**AFFILIATED INSTITUTIONS**  
**ANNA UNIVERSITY, CHENNAI**  
**REGULATIONS - 2009**  
**M.E. CONTROL AND INSTRUMENTATION ENGINEERING**  
**II TO IV SEMESTERS (FULL TIME) CURRICULUM AND SYLLABUS**

**SEMESTER II**

<table>
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**TOTAL CREDITS TO BE EARNED FOR THE AWARD THE DEGREE** 20+22+15+12=69
# ELECTIVES FOR M.E CONTROL AND INSTRUMENTATION ENGINEERING

## ELECTIVE I

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## ELECTIVE II & III

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## ELECTIVE IV, V & VI

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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, RS 232/RS485, GPIB, USB protocols,

UNIT II  VIRTUAL INSTRUMENTATION PROGRAMMING TECHNIQUES  9
Block diagram and architecture of a virtual instrument, Graphical programming in data flow, comparison with conventional programming, Vis and sub-Vis, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O.

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 – Real-time Clocking, Noise-Gaussian, White analysis

UNIT IV  PC BASED INSTRUMENTATION  9

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.

L=30, P=30, TOTAL : 60 PERIODS

REFERENCES:

4. MAPLE V programming guide
5. MATLAB/SIMULINK user manual
6. MATHCAD/VIS SIM user manual.
7. LABVIEW simulation user manual
UNIT I DATA ACQUISITION SYSTEMS
Overview of A/D converter, types and characteristics – Sampling, Errors. 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

UNIT III INSTRUMENTATION BUS

UNIT IV PARALLEL PORT BUSES

UNIT V CASE STUDIES
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

REFERENCES:

UNIT I PROCESS DYNAMICS
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

UNIT V  COMPUTER CONTROL OF PROCESSES  9
PLC based control of processes – Computer control of liquid level system – heat exchanger – Smart sensors and Field bus.

L=45, T=15,TOTAL: 60 PERIODS

REFERENCES
1. George Stephanopolus, "Chemical Process Control", Prentice Hall India

CL 9324  NONLINEAR CONTROL  LT P C
3 0 0 3

UNIT I  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- Existence of Limit Cycles.

UNIT II  DESCRIBING FUNCTION  9
UNIT III  LYAPUNOV THEORY

UNIT IV  FEEDBACK LINEARIZATION

UNIT V  SLIDING MODE CONTROL
Sliding Surfaces- Continuous approximations of Switching Control laws-The Modeling/Performance Trade-Offs-MIMO Systems.

TOTAL : 45 PERIODS

REFERENCES:

CL 9325  DIGITAL CONTROL AND INSTRUMENTATION LAB  L T P C
1. Simulation of Converters
2. Simulation of Machines
3. Simulation of Power System
4. Simulation of Process Loop
5. Design of analog and digital interfaces
   (i) Digital input,
   (ii) Analog input,
   (iii) Digital output,
   (iv) Analog output,
6. Design of analog and digital interfaces
   interrupts,
timer handling.
7. Design of controllers for linear systems
8. Design of controllers for non linear systems
9. Hardware in loop simulation of system. (serial interface)
   (i) ELVIS
   (ii) Microcontroller
10. Hardware in loop simulation of closed loop control system.

TOTAL: 45 PERIODS

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AIM
To expose the students to the fundamentals of digital logic based system design.

OBJECTIVES
To impart knowledge on
- Basics on Synchronous & Async digital switching design.
- Design & realisation of error free functional blocks for digital systems

UNIT I  SEQUENTIAL CIRCUIT DESIGN

UNIT II  ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN

UNIT III  FAULT DIAGNOSIS AND TESTABILITY ALGORITHMS
UNIT IV    SYNCHRONOUS DESIGN USING PROGRAMMABLE DEVICES
Programming Techniques - Re-Programmable Devices Architecture- Function blocks, I/O blocks, Interconnects, Realize combinational, Arithmetic, Sequential Circuit with Programmable Array Logic; Architecture and application of Field Programmable Logic Sequence.

