICAL INSTRUMENTS' SAFETY AND CERTIFICATION **9**

Regulations, Standards and organizations – Basic Protection Concepts – Verification of Constructional Requirements – Medical Equipment safety tests – Electromagnetic Compatibility - Patient care technology and safety.

L : 45 TOTAL : 45 PERIODS

TEXT BOOKS

1. S.Ananthi, "A Textbook of Medical Instruments", New Age International Pub Ltd., 2005.
2. Joseph D Bronzino, Taylor and Francis, "The Biomedical Engineering Handbook", "Medical Devices and Systems", 3rd Edition, 2006.

REFERENCES

1. Claudio Becchetti, Alessandro Neri, "Medical Instrument Design and Development: From Requirements to Market Placements", John Wiley & Sons Ltd., 2013.
2. R. S. Khandpur, "Handbook of Bio – Medical Instrumentation", Tata Mcgraw Hill Education, 2003.
3. Mandeep Singh, "Introduction to Biomedical Instrumentation," PHI Publication, 2010.

15CI18E ADVANCED DIGITAL SYSTEM DESIGN **LT PC**
(Common to C&I and HVE) **3 0 0 3**

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : design a small digital system to the specified functionality. (K3)
CO 2 : apply modern tools in combinational and sequential circuit design with VHDL. (K3)
CO 3 : explain new generation programmable logic devices. (K2)
CO 4 : apply testability algorithms in the design of digital circuits. (K3)

UNIT I SEQUENTIAL CIRCUIT DESIGN 9

Analysis of Clocked Synchronous Sequential Networks (CSSN) Modelling of CSSN – State Stable Assignment and Reduction – Design of CSSN – Design of Iterative Circuits – ASM Chart – ASM Realization, Design of Arithmetic circuits for Fast adder- Array Multiplier.

UNIT II ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN 9

Analysis of Asynchronous Sequential Circuit (ASC) – Flow Table Reduction – Races in ASC – State Assignment Problem and the Transition Table – Design of ASC – Static and Dynamic Hazards – Essential Hazards – Data Synchronizers – Designing Vending Machine Controller – Mixed Operating Mode Asynchronous Circuits.

UNIT III FAULT DIAGNOSIS AND TESTABILITY ALGORITHMS 9

Fault Table Method – Path Sensitization Method – Boolean Difference Method – Kohavi Algorithm – Tolerance Techniques – The Compact Algorithm – Practical PLA's – Fault in PLA – Test Generation – Masking Cycle – DFT Schemes – Built-in Self Test.

UNIT IV SYSTEM DESIGN USING VHDL 9

VHDL operators – Arrays – concurrent and sequential statements – packages- Data flow – Behavioral – structural modeling – compilation and simulation of VHDL code –Test bench - Realization of combinational and sequential circuits using HDL – Registers – counters – sequential machine – serial adder – Multiplier- Divider – Design of simple microprocessor.

UNIT V NEW GENERATION PROGRAMMABLE LOGIC DEVICES 9

Foldback Architecture with GAL,PEEL, PML; PROM – Realization State machine using PLD – FPGA – Xilinx FPGA – Xilinx 2000 - Xilinx 3000.

L : 45 TOTAL : 45 PERIODS

TEXT BOOKS

1. Donald G. Givone, "Digital principles and Design", Tata McGraw Hill 2001.
2. Stephen Brown and Zvonk Vranesic, "Fundamentals of Digital Logic with VHDL Design", Tata McGraw Hill Higher Education, 2009.

REFERENCES

1. Mark Zwolinski, "Digital System Design with VHDL", Pearson Education, 2001.
2. Parag K Lala, "Digital System design using PLD", BS Publications, 2001.
3. John M Yarbrough, "Digital Logic applications and Design", Thomson Learning, 2001.
4. Nripendra N Biswas, "Logic Design Theory", Prentice Hall of India, 2001.
5. Charles H. Roth Jr., "Fundamentals of Logic design", 6th Edition Thomson Learning., 2010.
6. Charles H Roth Jr."Digital System Design using VHDL" Thomson learning, 2004.
7. Douglas L.Perry "VHDL programming by Example" Tata McGraw.Hill – 2006.

