NATIONAL ENGINEERING COLLEGE

(An Autonomous Institution – Affiliated to Anna University Chennai)

K.R.NAGAR, KOVILPATTI – 628 503

www.nec.edu.in

REGULATIONS - 2013

DEPARTMENT OF

ELECTRONICS AND INSTRUMENTATION ENGINEERING

CURRICULUM AND SYLLABI OF

M.E. – CONTROL AND INSTRUMENTATION

REGULATIONS - 2013
CURRICULUM AND SYLLABI OF FULL TIME
M.E. CONTROL AND INSTRUMENTATION

SEMESTER I

SL. No.	Course Code	Course Title	L	T	P	C
THEORY						
1	CIC11	Applied Mathematics for Electrical Engineers *(Common to HVE, C&I, EST)*	3	1	0	4
2	CIC12	Transducers and Measurements	3	0	0	3
3	CIC13	System Theory *(Common to C&I, HVE)*	3	0	0	3
4	CIC14	Digital Control System	3	1	0	4
5	CIC15	Microcontroller based System Design	3	0	0	3
6	CIC16	Digital Instrumentation	3	0	0	3
PRACTICAL						
7	CIC17	Digital Control and Instrumentation Laboratory - I	0	0	3	2
		TOTAL	**18**	**2**	**3**	**22**

SEMESTER II

SL. No.	Course Code	Course Title	L	T	P	C
THEORY						
1	CIC21	PC Based Instrumentation System Design	3	0	0	3
2	CIC22	Process Dynamics and Control	3	0	0	3
3	CIC23	Nonlinear Control	3	0	0	3
4		Elective - I	3	0	0	3
5		Elective - II	3	0	0	3
6		Elective - III	3	0	0	3
PRACTICAL						
7	CIC24	Digital Control and Instrumentation Laboratory - II	0	0	3	2
		TOTAL	**18**	**0**	**3**	**20**

L - Lecture hours T-Tutorial hours P- Practical hours C- Credit

SEMESTER – II (ELECTIVE I, II & III)

SEMESTER – II (Elective I)

SL. No.	Course Code	Course Title	L	T	P	C
1	CIE2D	Power Plant Instrumentation	3	0	0	3
2	CIE2C	Instrumentation for Non-Destructive Testing *(Common to C&I, MPE)*	3	0	0	3
3	CIE2E	Instrumentation in Pulp and Paper Industries	3	0	0	3

SEMESTER – II (Elective II)

SL. No.	Course Code	Course Title	L	T	P	C
1	CIE2F	Smart Sensors	3	0	0	3
2	CIE2G	Multi Sensor Data Fusion	3	0	0	3
3	CIE2H	Micro Electro Mechanical Systems	3	0	0	3
4	CIE2J	Medical Imaging Systems	3	0	0	3

SEMESTER – II (Elective III)

SL. No.	Course Code	Course Title	L	T	P	C
1	CIE2B	Soft Computing Techniques *(Common to HVE, C&I)*	3	0	0	3
2	CIE2K	Robotics and Industrial Automation	3	0	0	3
3	CIE2A	Electromagnetic Interference and Electromagnetic Compatibility *(Common to HVE, C&I)*	3	0	0	3

L - Lecture hours *T-Tutorial hours* *P- Practical hours* *C- Credit*

SEMESTER III

SL. No.	Course Code	Course Title	L	T	P	C
THEORY						
1		Elective IV	3	0	0	3
2		Elective V	3	0	0	3
3		Elective VI	3	0	0	3
PRACTICAL						
4	CIC31	Project Work Phase I	0	0	12	6
		TOTAL	9	0	12	15

SEMESTER IV

SL. No.	Course Code	Course Title	L	T	P	C
PRACTICAL						
1	CIC41	Project Work Phase II	0	0	24	12
		TOTAL	0	0	24	12

ELECTIVES FOR M.E CONTROL AND INSTRUMENTATION

SEMESTER – III (Elective IV)

SL. No.	Course Code	Course Title	L	T	P	C
1	CIE3A	Optimal Control and Filtering	3	0	0	3
2	CIE3C	System Identification and Adaptive control	3	0	0	3
3	CIE3E	Biocontrol	3	0	0	3
4	CIE3F	Advanced Process Control	3	0	0	3

SEMESTER – III (Elective V)