UNIT V    NEW GENERATION PROGRAMMABLE LOGIC DEVICES

TOTAL : 45 PERIODS

REFERENCES:

CL9002    SOFT COMPUTING TECHNIQUES

UNIT I    INTRODUCTION

UNIT II    ARTIFICIAL NEURAL NETWORKS
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
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 ants-colony search techniques for
solving optimization problems.

UNIT V  APPLICATIONS  9
GA application to power system optimisation 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:
2. KOSKO,B. "Neural Networks And Fuzzy Systems", Prentice-Hall of India Pvt. Ltd.,
   1994.
3. KLIR G.J. & FOLGER T.A. "Fuzzy sets, uncertainty and Information", Prentice-Hall of

CL9003  ANALYSIS OF POWER CONVERTERS  L T P C
        3 0 0 3

UNIT I  SINGLE PHASE AC-DC CONVERTERS  9
Uncontrolled, half controlled and fully controlled with R-L, R-L-E loads and free wheeling
diode - continuous and discontinuous modes of operation – inverter operation –Dual
converter – Sequence control of converters – Performance parameters: harmonics,
ripple, distortion, power factor – effect of source impedance and overlap.

UNIT II  THREE PHASE AC-DC CONVERTERS  9
Uncontrolled, half controlled and fully controlled with R-L, R-L-E loads and free wheeling
diodes – Inverter operation and its limit – Dual converter – Performance parameter effect
of source impedance and overlap.

UNIT III  DC – DC CONVERTERS  9
Principles of step-down and step-up converters – Analysis of buck, boost, buck-boost
and Cuk converters – Time ratio and current limit control – Full bridge converter –
Resonant and Quasi-resonant converters.
UNIT IV   DC – AC CONVERTERS  
Voltage source inverters - Principle of operation of half and full bridge inverters – 180 degree and 120 degree conduction mode inverters – Voltage control of three phase inverters using various PWM techniques – Harmonics and various harmonic elimination techniques – Analysis with R-L, R-L-E loads – Multi level inverters.

UNIT V   AC – AC CONVERTERS  

TOTAL: 45 PERIODS

TEXT BOOKS

REFERENCES

PE9223   SPECIAL ELECTRICAL MACHINES  L T P C  3 0 0 3

UNIT I   STEPPING MOTOR  
Constructional features – Principle of operation – Modes of excitation – Torque production in variable reluctance stepping motor - Dynamic characteristics – Drive systems and circuit for open loop control – Closed loop control of stepping motor.

UNIT II   SWITCHED RELUCTANCE MOTORS  
Constructional features – principle of operation – Torque equation – Power controllers – Characteristics and control microprocessor based controller.

UNIT III   SYNCHRONOUS RELUCTANCE MOTORS  

UNIT IV   PERMANENT MAGNET SYNCHRONOUS MOTROS  

UNIT V   PERMANENT MAGNET BRUSHLESS DC MOTORS  
Commutation in DC motors, Difference between mechanical and electronic commutators- Hall sensors, Optical sensors - Multiphase Brushless motor –Square wave permanent magnet brushless motor drives –Torque and emf equation-Torque speed characteristics-Controllers –Microprocessors based controller

TOTAL : 45 PERIODS
REFERENCES:

REFERENCES:

ET9222 REAL TIME OPERATING SYSTEMS

UNIT I REVIEW OF OPERATING SYSTEMS

UNIT II OVERVIEW OF RTOS

UNIT III REAL TIME MODELS AND LANGUAGES
Event Based – Process Based and Graph based Models – Real Time Languages – RTOS Tasks – RT scheduling - Interrupt processing – Synchronization – Control Blocks – Memory Requirements.

UNIT IV REAL TIME KERNEL

UNIT V RTOS APPLICATION DOMAINS

TOTAL: 45 PERIODS

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**UNIT I**  
MULTISENSOR DATA FUSION INTRODUCTION  

**UNIT II**  
ALGORITHMS FOR DATA FUSION  
Taxonomy of algorithms for multisensor data fusion. Data association. Identity declaration.