15CI19E ADVANCED DIGITAL SIGNAL PROCESSING **L T P C**
(Common to CS, HVE and C&I) **3 0 0 3**

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: discuss the essentials for the postgraduate level research in the area of statistical signal processing. (K1-K2)
CO 2: model random signals and determine its solution. (K1-K3)
CO 3: estimate the coefficient for perfect reproduction filter for both the stationary and non-stationary signals. (K1- K3)
CO 4: design FIR and IIR adaptive filters using adaptive algorithms. (K1- K4)
CO 5: estimate the power spectrum for discrete random signals using classical and non-classical methods. (K1- K3)

UNIT I DISCRETE RANDOM SIGNAL PROCESSING **9**

Random Processes - Ensemble Averages, Gaussian processes, Stationary processes, Auto covariance and Autocorrelation matrices, Bias and Estimation, Parseval's theorem, Wiener-Khintchine relation, White noise, Power Spectral Density, Spectral factorization, Filtering Random Processes, Special types of Random Processes - ARMA, AR, MA.

UNIT II SIGNAL MODELING **9**

Least Squares method, Pade approximations, Prony's method – Pole zero modeling, All pole modeling, Linear prediction, Forward and Backward prediction, Finite data records, stochastic models, Solution of Prony's normal equations – Levinson Durbin recursion.

UNIT III WIENER FILTERING **9**

FIR Wiener filter – Filtering, Linear prediction, Noise cancellation, Lattice representation, Causal and Non-causal IIR Wiener filters, Weiner Deconvolution, Discrete Kalman filter.

UNIT IV ADAPTIVE FILTERS **9**

FIR adaptive filters, Steepest Descent Adaptive Filter, LMS algorithm, Normalized LMS algorithm, Noise cancellation, Channel equalization, Adaptive Recursive filters, Recursive Least squares algorithm.

UNIT V SPECTRAL ESTIMATION **9**

Nonparametric methods - Periodogram, Modified periodogram, Bartlett, Welch and Blackman-Tukey methods, Parametric methods - ARMA, AR and MA model based spectral estimation.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons, Inc, Singapore, 1st Edition, 2008.
2. John G. Proakis and Dimitris K Manolakis, "Digital Signal Processing", Pearson Education, 4th Edition, 2009.
3. Alan V. Oppenheim and Ronald W. Schafer, "Discrete-Time Signal Processing", 3rd Edition, Prentice Hall, 2009.
4. Emmanuel C. Ifeachor and Barrie W. Jervis, "Digital signal processing: A practical approach" 2nd Edition, Prentice Hall, 2002.

15CI20E DIGITAL IMAGE PROCESSING TECHNIQUES L T P C
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : describe the image formation and the human visual system. (K2)
CO 2 : apply image processing techniques in both the spatial and frequency (Fourier) domains. (K3)
CO 3 : explain the techniques in image segmentation and feature extraction (K3)
CO 4 : describe the concepts of image registration and image fusion. (K2)

UNIT I FUNDAMENTALS OF DIGITAL IMAGE PROCESSING 9

Elements of visual perception, brightness, contrast, hue, saturation, mach band effect, 2D image transforms-DFT, DCT, KLT, and SVD. Image enhancement in spatial and frequency domain, Review of morphological image processing.

UNIT II SEGMENTATION 9

Edge detection, Thresholding, Region growing, Fuzzy clustering, Watershed algorithm, Active contour methods, Texture feature based segmentation, Model based segmentation, Atlas based segmentation, Wavelet based Segmentation methods

UNIT III FEATURE EXTRACTION 9

First and second order edge detection operators, Phase congruency, Localized feature extraction-detecting image curvature, shape features Hough transform, shape skeletonization, Boundary descriptors, Moments, Texture descriptors- Autocorrelation, Co-occurrence features, Runlength features, Fractal model based features, Gabor filter, wavelet features.

UNIT IV REGISTRATION AND IMAGE FUSION 9

Registration- Preprocessing, Feature selection-points, lines, regions and templates Feature correspondence - Point pattern matching, Line matching, region matching Template matching. Transformation functions-Similarity transformation and Affine Transformation. Resampling-Nearest Neighbour and Cubic Splines Image Fusion-Overview of image fusion, pixel fusion, Multi resolution based fusion discrete wavelet transform, Curvelet transform. Region based fusion.