SL. No.	Course Code	Course Title	L	T	P	C
1	CIE3G	Industrial Automation	3	0	0	3
2	CIE3H	Solar Photovoltaic Technologies and Applications	3	0	0	3
3	CIE3J	Automobile Instrumentation	3	0	0	3
4	CIE3K	Applied Industrial Instrumentation	3	0	0	3
5	CIE3L	Modern Medical Instruments	3	0	0	3

SEMESTER – III (Elective VI)

SL. No.	Course Code	Course Title	L	T	P	C
1	CIE3D	Advanced Digital System Design *(Common to C&I, HVE)*	3	0	0	3
2	CIE3B	Advanced Digital Signal Processing *(Common to CC,CS, HVE,C&I)*	3	0	0	3
3	CIE3M	Advanced Digital Image Processing	3	0	0	3
4	CIE3N	Design of Embedded Systems	3	0	0	3

L - Lecture hours *T-Tutorial hours* *P- Practical hours* *C- Credit*

CIC11 APPLIED MATHEMATICS FOR ELECTRICAL ENGINEERS L T P C
(Common to HVE, C&I, EST) **3 1 0 4**

COURSE OBJECTIVES:

- To learn the concepts of matrix theory
- To understand simplex method, two phase method and graphical solution in linear programming.
- To learn moment generating functions and one dimensional random variables.
- To understand queueing models and computation methods in engineering

UNIT I ADVANCED MATRIX THEORY 9

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

UNIT II LINEAR PROGRAMMING 9

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

UNIT III ONE DIMENSIONAL RANDOM VARIABLES 9

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

UNIT IV QUEUEING MODELS 9

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

UNIT V COMPUTATIONAL METHODS IN ENGINEERING 9

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: 15 TOTAL: 60 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, 2000.

CIC12 TRANSDUCERS AND MEASUREMENTS L T P C
3 0 0 3

COURSE OBJECTIVES:

The student can able

i. To understand the characteristics of various sensors.
ii. To calibrate the measuring instruments.
iii. To apply sensors in various aspects.

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

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.

CIC13 SYSTEM THEORY **L T P C**
(Common to C&I, HVE) **3 0 0 3**

COURSE OBJECTIVES:

The student can able
i. To design a state space model for a system
ii. To determine the controllability, observability, and stability of state variable systems.
iii. To use state variable feedback to place systems poles.
iv. To design state variable observers and controllers.

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.

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 Ltd., 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.

CIC14 DIGITAL CONTROL SYSTEM **LT P C**
3 1 0 4

COURSE OBJECTIVES:

The Student can able to

i. Discretize the continuous plants
ii. Design a compensator and digital controller
iii. Analyses the state variable present in digital system

UNIT I SIGNAL PROCESSING IN DIGITAL CONTROL 12

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 12

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 12

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 12

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 12

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:15 Total : 60 PERIODS

TEXT BOOK

1. M.Gopal "Digital Control and State Variable Methods", 4th Edition, Tata Mcgraw 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.

CIC15 MICROCONTROLLER BASED SYSTEM DESIGN L T P C
3 0 0 3

COURSE OBJECTIVES:

i. To familiarizes the architecture of 8051 microcontroller
ii. To study the architecture of PIC microcontroller
iii. To understand the operation of CCP modules, ADC and DAC programming

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 –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.

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 BOOK

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

CIC16 DIGITAL INSTRUMENTATION L T P C
3 0 0 3

COURSE OBJECTIVES:

i. To make the students to gain a clear knowledge of the basics of digital instruments and measurement techniques.
ii. To have an adequate knowledge in various display and recording devices.
iii. To have an elaborate study of communication standards

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.

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 Pvt. Ltd., Brooks/Cole, Thomson, 2001.

CIC17 DIGITAL CONTROL AND INSTRUMENTATION LABORATORY – I

L T P C
0 0 3 2

COURSE OBJECTIVES:

The Student can able

i. To understand the components present in the system
ii. To tune the controllers for our needs
iii. To solve a real practical problems in process industry
iv. To use software such as Matlab and LabVIEW for simulating a system
v. Familiar with different types of flow meters.

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, lead-lag compensator and implementation using ELVIS.

TOTAL: 45 PERIODS

CIC21 PC BASED INSTRUMENTATION SYSTEM DESIGN L T P C
3 0 0 3

COURSE OBJECTIVES:

i. To make the students to gain a clear knowledge of the basics of digital instruments and measurement techniques.
ii. To have an adequate knowledge in various display and recording devices.
iii. To have a study of virtual instrumentation and its applications.