**UNIT III**  
ESTIMATION  

**UNIT IV**  
ADVANCED FILTERING  

**UNIT V**  
HIGH PERFORMANCE DATA STRUCTURES  
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

**REFERENCES:**
UNIT I  EMBEDDED DESIGN LIFE CYCLE

UNIT II  PARTITIONING DECISION

UNIT III  INTERRUPT SERVICE ROUTINES
Watch dog timers – Flash Memory basic toolset – Host based debugging – Remote debugging – ROM emulators – Logic analyser – Caches – Computer optimisation – Statistical profiling

UNIT IV  INCIRCUIT EMULATORS

UNIT V  TESTING

TOTAL: 45 PERIODS

REFERENCES:
2. Sriram Iyer, “Embedded Real time System Programming”
UNIT III INVERTER FED INDUCTION MOTOR DRIVE

Microcomputer controlled VSI fed induction motor drive - Detailed power circuit, generation of firing pulses and firing circuit, flow charts and waveforms for 1-phase, 3-phase Non-PWM and 3-phase PWM VSI fed induction motor drives. Sampling techniques for PWM inverter.

UNIT IV MATHEMATICAL MODELING OF FREQUENCY CONTROLLED DRIVE

Development of mathematical model for various components of frequency controlled induction drive, mathematical model of the system for steady state and dynamic behaviour, Study of stability based on the dynamic model of the system.

UNIT V CLOSED LOOP CONTROL OF MICROCOMPUTER BASED DRIVES

Voltage, Current, Torque and Speed measurements using digital measurement techniques. Types of controllers, position and velocity measurement algorithm, closed loop control of microcomputer based drives.

TOTAL: 45 PERIODS

TEXT BOOKS:

REFERENCES:
3 Dubey G.K., Power semiconductor controlled drives, Prentice-HALL 1989

HV9311 ELECTROMAGNETIC FIELD COMPUTATION AND MODELLING

UNIT I INTRODUCTION


UNIT II SOLUTION OF FIELD EQUATIONS I

Limitations of the conventional design procedure, need for the field analysis based design, problem definition , solution by analytical methods-direct integration method – variable separable method – method of images, solution by numerical methods- Finite Difference Method.
UNIT III SOLUTION OF FIELD EQUATIONS II
Finite element method (FEM) – Differential/ integral functions – Variational method –
Energy minimization – Discretisation – Shape functions – Stiffness matrix – 1D and 2D
planar and axial symmetry problem.

UNIT IV FIELD COMPUTATION FOR BASIC CONFIGURATIONS
Computation of electric and magnetic field intensities – Capacitance and Inductance –
Force, Torque, Energy for basic configurations.

UNIT V DESIGN APPLICATIONS
Insulators – Bushings – Cylindrical magnetic actuators – Transformers – Rotating
machines.

L=45, T=15, TOTAL: 60 PERIODS

REFERENCES:
1. K.J.Binns, P.J.Lawrenson, C.W Trowbridge, “The analytical and numerical solution of
India
5. User manuals of MAGNET, MAXWELL & ANSYS software.
University press, 1983.
UNIT IV  DIGITAL CIRCUIT NOISE AND LAYOUT  9

UNIT V  ELECTROSTATIC DISCHARGE,STANDARDS AND LABORATORY TECHNIQUES  9

REFERENCES:

TOTAL: 45 PERIODS

CL9354  MICRO ELECTRO MECHANICAL SYSTEMS  L T P C  3 0 0 3

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

REFERENCES:

CL9355     PRINCIPLES OF ROBOTICS
L T P C
3 0 0 3

UNIT I     INTRODUCTION AND TERMINOLOGIES:
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
Mechanism-matrix representation-homogenous transformation-DH representation-Inverse kinematics-solution and programming-degeneracy and dexterity