UNIT V 3D IMAGE VISUALIZATION 9

Sources of 3D Data sets, Slicing the Data set, Arbitrary section planes, The use of color, Volumetric display, Stereo Viewing, Ray tracing, Reflection, Surfaces, Multiply connected surfaces, Image processing in 3D, Measurements on 3D images.

L : 45 TOTAL : 45 PERIODS

TEXT BOOKS

1. John C.Russ, “The Image Processing Handbook”, CRC Press, 2007.
2. Mark Nixon, Alberto Aguado, “Feature Extraction and Image Processing”, Academic Press, 2008.
3. Ardeshir Goshtasby, “2D and 3D Image registration for Medical, Remote Sensing and Industrial Applications”, John Wiley and Sons, 2005.

REFERENCES

1. Rafael C. Gonzalez, Richard E. Woods, “Digital Image Processing”, 2nd Edition Pearson, Education, Inc., 2004.
2. Anil K. Jain, “Fundamentals of Digital Image Processing”, Pearson Education, Inc., 2002.
3. Rick S.Blum, Zheng Liu,“ Multisensor image fusion and its Applications”, Taylor & Francis, 2006.

15CI21E DESIGN OF EMBEDDED SYSTEMS **L T P C**
(Common to C&I and HVE) **3 0 0 3**

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : explain the basic concepts and building blocks of embedded system. (K2)
CO 2 : infer the fundamentals of Embedded processor Modeling. (K2)
CO 3 : illustrate bus communication in processors and I/O interfacing. (K2)
CO 4 : summarize processor scheduling algorithms and to explain the basics of RTOS. (K2)
CO 5 : distinguish the different phases & modeling of embedded system with its applications on various fields. (K3)

UNIT I INTRODUCTION TO EMBEDDED SYSTEMS 9

Introduction to Embedded Systems -The build process for embedded systems-Structural units in Embedded processor-Selection of processor & memory devices- DMA – Memory management methods-Timer and Counting devices, Watchdog Timer, Real Time Clock-Software Development tools-IDE, assembler, compiler, linker, simulator, debugger-In circuit emulator, Target Hardware Debugging, Boundary Scan.

UNIT II HARDWARE SOFTWARE PARTITIONING 9

Hardware/ Software Co-Design-Basic concepts-Goals-Issues in Co-Design Models - Finite state Machine-HFSM-PSM-Architectures control / data flow nets, task graphs - Generic Co-Design Methodology – Approaches - Challenges, System Specification languages - State charts and modeling - Single processor Architectures - Hardware / Software duality - HW/SW portioning-Algorithm development - Prototyping & emulation technique.

UNIT III EMBEDDED NETWORKING AND INTERRUPTS SERVICE MECHANISM 9

Embedded Networking: Introduction, I/O Device Ports & Buses-Serial Bus communication protocols -RS232 standard-RS485-CAN Bus-Inter Integrated Circuits (I2C)-Interrupt sources, Programmed I/O-Busy-wait approach without interrupt service mechanism-ISR concept-Multiple interrupts-Context and periods for context switching, interrupt latency and deadline-Device Driver-Introduction to Basic Concept of Parallel port & Serial port Device Drivers.

UNIT IV RTOS BASED EMBEDDED SYSTEM DESIGN 9

Introduction to basic concepts of RTOS-Need, Task, process & threads, interrupt routines in RTOS-Multiprocessing and Multitasking- Preemptive and non-preemptive scheduling-Task Communication - Shared memory - Message passing – Inter process Communication-Synchronization between processes-Semaphores-Mailbox-Pipes-Priority inversion-Priority inheritance-Comparison of Real time Operating systems: VxWorks, µC/OS-II, RT Linux

UNIT V EMBEDDED SYSTEM APPLICATION DEVELOPMENT WITH PROCESSOR 9

Objective, Need, different Phases & Modelling of the EDLC-Choice of Target Architectures for Embedded Application Development for Control Dominated-Data Dominated Systems-Case studies on Digital Camera, Adaptive Cruise control in a Car, Mobile Phone software for key inputs.

L : 45 TOTAL : 45 PERIODS

TEXT BOOKS

1. Rajkamal, “Embedded system-Architecture, Programming, Design”, Tata Mcgraw Hill, 2011.
2. Shibu.K.V, “Introduction to Embedded Systems”, Tata Mcgraw Hill, 2009.

REFERENCES

1. Peckol, “Embedded system Design”, John Wiley & Sons, 2010.
2. Lyla.B.Das, “Embedded Systems-An Integrated Approach”, Pearson, 2013.
3. Elicia White, “Making Embedded Systems”, O’ Reilly Series, SPD, 2011.
4. Tammy Noergaard, “Embedded System Architecture, A comprehensive Guide for Engineers and Programmers”, Elsevier, 2006.
5. Prasad.K.V.K.K., “Embedded / Real-Time Systems-Concepts, Design & Programming-Black Book”, Dream tech Press, 2010.

15CI22E POWER PLANT INSTRUMENTATION L T P C
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : explain the operation of various conventional power plants and controllers in boilers. (K2)

CO 2 : describe the working of solar radiation measurements, Solar Photovoltaic systems and applications of solar energy. (K2)

CO 3 : describe the functioning of Wind Energy Conversion Systems and Biomass conversion technologies. (K2)

CO 4 : discuss the Geothermal resources, Ocean Energy and additional alternate energy resources. (K2)

UNIT I OVERVIEW OF CONVENTIONAL POWER GENERATION AND CONTROL LOOPS IN BOILER 9

Brief survey of methods of power generation – Thermal Power plant, Hydro-Electric Power plant, Nuclear Power plant and Cogeneration – Control system diagramming – P&I diagram of boiler – Control loops in boiler – Combustion control – Measurement of furnace draft – Drum level control – Main steam and reheat steam temperature control – Deaerator – Combustion air flow control.

UNIT II SOLAR ENERGY 9

Solar radiation – Solar radiation measurements, Estimation of average solar radiation, Solar radiation on tilted surfaces – Solar energy collectors –Solar Photovoltaic systems – Solar cell characteristics, Solar cell Classification, Construction of PV module, panel and array, MPPT, Classification of PV systems – Applications of solar energy – Solar water heaters, Solar thermal electric conversion, Solar PV power generation, Solar cooking.

UNIT III WIND AND BIOMASS ENERGY 9

Wind Energy – Origin of winds, Nature of winds, Site selection considerations, Wind turbine aerodynamics, Basic components of a Wind Energy Conversion System, Wind turbine types and their construction, Design consideration of horizontal axis type wind turbine, Schemes for electrical energy generation (CSCF, VSCF, VSVF), Environmental aspects.

Biomass Energy – Biomass resources, Biomass conversion technologies, Biomass gasification, Constant pressure type and constant volume type biogas plants.

UNIT IV GEOTHERMAL AND OCEAN ENERGY 9

Geothermal Energy – Types of Geothermal resources, Analysis of geothermal resources, Environmental consideration. Ocean Energy – Tidal Energy – Conversion scheme, Estimation of power – Wave Energy – Power in waves, Wave energy technology – Ocean Thermal Energy Conversion (OTEC) schemes – Claude cycle, Anderson cycle, Hybrid cycle, Environmental impacts.

UNIT V ADDITIONAL ALTERNATE ENERGY RESOURCES 9

Magneto Hydro Dynamic (MHD) power generation – Principles, MHD systems, Voltage and Power output of MHD generator, Materials for MHD generator. Thermoelectric power generation – Basic principles, Thermoelectric power generator and its performance analysis, Selection of materials. Thermionic power generation – Principle, Thermionic generator and its performance analysis.

L: 45 TOTAL: 45 PERIODS

TEXT BOOKS

1. G.D.Rai, “Non-Conventional Energy Resources”, 5th Edition, Khanna Publishers, 2011.
2. B.H. Khan, “Non-Conventional Energy Resources”, 11th Edition, Tata McGraw Hill, New Delhi, 2012.

REFERENCES

1. G.F. Gilman, “Boiler Control Systems Engineering”, 2005, ISA Publication.
2. E.Al. Wakil, “Power Plant Engineering”, Tata McGraw Hill, 1984.
3. S. P. Sukhatme, “Solar Energy”, Tata McGraw Hill, New Delhi, 1996.
4. Sam G. Dukelow, “The Control of Boilers”, Instrument Society of America, 1991.
5. P.K. Nag, “Power Plant Engineering”, 3rd Edition, Tata McGraw Hill, 2008.

15CI23E INSTRUMENTATION FOR NON-DESTRUCTIVE TESTING L T P C
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: list the concepts of Visual Inspection & Liquid Penetrant Testing. (K2)
CO 2: differentiate the various types of Electromagnetic Testing. (K2)
CO 3: explain the concepts of Industrial Application using NDT. (K2)

UNIT I NON-DESTRUCTIVE TESTING: AN INTRODUCTION, VISUAL INSPECTION & LIQUID PENETRANT TESTING 6

Introduction to various non-destructive methods, Comparison of Destructive and Non destructive Tests, Conditions for effective non-destructive testing - Visual Inspection, Optical aids used for visual inspection, Applications. Physical principles, procedure for penetrant testing, Penetrant testing materials, Penetrant testing methods-water washable, Post – Emulsification methods, Applications.

UNIT II ELECTROMAGNETIC TESTING 10

Eddy Current Testing: Principles, Instrumentation for ECT, Absolute, differential probes, Inspection of Ferromagnetic materials – Instrumentation for pulsed eddy current techniques - applications

Magnetic Flux Leakage Testing: Principles, Inductive coils probe and Hall Effect probes -Factors affecting flux leakage- applications.

Magnetic particle testing: Principle of MPT, procedure used for testing a component, Equipment used for MPT, Magnetizing techniques, Applications.

UNIT III RADIOGRAPHY AND THERMOGRAPHY 10

Principle of Radiography, Radiographic imaging, Inspection Techniques – Single wall single image, Double wall Penetration, Multiwall Penetration technique- Applications and limitations of radiographic inspection- Real Time Radiography

Principle of Thermography, Detectors and Equipments. Applications – Thermal Imaging for condition Monitoring of Industrial Components.

UNIT IV ULTRASONIC AND ACOUSTIC EMISSION TESTING 10

Principle, Ultrasonic transducers, Ultrasonic Flaw detection Equipment- Inspection Methods- Normal Incident Pulse- Echo Inspection, Normal Incident Through-transmission Testing, Angle Beam Pulse- Echo testing- Applications of Normal Beam Inspection in detecting fatigue cracks, Inclusions, Slag, Porosity and Intergranular cracks. Modes of display A- scan, B-Scan, C- Scan, Applications, - Principle of AET, Instrumentation, Applications - testing of metal pressure vessels, Fatigue crack detection in aerospace structures

UNIT V INDUSTRIAL APPLICATIONS, COMPARISON AND SELECTION OF NDT METHODS 9

Applications of NDE in Nuclear, Aircraft, Automotive and petroleum Industries. A Comparison and selection of various NDT techniques. Codes, standards, specification and procedures.

L: 45 TOTAL: 45 PERIODS

TEXT BOOK

1. Baldev Raj, Jeyakumar.T., Thavasimuthu.M., “Practical Non Destructive Testing” Narosa publishing house, New Delhi, 2002.

REFERENCES

1. Krautkramer. J., “Ultra Sonic Testing of Materials”, 1st Edition, Springer – Verlag Publication, New York, 1996.
2. Peter J. Shull “Non Destructive Evaluation: Theory, Techniques and Application” Marcel Dekker, Inc., New York, 2002.
3. www.ndt.net.
4. Prasad J and C.G.K. Nair, “Non-Destructive Test and Evaluation of Materials”, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008.
5. Charles J. Hellier, “Hand Book of Non-Destructive Evaluation”, The McGraw-Hill Companies, New York, 2001.

15CI24E INSTRUMENTATION IN PULP AND PAPER INDUSTRIES L T P C
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : discuss the fundamental concepts of paper making process. (K2)
CO 2 : explain the various types of paper properties and measurement techniques. (K2)
CO 3 : describe the consistency measurement & control techniques. (K2)
CO 4 : discuss the working of paper making machine. (K2)

UNIT I AN OVERVIEW OF PAPER MAKING PROCESS 9

Paper making process - Raw materials - Pulp separation - screening - Bleaching - Cooking - Chemical reaction - chippers - types of digesters - H factor and Kappa factors-Stock preparation - Instrumentation needs - Energy conservation and paper quality control.

UNIT II PAPER PROPERTIES AND ITS MEASUREMENT 9

Physical, electrical, optical and chemical properties of paper - Basic weight, thickness, density, Porosity, smoothness, softness, hardness and compressibility - stress-strain relationship-Tensile strength, bursting strength, tearing resistance, folding endurance, stifihess and impact strength - Dielectric constant, dielectric strength, dielectric loss and Properties of electrical insulating paper - Brightness, color, gloss and capacity - Starch constant acidity and pH - Measurement techniques.

UNIT III CONSISTENCY MEASUREMENT 9

Definition of consistency - Techniques for head box consistency measurement - Stock consistency measurement and control.

UNIT IV PAPER MAKING MACHINE 9

Functioning of Paper making machine - Quality parameters - moisture, basic weight, caliper, brightness, colour, ash content, strength, gloss and tensile strength - parameters monitoring Instrumentation.

UNIT V CONTROL ASPECTS 9

Machine and cross direction control technique — consistency, moisture and basic weight control dryer control — computer based control systems - mill wide control.

L: 45 TOTAL: 45 PERIODS

TEXT BOOKS

1. Sankaranarayanan, P.E., “Pulp and Paper Industries - Technology and Instrumentation”, Kotharis Desk book series, 1995.
2. James P.Casey, “Pulp and Paper chemistry and chemical Technology”, John Wiley and sons, 1981.

REFERENCES

1. Kenneth W. Britt, “Handbook of Pulp and Paper technology”, Britt K.W.Van Nostrand Reinbold Company, 1970.
2. Austin G.T., Shrencs “Chemical Process Industries”, McGraw Hill International Student Edition, Singapore, 1985.

15CI25E ROBOTICS AND INDUSTRIAL AUTOMATION L T P C
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1 : explain the individual components of Robotics. (K2)
CO 2 : summarize the kinematics transformation techniques used in Robotics. (K2)
CO 3 : explain about Jacobian matrix used for robotic differential motion and velocities. (K2)
CO 4 : describe the role of image processing and vision system for an automation of robot. (K2)

UNIT I INTRODUCTION AND TERMINOLOGIES 9

Definition-Classification-History- Robots components - Degrees of freedom-Robot joints coordinates- Reference frames-workspace-Robot languages-actuators-sensors-Position, velocity and acceleration sensors-Torque sensors-tactile and touch sensors proximity and range sensors-social issues.

UNIT II KINEMATICS 9

Mechanism-matrix representation-homogenous transformation-DH representation - Inverse kinematics-solution and programming-degeneracy and dexterity.

UNIT III DIFFERENTIAL MOTION AND VELOCITIES 9

Jacobian-differential motion of frames-Interpretation-calculation of Jacobian-Inverse Jacobian-Design-Lagrangian mechanics-dynamic equations-static force analysis.

UNIT IV ROBOT CONTROL SYSTEM 9

Sensor characteristics- Hydraulic, Pneumatic and Electric actuators-trajectory planning decentralised PID control- non-linear decoupling control.

UNIT V IMAGE PROCESSING AND VISION SYSTEMS 9

Two and three dimensional images-spatial and frequency domain representation-noise and edges-convolution masks-Processing techniques-thersholding-noise reductionedge detection-segmentation-Image analysis and object recognition.

L : 45 TOTAL : 45 PERIODS

TEXT BOOK

1. Saeed B. Niku, “Introduction to Robotics”, 2nd Edition, Pearson Education, 2010.

REFERENCES

1. Fu, Gonzalez and Lee McGrahill, “Robotics”, International TATA McGraw Hill, 2008.
2. R.D. Klafter, TA Chmielewski and Michael Negin, “Robotic Engineering, An Integrated Approach”, Prentice Hall of India, 2003.