UNIT I DATA ACQUISITION AND INSTRUMENT INTERFACE 9

Programming and simulation of Building block of instrument Automation system – Signal analysis, I/O port configuration with instrument bus protocols - ADC, DAC, DIO, counters & timers, PC hardware structure, timing, interrupts, DMA, software and hardware installation, current loop.

UNIT II VIRTUAL INSTRUMENTATION PROGRAMMING TECHNIQUES 9

Block diagram and architecture of a virtual instrument, Graphical programming in data flow, comparison with conventional programming, VI's and sub-VI's, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O.

UNIT III DESIGN TEST & ANALYSIS 9

Spectral estimation using Fourier Transform, power spectrum, correlation methods, Stability analysis, Fault analysis –Sampling, Data Parity and error coding checks, Synchronization testing – Watch dog timer, DMA method – Realtime Clocking, Noise- Gaussian, White analysis.

UNIT IV PC BASED INSTRUMENTATION 9

Introduction - Evolution of signal standard – HART Communication protocol communication modes – HART networks – control system interface – HART commands – HART field controller implementation – HART and the OSI model

UNIT V SIMULATION OF PHYSICAL SYSTEMS 9

Simulation of linear & Non-linear models of systems, Hardware in loop simulation of physical systems using special softwares.

TOTAL: 45 PERIODS

TEXT BOOKS

1. N. Mathivanan, "Pc-Based Instrumentation:Concepts and Practice", PHI Learning Pvt. Ltd., 2007.
2. K. Ogatta, "Modern control Engineering", 5th Edition, Perason Education 2010.
3. Jovitha Jerome, "Virtual Instrumentation using Labview", PHI Learning Pvt. Ltd., 2010.

REFERENCES

1. Dorf and Bishop, "Modern Control Systems", Prentice Hall, 2008.
2. Patrick H. Garrett, "High performance Instrumentation and Automation", CRC Press, Taylor & Francis Group, 2005.
3. MAPLE V programming guide
4. MATLAB/SIMULINK user manual
5. MATHCAD/VIS SIM user manual.
6. LABVIEW simulation user manual

CIC22 PROCESS DYNAMICS AND CONTROL L T P C
3 0 0 3

COURSE OBJECTIVES:

i. To analyze the dynamics of process operations mathematically
ii. To analyze the characteristics of various controller
iii. To design the controller and to obtain the controller parameter
iv. To understand control schemes and analysis its performance

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-split range-inferential-predictive-adaptive and multivariable control.

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.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Chidambarm. 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. NY 1986.

CIC23 NONLINEAR CONTROL L T P C
3 0 0 3

COURSE OBJECTIVES:

By the end of the course, students can able to:

i. Understand issues related to nonlinear systems and their stability analysis
ii. Understand controls design techniques involving feedback linearization and input-state linearization.
iii. Understand Lyapunov stability analysis.

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.

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", 4th Edition, McGraw-Hill Inc., New Delhi, 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.

CIC24 DIGITAL CONTROL AND INSTRUMENTATION LABORATORY – II

L T P C
0 0 3 2

COURSE OBJECTIVES:

The Student can able

i. To design linear and nonlinear controller.
ii. To acquire data from real world into pc for analysis purpose.
iii. To verify the system's controllability and observability
iv. To use software such as Matlab and LabVIEW for simulating a system
v. Familiar with DCS, NI ELVIS and PLC

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.

TOTAL: 45 PERIODS

CIE2D POWER PLANT INSTRUMENTATION L T P C
3 0 0 3

COURSE OBJECTIVES:

i. To gain knowledge on the operation of various conventional power plants & also on the different types of controls being used in boilers.
ii. To acquire knowledge in Solar radiation measurements, Solar Photovoltaic systems and applications of solar energy.
iii. To understand the prospective ideas about Wind Energy Conversion Systems and Biomass conversion technologies.
iv. To extend the views in the analysis of Geothermal resources, Ocean Energy and additional alternate energy resources

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

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.

CIE2C INSTRUMENTATION FOR NON-DESTRUCTIVE TESTING L T P C
(Common to C&I, MPE) **3 0 0 3**

COURSE OBJECTIVES:

i. To study the fundamental concepts of Visual Inspection & Liquid Penetrant Testing
ii. To learn various types of Electromagnetic Testing
iii. To understand the clear concepts of Industrial Application using NDT

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 & 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 & 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.

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.

CIE2E INSTRUMENTATION IN PULP AND PAPER INDUSTRIES L T P C
3 0 0 3

COURSE OBJECTIVES:

i. To study the fundamental concepts of paper making process
ii. To understand the various types of paper properties and measurement techniques
iii. To introduce the consistency measurement & control techniques
iv. To learn the concepts of paper making machine

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.

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.

CIE2F SMART SENSORS **L T P C**
3 0 0 3

COURSE OBJECTIVES:

The Student can able

i. To study the fundamental concepts of micro sensors and actuators
ii. To understand the various types of sensors used in industries

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 & 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 & HALL MAGNETIC SENSORS **9**

Smart Temperature Sensors and Temperature-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.

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.

CIE2G MULTI SENSOR DATA FUSION L T P C
3 0 0 3

COURSE OBJECTIVES:

i. To study the fundamental concepts of multisensor Data Fusion
ii. To learn and understand the various types of Algorithm for Data Fusion
iii. To introduce advanced filtering techniques and estimation analysis
iv. To gain the knowledge of high performance Data Structure Algorithm and its application

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 Kalmal 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.

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.

CIE2H MICRO ELECTRO MECHANICAL SYSTEMS L T P C
3 0 0 3

COURSE OBJECTIVES:

i. To describe various Microsystems & MEMS technologies and their applications
ii. To explain various semiconductor processes, micro fabrication, techniques & water – level packaging technologies.
iii. To describe different sensing & actuating mechanisms in Microsystems
iv. To study various MEMS systems using micro fabrication techniques & transduction mechanisms

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 Vapor 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.

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 Mcraw Hill, 2002.
3. Chang Liu, "Foundations of MEMS", Pearson education India limited, 2006.

CIE2J MEDICAL IMAGING SYSTEMS L T P C
3 0 0 3

COURSE OBJECTIVES

i. To apply the knowledge of human physiology in imaging modalities.
ii. To understand the latest technology of image formation techniques in various imaging modalities.

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.

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; 2Rev Edition, 2008.
4. R.S.Khandpur, "Hand Book of Bio-Medical instrumentation", Tata McGraw Hill Publishing Co Ltd., 2003.

CIE2B	SOFT COMPUTING TECHNIQUES (Common to HVE and C&I)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

i. To understand the fundamental concept of intelligent control.
ii. To study about the applications of ANN, various transformations and its controllers.
iii. To aware about the fuzzy logic system and to design a various control schemes for non-linear systems.
iv. To understand the basic concepts of genetic algorithms.
v. To study about the applications of GA, ANN and Fuzzy logic system.

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.

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.

CIE2K ROBOTICS AND INDUSTRIAL AUTOMATION L T P C
3 0 0 3

COURSE OBJECTIVES:

i. To study the individual components of Robotics
ii. To learn the kinematics transformation techniques used in Robotics
iii. To gain the knowledge about Jacobian matrix
iv. To understand how the image processing techniques used in Robotics

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 sensorsproximity 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 & 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 planningdecentalised PID control- non-linear decoupling control.

UNIT V IMAGE PROCESSING & 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.

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.

CIE2A	ELECTROMAGNETIC INTERFERENCE AND ELECTROMAGNETIC COMPATIBILITY (Common to HVE and C&I)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

i. To study characteristics and design of electromagnetic compatibility and methods of eliminating interferences.
ii. To learn coupling, grounding and guard shields.
iii. To know filtering, shielding and methods of coating.
iv. To study digital logic noise and digital circuit ground noise**.**
v. To learn electrostatic discharge, standards and laboratory techniques.

UNIT I INTRODUCTION **9**

Sources of EMI - Conducted and radiated interference - Characteristics - Designing for electromagnetic compatibility (EMC) - EMC regulation - typical noise path - use of network theory - methods of eliminating interferences.

UNIT II METHOD OF HARDENING **9**

Cabling – capacitive coupling - inductive coupling - shielding to prevent magnetic radiation - shield transfer impedance - Grounding – safety grounds – signal grounds - single point and multipoint ground systems- hybrid grounds - functional ground layout – grounding of cable shields- ground loops - guard shields.

UNIT III BALANCING, FILTERING AND SHIELDING **9**

Power supply decoupling - decoupling filters-amplifier filtering – high frequency filtering shielding – near and far fields - shielding effectiveness - absorption and reflection loss - Shielding with magnetic material - conductive gaskets - windows and coatings - grounding of shields.

UNIT IV DIGITAL CIRCUIT NOISE AND LAYOUT **9**

Frequency versus time domain - analog versus digital circuits - digital logic noise- internal noise sources - digital circuit ground noise – power distribution - noise voltage objectives measuring noise voltages - unused inputs - logic families.

UNIT V ELECTROSTATIC DISCHARGE, STANDARDS AND LABORATORY TECHNIQUES **9**

Static Generation - human body model - static discharges -ED protection in equipment design - ESD versus EMC - Industrial and Government standards – FCC requirements – CISPR recommendations - Laboratory techniques - Measurement methods for field strength - EMI.

Total: 45 Periods

REFERENCES

1. Henry W.Ott, "Noise reduction techniques in electronic systems", John Wiley &Sons, 2011.
2. Bernhard Keiser, "Principles of Electro-magnetic Compatibility", Artech House, Inc. (685 canton street, Norwood, MA 020062 USA) 1987.
3. Bridges J.E., Milleta J. and Ricketts L.W., "EMP Radiation and Protective techniques", John Wiley and sons, USA 1976.
4. IEEE National Symposium on "Electromagnetic Compatibility", IEEE, 445, Hoes Lane, Piscataway, NJ 08854. USA.

CIE3A OPTIMAL CONTROL AND FILTERING L T P C
3 0 0 3

COURSE OUTCOMES

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

- Describe the classification of optimal control problem
- Investigate the dynamic programming Analysis of optimal control
- Acquire a effective knowledge on Filtering and Estimation in optimal control
- Attain the performance analysis of Kalman Filter and its properties

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.

TOTAL: 45 PERIODS

TEXT BOOKS

1. KiRk D.E., "Optimal Control Theory – An introduction", Dover Pub,2001.V
2. Anderson, BD.O. And Moore J.B., "Optimal Filtering", Prentice hall Inc., N.J., 2nd edition 2005.

REFERENCES

1. S.M. Bozic, "Digital and Kalman Filtering", Edward Arnould, London, 2nd Edition 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).

CIE3C SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL L T P C
3 0 0 3

COURSE OUTCOMES

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

- Explain why different system identification methods and model structures are necessary in engineering practice
- Describe the different phases that constitute the process of building models, from identification experiment to model validation
- Show hands-on experience with analyzing actual data, have working knowledge of the available tools, and to reason how to choose identification methods and model structures for real-life problems.
- Extend the definition of adaptive control and methods of adaptation.
- Show the practical application through case studies of adaptive control system.

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.

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) Ltd, 1994.
2. Narendra and Annasamy, "Stable Adaptive Control Systems", Prentice Hall, Dover Edition 2005.

CIE3E BIOCONTROL L T P C
3 0 0 3

COURSE OUTCOMES

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

- Gain the system concepts and different mathematical techniques applied in analyzing any given system.
- Acquire the knowledge on the techniques of plotting the responses in both domain analysis.
- Apply these analysis to study the biological systems.

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.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Ogata Katsuhika, "Modern Control Engineering", Second Edition, Prentice Hall of India, 2010.
2. John Enderle, Susan Blanchard, Joseph Bronzino, "Introduction to Biomedical Engineering", third 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.

CIE3F ADVANCED PROCESS CONTROL L T P C
3 0 0 3

COURSE OUTCOMES

Upon completion of the course, students will be able to

- Describe the various linear model identification
- Analyze the Internal Model Control
- Appraise the transient response of open and closed loop control systems
- Develop advanced controller for real time process

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.

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.

CIE3G INDUSTRIAL AUTOMATION **L T P C**
3 0 0 3

COURSE OUTCOMES

Upon completion of the course, students will be able to

- Gain knowledge in DCS and its architecture.
- Explain the overview of SCADA.
- Describe the programming techniques in PLC.
- Acquire knowledge in hardware part of Automation-Field bus and its topology.
- Comprehend the application of DCS in Various Industries.

UNIT I DISTRIBUTED CONTROL SYSTEM **9**

Evolution-Different architectures-Local Control Unit-Operator Interface-Displays-Engineering Interface.

UNIT II SCADA **9**

Supervisory Control and Data Acquisition(SCADA)-overview-Developer and run time packages-architecture-Tools-Tag-Internal and External Graphics, Alarm logging-Tag logging-Structured tags-Trends-History-Report Generation.

UNIT III PLC **9**

Evolution of PLC-Components of PLC-Advantages over relay logic-PLC Programming languages-Ladder diagram-Programming Timers and Counters-Design of PLC. Program control Instructions-Math Instructions-Sequencer instructions.

UNIT IV FIELD BUS **9**

Introduction-Architecture-Basic requirements of field bus standard-Field Bus topology-Interoperability-Interchangeability.

UNIT V APPLICATIONS OF DCS **9**

Applications of DCS in Power Plants-Iron and Steel Plants, Chemical Plants, Cement Plants, Pulp and Paper Plants.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Lukas, Michael.P., "Distributed Control Systems", Van Nostrand Rein fold company,2002.
2. Popovic D and Bhatkar V.P., "Distributed Computer Control For Industrial Automation", Marcel Dekkar Inc., New York, 1990.

REFERENCES

1. Climlicity SCADA Packages Manual Fanuc India Ltd, 2004.
2. Deshpande, P.B and Ash R. H., "Computer Process Control", Instrument Society of America Publication, Newyork, 1995.

CIE3H SOLAR PHOTOVOLTAIC TECHNOLOGIES AND APPLICATIONS **L T P C 3 0 0 3**

COURSE OUTCOMES

Upon completion of the course, students will be able to

- Acquire knowledge on fundamentals of Electronics & Solar photo voltaic
- Design Power Electronic converters
- Comprehend the different algorithm on MPPT

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.

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. Solar Energy utilization: Khanna Publishers. 2010.

CIE3J AUTOMOBILE INSTRUMENTATION **L T P C**
3 0 0 3

COURSE OUTCOMES

Upon completion of the course, students will be able to

- Recall the fundamentals of Automotive Electronics
- Identify basic electric and electronic components
- Describe the principles of magnetism and magnetic fields
- Identify types of electrical test meters and equipment

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.

TOTAL: 45 PERIODS

TEXTS BOOKS

1. Robert Bosch, "Automotive Hand Book", 5th Edition, 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.

CIE3K APPLIED INDUSTRIAL INSTRUMENTATION LT P C
3 0 0 3

COURSE OUTCOMES

Upon completion of the course, students will be able to

- Demonstrate the measurement procedure of different industrial parameters.
- Explain the measurement procedure of different parameters in thermal power plant.
- Illustrate the measurement procedures for measurement of process parameters in Petrochemical Industry.
- Describe the various types of pulp and paper properties and measurement techniques.
- Explain the measurement principles for measuring the industrial parameters for different applications.

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.

TOTAL: 45 PERIODS

TEXT BOOK

1. B.G.Liptak, "Instrument Engineers Hand Book", Fourth Edition, CRC press, 2012.

REFERENCES

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

CIE3L MODERN MEDICAL INSTRUMENTS **L T P C**
3 0 0 3

COURSE OUTCOMES

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

- Explain the human physiology
- Model and experiment with the medical equipment
- Test the safety of medical equipment

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.

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. Medical Instrument Design and Development: From Requirements to Market Placements - Claudio Becchetti, Alessandro Neri, 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.

CIE3D ADVANCED DIGITAL SYSTEM DESIGN LT PC
(Common to C&I, HVE) **3 0 0 3**

COURSE OUTCOMES

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

- Design a small digital system to the specified functionality
- Recognize modern techniques in combinational and sequential circuit design with VHDL
- Describe modern technology in implementation of digital designs
- Explain the structure of field programmable logic circuits (FPGA)

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.

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", Thomson Learning, 6th Edition 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.

CIE3M ADVANCED DIGITAL IMAGE PROCESSING L T P C
3 0 0 3

COURSE OUTCOMES

Upon Completion of the course, the students will be able to

- Understand image formation and the role human visual system plays in perception of gray and color image data.
- Apply image processing techniques in both the spatial and frequency (Fourier) domains.
- Design image analysis techniques in the form of image segmentation and to evaluate the methodologies for segmentation.
- Conduct independent study and analysis of feature extraction techniques.
- Understand the concepts of image registration and image fusion.
- Analyze the constraints in image processing when dealing with 3D data sets and to apply image processing algorithms in practical applications.

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.

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", Pearson, Education, Inc., Second Edition, 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.

CIE3N DESIGN OF EMBEDDED SYSTEMS **L T P C**
3 0 0 3

COURSE OUTCOMES:

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

- Explain the basic concepts and building blocks of embedded system
- Infer the fundamentals of Embedded processor Modeling
- Illustrate bus communication in processors and I/O interfacing
- Summarize processor scheduling algorithms and to explain the basics of RTOS
- Distinguish the different phases & modeling of embedded system with its applications on various fields

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, ЧC/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.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Rajkamal, "Embedded system-Architecture, Programming, Design", TMH, 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 KVKK, "Embedded/ Real-Time Systems-Concepts, Design & Programming-Black Book", dream tech Press, 2010.