UNIT III    DIFFERENTIAL MOTION & VELOCITIES
Jacobian-differential motion of frames-Interpretation-calculation of Jacobian-Inverse Jacobian-Design-Lagrangian mechanics-dynamic equations-static force analysis

UNIT IV     ROBOT CONTROL SYSTEM
Sensor characteristics- Hydraulic, Pneumatic and electric actuators-trajectory planning-decentralised PID control- non-linear decoupling control

UNIT V     IMAGE PROCESSING & VISION SYSTEMS
Two and three dimensional images-spatial and frequency domain representation-noise and edges- convolution masks-Processing techniques-thersholding-noise reduction-edge detection-segmentation-Image analysis and object recognition

REFERENCES:
2. Fu, Gonzalez and Lee Mcgrahill ,"Robotics ", international
UNIT I  INTRODUCTION

UNIT II  LQ CONTROL PROBLEMS AND DYNAMIC PROGRAMMING

UNIT III  NUMERICAL TECHNIQUES FOR OPTIMAL CONTROL
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

UNIT V  KALMAN FILTER AND PROPERTIES

TOTAL : 45 PERIODS

REFERENCES:

UNIT I  PERTURBATION THEORY
UNIT II SINGULAR PERTURBATIONS 9
Standard singular perturbation model – Time scale properties – Singular perturbation on the infinite interval – Slow and fast manifolds – stability analysis – exercises

UNIT III GAIN SCHEDULING AND FEEDBACK LINEARIZATION 9

UNIT IV INPUT-OUTPUT STABILITY 9

UNIT V BAKSTEPPING CONTROL ALGORITHMS 9
Passivity based control – High gain observers – stabilization – Regulation via integral control - exercises

TOTAL: 45 PERIODS

REFERENCES:
1. Hasan Khalil," Nonlinear systems and control", 3\(^{rd}\) ed, PHI,

CL9358 SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL

UNIT I MODELS FOR IDENTIFICATION 9

UNIT II NON-PARAMETRIC AND PARAMETRIC IDENTIFICATON 9

UNIT III NON-LINEAR IDENTIFICATION AND MODEL VALIDATION 9

UNIT IV ADAPTIVE COTROL AND ADAPTATION TECHNIQUES 9
UNIT V CASE STUDIES
Inverted Pendulum, Robot arm, process control application: heat exchanger, Distillation column, application to power system, Ship steering control.

TOTAL: 45 PERIODS

REFERENCES:

ET9274 PROGRAMMING WITH VHDL

UNIT I VHDL FUNDAMENTALS
Fundamental concepts- Modeling digital system-Domain and levels of modeling-modeling languages-VHDL modeling concepts-Scalar Data types and operations-constants and Variable-Scalar Types- Type Classification-Attributes and scalar types-expression and operators-Sequential statements.

UNIT II DATA TYPES AND BASIC MODELING CONSTRUCTS
Arrays- unconstrained array types-array operations and referencing- records - Access Types- Abstract Date types- -basic modeling constructs-entity declarations-Architecture bodies-behavioral description-structural descriptions- design Processing, case study: A pipelined Multiplier accumulator.

UNIT III SUBPROGRAMS, PACKAGES AND FILES

UNIT IV SIGNALS, COMPONENTS, CONFIGURATIONS

UNIT V DESIGN WITH PROGRAMMABLE LOGIC DEVICES
Realization of -Micro controller CPU.- Memories- I/O devices-MAC-Design,synthesis,simulation and testing.

TOTAL: 45 PERIODS
REFERENCES:

CL9359   DIGITAL IMAGE PROCESSING   L T P C
3 0 0 3

UNIT I   FUNDAMENTALS OF IMAGE PROCESSING   9

UNIT II   IMAGE ENHANCEMENT   9

UNIT III   IMAGE SEGMENTATION AND FEATURE ANALYSIS   9

UNIT IV   MULTI RESOLUTION ANALYSIS AND COMPRESSIONS   9

UNIT V   APPLICATION OF IMAGE PROCESSING   9

TOTAL: 45 PERIODS

REFERENCES: