<table>
<thead>
<tr>
<th>SL.NO.</th>
<th>CODE</th>
<th>COURSE TITLE</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>MA7163</td>
<td>Applied Mathematics for Electrical Engineers</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>CL7101</td>
<td>Control System Design</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>CL7102</td>
<td>Transducers and Measurements</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>CL7103</td>
<td>System Theory</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>ET7102</td>
<td>Microcontroller Based System Design</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Elective I</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TOTAL</strong></td>
<td>18</td>
<td>3</td>
<td>0</td>
<td>21</td>
</tr>
</tbody>
</table>

**SEMESTER – II**

<table>
<thead>
<tr>
<th>SL.NO.</th>
<th>CODE</th>
<th>COURSE TITLE</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>CL7201</td>
<td>Process Dynamics and Control</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>CL7202</td>
<td>Industrial Automation</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>CL7203</td>
<td>Non-Linear Control</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>CL7204</td>
<td>Soft Computing Techniques</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Elective II</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Elective III</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>PRACTICAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>CL7211</td>
<td>Digital Control and Instrumentation Laboratory</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TOTAL</strong></td>
<td>18</td>
<td>0</td>
<td>3</td>
<td>20</td>
</tr>
</tbody>
</table>

**SEMESTER – III**

<table>
<thead>
<tr>
<th>SL.NO.</th>
<th>CODE</th>
<th>COURSE TITLE</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>THEORY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>Elective IV</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Elective V</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Elective VI</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>PRACTICAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>CL7311</td>
<td>Project Work (Phase I)</td>
<td>0</td>
<td>0</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>TOTAL</strong></td>
<td>9</td>
<td>0</td>
<td>12</td>
<td>15</td>
</tr>
</tbody>
</table>
### SEMESTER – IV

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>CODE</th>
<th>COURSE TITLE</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PRACTICAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>CL7411</td>
<td>Project Work (Phase II)</td>
<td>0</td>
<td>0</td>
<td>24</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>0</td>
<td>0</td>
<td>24</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL NUMBER OF CREDITS 68**

### ELECTIVES FOR M.E CONTROL AND INSTRUMENTATION ENGINEERING

#### ELECTIVE I

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>CODE</th>
<th>COURSE TITLE</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ET7101</td>
<td>Advanced Digital System Design</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>ET7104</td>
<td>Design of Embedded Systems</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>PX7102</td>
<td>Analysis of Power Converters</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

#### ELECTIVE II & III

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>CODE</th>
<th>COURSE TITLE</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
<td>PX7203</td>
<td>Special Electrical Machines</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>ET7006</td>
<td>Advanced Digital Signal Processing</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>ET7004</td>
<td>Programming with VHDL</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td>PS7001</td>
<td>Optimization Techniques</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>8.</td>
<td>EB7202</td>
<td>Control of Electric Drives</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>9.</td>
<td>CL7001</td>
<td>Applied Industrial Instrumentation</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

#### ELECTIVE IV, V & VI

<table>
<thead>
<tr>
<th>SL. NO</th>
<th>CODE</th>
<th>COURSE TITLE</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.</td>
<td>CL7002</td>
<td>Robust Control</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>11.</td>
<td>CL7003</td>
<td>Wireless Sensor Networks</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>12.</td>
<td>ET7014</td>
<td>Application of MEMS Technology</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>13.</td>
<td>CL7004</td>
<td>Robotics and Control</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>14.</td>
<td>CL7005</td>
<td>Optimal Control and Filtering</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>15.</td>
<td>CL7006</td>
<td>Advanced Topics in Nonlinear Control</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>16.</td>
<td>CL7007</td>
<td>System Identification and Adaptive Control</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>17.</td>
<td>CL7008</td>
<td>Fault Tolerant Control</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>18.</td>
<td>ET7011</td>
<td>Smart Meter and Smart Grid Communication</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>
OBJECTIVES:
- To develop the ability to apply the concepts of Matrix theory and Linear programming in Electrical Engineering problems.
- To achieve an understanding of the basic concepts of one dimensional random variables and apply in electrical engineering problems.
- To familiarize the students in calculus of variations and solve problems using Fourier transforms associated with engineering applications.

UNIT I  MATRIX THEORY  (9+3)
The Cholesky decomposition - Generalized Eigen vectors, Canonical basis - QR factorization - Least squares method - Singular value decomposition.

UNIT II  CALCULUS OF VARIATIONS  (9+3)
Concept of variation and its properties – Euler’s equation – Functional dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries – problems with constraints - Direct methods: Ritz and Kantorovich methods.

UNIT III  ONE DIMENSIONAL RANDOM VARIABLES  (9+3)

UNIT IV  LINEAR PROGRAMMING  (9+3)
Formulation – Graphical solution – Simplex method – Two phase method - Transportation and Assignment Models

UNIT V  FOURIER SERIES  (9+3)

REFERENCES:

CL7101 CONTROL SYSTEM DESIGN LT P C
3 1 0 4

OBJECTIVES

- To impart knowledge on performance specification, limitations and structure of controllers
- To impart knowledge on design of controllers using root-locus and frequency domain techniques
- To introduce the techniques of extending the theory on continuous systems to discrete time systems
- To introduce design in discrete state space systems
- To introduce the linear quadratic regulator and estimation in the presence of noise

UNIT I BASICS AND ROOT-LOCUS DESIGN
Design specifications - sensitivity and stability - Limitations - Controller structure - one and two degrees of freedom - PID controllers and Lag-lead compensators - Root locus design - Design examples

UNIT II FREQUENCY RESPONSE BASED DESIGN
PID controllers and Lag-lead compensators – Design using Bode plots - use of Nyquist plots and Routh-Hurwitz Criterion - Design examples

UNIT III DESIGN IN DISCRETE DOMAIN
Sample and Hold devices - Discretisation - Effect of sampling on transfer function – Discrete root locus, Nyquist plots – Jury’s stability test - Direct discrete design - Design examples

UNIT IV DISCRETE STATE VARIABLE DESIGN
Effect of sampling on Controllability, observability - state and output feedback - observers - estimated state feedback – Design examples

UNIT V LQR AND LQG DESIGN

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

CL7102 TRANSDUCERS AND MEASUREMENTS L T P C 3 1 0 4

OBJECTIVES
• To introduce the resistive, inductive and capacitive transducers and their transduction principles
• To educate on magnetic transducer elements
• Study of acoustic, mechanical and flow metering elements , their working principle
• To introduce various optical sensors, their transduction principles and their applications
• To introduce various advanced and miniature sensors and their applications

UNIT I RESISTIVE, INDUCTIVE AND CAPACITIVE ELEMENTS
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
Transformer elements: Single core, differential, rotating coil and synchro transformers, weak-field sensors - Electrodynmamic 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
Stresses state of diaphragm, dynamic characteristics of diaphragm, temperature drifts, sensitivity drifts, sensitivity to acceleration – Inertial mass elements: sensing and transduction elements of flowmeters, electromagnetic flowmeters, nanoelectrode electromagnetic flowmeters -ultrasonic elements – Acoustical elements: acoustical filters.
UNIT IV  OPTICAL MICROSTRUCTURE SENSORS  9
Photo detectors: Thermal detectors, pneumatic detectors, pyroelectric detectors, photoemissive devices, photo conductive detectors, photo diodes, avalanche photo diodes, schottky photo diodes, photo transistors – Fiber optic sensors: Fibers as light guides, reflection sensors, Intrinsic multimode sensor, temperature sensor, phase modulated sensor, fiber optic gyroscopes and other fiber sensors

UNIT V  MISCELLANEOUS MINIATURE SENSORS  9
Magnetic sensors: Hall Effect sensors, magnetoresistors and other sensors – Solid state chemical sensors: Silicon based sensors, metal oxide sensors, solid electrolyte sensors, membranes – Electromechanical micro sensors and basic factors of design

L=45, T=15 TOTAL : 60 PERIODS

REFERENCES:
UNIT IV  STABILITY

UNIT V  MODAL CONTROL
Introduction-Controllable and Observable Companion Forms-SISO and MIMO Systems-The Effect of State Feedback on Controllability and Observability-Pole Placement by State Feedback for both SISO and MIMO Systems-Full Order and Reduced Order Observers.

REFERENCES:

ET7102  MICROCONTROLLER BASED SYSTEM DESIGN  LT P C
3 0 0 3

OBJECTIVES
- To expose the students to the fundamentals of microcontroller based system design.
- To teach I/O and RTOS role on microcontroller.
- To impart knowledge on PIC Microcontroller based system design.
- To introduce Microchip PIC 8 bit peripheral system Design
- To give case study experiences for microcontroller based applications.

UNIT I  8051 ARCHITECTURE

UNIT II  8051 PROGRAMMING
UNIT III  PIC MICROCONTROLLER  

UNIT IV  PERIPHERAL OF PIC MICROCONTROLLER  

UNIT V  SYSTEM DESIGN – CASE STUDY  
Interfacing LCD Display – Keypad Interfacing - Generation of Gate signals for converters and Inverters - Motor Control – Controlling DC/ AC appliances – Measurement of frequency - Stand alone Data Acquisition System.

TOTAL : 45 PERIODS

REFERENCES:
OBJECTIVES

- To give an overview of the features associated with Industrial Type PID Controller such as reset windup, bumpless auto-manual transfer, proportional kick and derivative kick.
- To make the students understand the various PID tuning methods
- To elaborate different types of control schemes such as cascade control, feed-forward control etc.
- To educate on multivariable systems and multi-loop control
- To educate on various industrial processes

UNIT I  PROCESS DYNAMICS & CONTROL ACTIONS  9

UNIT II  PID CONTROLLER TUNING – SINGLE LOOP REGULATORY CONTROL  9

UNIT III  ENHANCEMENT TO SINGLE LOOP REGULATORY CONTROL & MODEL BASED CONTROL SCHEMES  9
Cascade control – Split-range - Feed-forward control – Ratio control – Inferential control — override control - Smith predictor control scheme - Internal Model Controller - IMC PID controller – Single Loop Dynamic Matrix Control – Generalized Predictive Control

UNIT IV  MULTIVARIABLE SYSTEMS & MULTI-LOOP REGULATORY CONTROL  9

UNIT V  CASE –STUDIES  9
Introduction to Multivariable control – Multivariable PID Controller –Predictive PID Control - Control Schemes for Distillation Column, CSTR, Four-tank system and pH .

TOTAL 45 PERIODS
REFERENCES


CL7202 INDUSTRIAL AUTOMATION

OBJECTIVES

- To educate on design of signal conditioning circuits for various applications
- To educate on signal transmission techniques and their design
- Study of components used in data acquisition systems interface techniques
- To educate on the components used in distributed control systems
- To introduce the communication buses namely field bus and profibus.

UNIT I DESIGN OF SIGNAL CONDITIONING AND TRANSMISSION


UNIT II DATA ACQUISITION AND INSTRUMENT INTERFACE

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 III PLC AND SCADA

SCADA:- Remote terminal units, Master station, Communication architectures and Open SCADA protocols.
UNIT IV DISTRIBUTED CONTROL SYSTEM
Evolution - Different architectures - Local control unit - Operator Interface – Displays - Engineering interface- Study of any one DCS available in market - Factors to be considered in selecting DCS.

UNIT V COMMUNICATION PROTOCOLS

TOTAL=45 PERIODS

REFERENCES
1. Alan s morris “measurement and instrumentation principles”, elsevier , 2006
2. C.j.chesmond, p.a.wilson & m.r.le pla “advanced control system technology”, viva books private limited, 1998
3. Patrick h.garrett “high performance instrumentation and automation” crc press, taylor & francis group, 2005

CL7203 NON-LINEAR CONTROL

Program Objectives
- To impart knowledge on phase plane analysis of non-linear systems.
- To impart knowledge on Describing function based approach to non-linear systems.
- To educate on stability analysis of systems using Lyapunov’s theory.
- To educate on stability analysis of systems using Lyapunov’s theory.
- To introduce the concept of sliding mode control.

UNIT I PHASE PLANE ANALYSIS
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-. simulation of phase portraits in matlab

UNIT II DESCRIBING FUNCTION

UNIT III LYAPUNOV THEORY

UNIT IV FEEDBACK LINEARIZATION 9

UNIT V SLIDING MODE CONTROL 9
Sliding Surfaces- Continuous approximations of Switching Control laws-The Modeling/Performance Trade-Offs- MIMO Systems. simulation of sliding mode controller in matlab

REFERENCES
OBJECTIVES

- To expose the concepts of feed forward neural networks.
- To provide adequate knowledge about feed back neural networks.
- To teach about the concept of fuzziness involved in various systems.
- To expose the ideas about genetic algorithm
- To provide adequate knowledge about of FLC and NN toolbox

UNIT I  INTRODUCTION AND ARTIFICIAL NEURAL NETWORKS  9

UNIT II  ARTIFICIAL NEURAL NETWORKS  9

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-inferencingand 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

TOTAL : 45 PERIODS
REFERENCES
1. Laurene V. Fausett, Fundamentals of Neural Networks: Architectures, Algorithms And Applications, Pearson Education,
2. Timothy J. Ross, “Fuzzy Logic with Engineering Applications” Wiley India.

CL7211 DIGITAL CONTROL AND INSTRUMENTATION
LABORATORY

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.
   (i) Microcontroller
   (ii) PC based Data acquisition and control
10. Hardware simulation of closed loop control system.

TOTAL: 45 PERIODS

For a Batch of 25 students
Branch: ME Control & Instrumentation
Course Title: Digital Control & Instrumentation Lab
Faculty: Electrical

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Description of Equipment</th>
<th>Quantity required</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control system Simulation Software package (e.g. MATLAB/ Labview/ PSIM or other equivalent )</td>
<td>25 user license</td>
</tr>
<tr>
<td>2</td>
<td>Computer Pentium IV or better configuration</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td>Data Acquisition interfaces with PC Analog input/ Analog Output/ Timer/ Digital input-output</td>
<td>Minimum 10 sets</td>
</tr>
<tr>
<td>4</td>
<td>Micro-controller based interface of DAQ with PC</td>
<td>Minimum 5 sets</td>
</tr>
<tr>
<td>5</td>
<td>Closed loop control system set</td>
<td>Minimum one</td>
</tr>
</tbody>
</table>
ET7101 ADVANCED DIGITAL SYSTEM DESIGN LT P C 3 0 0 3

OBJECTIVES
- To expose the students to the fundamentals of sequential system design, modelling
- To teach the fundamentals of Asynchronous circuits, switching errors
- To study on Fault identification in digital switching circuits
- To introduce logics for design of Programmable Devices
- To comparatively study the classification of commercial family of Programmable Devices

UNIT I SEQUENTIAL CIRCUIT DESIGN 9

UNIT II ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN 9

UNIT III FAULT DIAGNOSIS AND TESTABILITY ALGORITHMS 9

UNIT IV SYNCHRONOUS DESIGN USING PROGRAMMABLE DEVICES 9
Programming Techniques -Re-Programmable Devices Architecture- Function blocks, I/Oblocks, Interconnects, Realize combinational, Arithmetic, Sequential Circuit with Programmable Array Logic; Architecture and application of Field Programmable Logic Sequence.

UNIT V ARCHITECTURES AND PROGRAMMING PROGRAMMABLE LOGIC DEVICES 9
REFERENCES:

ET7104 DESIGN OF EMBEDDED SYSTEMS  L T P C
3 0 0 3

OBJECTIVES

• To provide a clear understanding on the basic concepts, Building Blocks for Embedded System
• To teach the fundamentals of System design with Partitioning
• To introduce on Embedded Process development Environment
• To study on Basic tool features for target configuration
• To introduce different EDLC Phases & Testing of embedded system

UNIT I EMBEDDED DESIGN WITH MICROCONTROLLERS 9

UNIT II PARTITIONING DECISION 9

UNIT III FUNCTIONALITIES FOR SYSTEM DESIGN 9
UNIT IV IN CIRCUIT EMULATORS


UNIT V EMBEDDED DESIGN LIFE CYCLE & TESTING


TOTAL : 45 PERIODS

REFERENCES


PX7102 ANALYSIS OF POWER CONVERTERS  L T P C

OBJECTIVES :

- To provide the electrical circuit concepts behind the different working modes of power converters so as to enable deep understanding of their operation.
- To equip with required skills to derive the criteria for the design of power converters starting from basic fundamentals.
- To analyze and comprehend the various operating modes of different configurations of power converters.
- To design different power converters namely AC to DC, DC to DC and AC to AC converters.

UNIT I SINGLE PHASE AC-DC CONVERTER


UNIT II THREE PHASE AC-DC CONVERTER

UNIT III    DC-DC CONVERTERS

UNIT IV    AC VOLTAGE CONTROLLERS

UNIT V     CYCLOCONVERTERS

TOTAL : 45 PERIODS

REFERENCES

PX7203    SPECIAL ELECTRICAL MACHINES    LT P C
3 0 0 3

OBJECTIVES
• To review the fundamental concepts of permanent magnets and the operation of permanent magnet brushless DC motors.
• To introduce the concepts of permanent magnet brushless synchronous motors and synchronous reluctance motors.
• To develop the control methods and operating principles of switched reluctance motors.
• To introduce the concepts of stepper motors and its applications.
• To understand the basic concepts of other special machines.

UNIT I        PERMANENT MAGNET BRUSHLESS DC MOTORS
Fundamentals of Permanent Magnets- Types- Principle of operation- Magnetic circuit analysis-EMF and Torque equations- Characteristics and control
UNIT II PERMANENT MAGNET SYNCHRONOUS MOTORS

UNIT III SWITCHED RELUCTANCE MOTORS
Constructional features –Principle of operation- Torque prediction–CharacteristicsPower controllers – Control of SRM drive- Sensorless operation of SRM – Applications.

UNIT IV STEPPER MOTORS

UNIT V OTHER SPECIAL MACHINES
Principle of operation and characteristics of Hysteresis motor – AC series motors – Linear motor – Applications.

TOTAL: 45 PERIODS

REFERENCES:

ET7006 ADVANCED DIGITAL SIGNAL PROCESSING

OBJECTIVES
- To expose the students to the fundamentals of digital signal processing in frequency domain & its application
- To teach the fundamentals of digital signal processing in time-frequency application
- To compare Architectures & features of Programmable DSpprocessors
- To discuss on Application development with commercial family of DSp Processors
- To design & develop logical functions of DSpProcessors with Re-Programmable Devices
UNIT I  INTRODUCTION TO DIGITAL SIGNAL PROCESSING


UNIT II  WAVELET TRANSFORM

Introduction to continuous wavelet transform- discrete wavelet transform -orthogonal wavelet decomposition- Multiresolution Analysis-Wavelet function-DWT,bases,orthogonal Basis-Scaling function, Wavelet coefficients- ortho normal wavelets and their relationship to filter banks- Digital filtering interpolation (i) Decomposition filters, (ii) reconstruction, the signal- Example MRA- Haar & Daubechies wavelet.

UNIT III  ARCHITECTURES OF COMMERCIAL DIGITAL SIGNAL PROCESSORS

Introduction, catogorisation of DSP Processors, Fixed Point (Blackfin),Floating Point (SHARC),TI TMS 320c6xxx & OMAP processors TMS320C54X & 54xx on Basic Architecture – comparision : of functional variations of Computational building blocks, MAC, Bus Architecture and memory, Data Addressing, Parallelism and pipelining, Parallel I/O interface,Memory Interface, Interrupt, DMA (one example Architecture in each of these case studies).

UNIT IV  INTERFACING I/O PERIPHERALS FOR DSP BASED APPLICATIONS


UNIT V  VLSI IMPLEMENTATION

Low power Design-need for Low power VLSI chips-Basics of DSP system architecture design using VHDL programming, Mapping of DSP algorithm onto hardware, Realisation of MAC & Filter structure.

TOTAL : 45 PERIODS

REFERENCES
OBJECTIVES

- To give an insight to the students about the significance of VHDL Programming
- To teach the importance and architectural modelling of programmable logic devices.
- To introduce the construction and design programming
- To teach the basic VLSI design configurations
- To study the Logic synthesis and simulation of digital system with PLD.

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

PS7001 OPTIMIZATION TECHNIQUES

OBJECTIVES

- To introduce the different optimization problems and techniques
- To study the fundamentals of the linear and non-linear programming problem.
- To understand the concept of dynamic programming and genetic algorithm technique

UNIT I INTRODUCTION

Definition, Classification of optimization problems, Classical Optimization Techniques, Single and Multiple Optimization with and without inequality constraints.

UNIT II LINEAR PROGRAMMING (LP)

Simplex method of solving LPP, revised simplex method, duality, Constrained optimization, Theorems and procedure, Linear programming, mathematical model, solution technique, duality.

UNIT III NON LINEAR PROGRAMMING


UNIT IV DYNAMIC PROGRAMMING (DP)

Multistage decision processes, concept of sub-optimization and principle of optimality, Recursive relations, Integer Linear programming, Branch and bound algorithm

UNIT V GENETIC ALGORITHM

Introduction to genetic Algorithm, working principle, coding of variables, fitness function, GA operators; Similarities and differences between Gas and traditional methods; Unconstrained and constrained optimization using genetic Algorithm, real coded gas, Advanced Gas, global optimization using GA, Applications to power system.

TOTAL: 45 PERIODS

REFERENCES:
OBJECTIVES
- To introduce the PWM converters and their analysis
- To educate on modeling of dc motor, drives and control techniques
- To educate on dynamic modeling of Induction motor drive
- To educate on the V/f and vector control of Induction motor
- To educate on generation of firing pulses and control algorithms in embedded platforms

UNIT I  POWER ELECTRONIC CONVERTERS FOR DRIVES  9
Power electronic switches-state space representation of switching converters-Fixed frequency PWM-variable frequency PWM- space vector PWM- Hysteresis current control-dynamic analysis of switching converters-PWM modulator model

UNIT II  CONTROL OF DC DRIVES  9
Modelling of DC machines-block diagram/transfer function-phase control-1phase/3phase converter fed DC drives- Chopper fed DC drives-four quadrant chopper circuit-closed loop control-speed control-current control-cascade control –constant torque/power operation-comparison of chopper/converter fed drives- techniques-merits/demits

UNIT III  ANALYSIS AND MODELLING OF INDUCTION MOTOR DRIVE  9
Basics of induction motor drive-classification – equivalent circuit- torque Vs slip characteristics-steady state performance- Dynamic modeling of induction motor, Three phase to two phase transformation-stator, rotor, synchronously rotating reference frame model

UNIT IV  CONTROL OF INDUCTION MOTOR DRIVE  9
VSI fed induction motor drives- waveforms for 1-phase, 3-phase Non-PWM and PWM VSI fed induction motor drives -principles of V/F control- principle of vector control-direct vector control- space vector modulation- indirect vector control .

UNIT V  EMBEDDED CONTROL OF DRIVES  9
Generation of firing pulses- generation of PWM pulses using embedded processors-IC control of DC drives- fixed frequency/variable frequency/current control- V/F control using PIC microcontroller- vector control using embedded processors

TOTAL : 45 PERIODS

REFERENCES
OBJECTIVES
- To enable students acquire knowledge about the various techniques used for the measurement of primary industrial parameters like flow, level, temperature and pressure.
- To understand the important parameters to be monitored and analyzed in Thermal power Plant.
- To get an exposure on the important parameters to be monitored and analyzed in Petrochemical Industry.
- To learn about the hazardous zone classification and intrinsic safety techniques to the adapted in industries.
- Learn about other special purpose instruments like Nuclear radiation detection techniques, fibre optic sensors, Instrumentation for NDT applications etc.

UNIT I REVIEW OF INDUSTRIAL INSTRUMENTATION
Overview of Measurement of Flow, level, Temperature and Pressure.

UNIT II MEASUREMENT IN THERMAL POWER PLANT (BOILERS)
Selection and Installation of instruments used for the Measurement of fuel flow, Air flow, Drum level, Steam pressure, Steam temperature – Feed water quality measurement- Flue gas Oxygen Analyzers- Coal Analyzer.

UNIT III MEASUREMENT IN PETROLEUM REFINERY
Parameters to be measured in petroleum industry:-Flow, Level, Temperature and Pressure measurement in Distillation, Pyrolysis, catalytic cracking and reforming process-Hydrocarbon analyzers-oil in or on water- sulphur in oil Analyzer.

UNIT IV INSTRUMENTATION FOR INDUSTRIAL SAFETY
Electrical and Intrinsic Safety - Explosion Suppression and Deluge systems -Conservation and emergency vents - Flame, fire and smoke detectors - Leak Detectors - Metal Detectors.

UNIT V SPECIAL PURPOSE INSTRUMENTATION

TOTAL : 45 PERIODS

REFERENCES

CL7002 ROBUST CONTROL

OBJECTIVES
- To introduce norms, random spaces and robustness measures
- To educate on H2 optimal control and estimation techniques
- To educate on Hinfinity optimal control techniques
- To educate on the LMI approach of Hinfinity control
- To educate on synthesis techniques for robust controllers and illustrate through case studies

UNIT I INTRODUCTION

UNIT II H2 OPTIMAL CONTROL
Linear Quadratic Controllers – Characterization of $H_2$ optimal controllers – $H_2$ optimal estimation-Kalman Bucy Filter – LQG Controller

UNIT III H-INFINITY OPTIMAL CONTROL-RICCATI APPROACH
Formulation – Characterization of H-infinity sub-optimal controllers by means of Riccati equations – H-infinity control with full information – Hinfinity estimation

UNIT IV H-INFINITY OPTIMAL CONTROL- LMI APPROACH

UNIT V SYNTHESIS OF ROBUST CONTROLLERS & CASE STUDIES
Synthesis of Robust Controllers – Small Gain Theorem – D-K –iteration- Control of Inverted Pendulum- Control of CSTR – Control of Aircraft – Robust Control of Second-order Plant- Robust Control of Distillation Column

TOTAL : 45 PERIODS

REFERENCES
4. I. R. Petersen, V.A. Ugrinovskii and A. V. Savkin, “Robust Control Design using H-

CL7003 WIRELESS SENSOR NETWORKS LT P C
3 0 0 3

OBJECTIVES
- To introduce the technologies and applications for the emerging domain of wireless
  sensor networks,
- To impart knowledge on the design and development of the various layers in the WSN
  protocol stack
- To elaborate the various issues related to WSN implementations
- To familiarize the students with the hardware and software platforms used in the design
  of WSN

COURSE OUTCOMES
- Ability to analyze WSN with respect to various performance parameters in the protocol
  stack
- Ability to understand MAC algorithms and Network protocols used for specific WSN
  applications
- Design and develop a WSN for a given application

UNIT I INTRODUCTION
Challenges for wireless sensor networks, Comparison of sensor network with ad hoc network,
Single node architecture – Hardware components, energy consumption of sensor nodes,
Network architecture – Sensor network scenarios, types of sources and sinks, single hop
versus multi-hop networks, multiple sinks and sources, design principles, Development of
wireless sensor networks.

UNIT II PHYSICAL LAYER
Wireless channel and communication fundamentals – frequency allocation, modulation and
demodulation, wave propagation effects and noise, channels models, spread spectrum
communication , packet transmission and synchronization, quality of wireless channels and
measures for improvement, physical layer and transceiver design consideration in wireless
sensor networks, energy usage profile, choice of modulation, power management.

UNIT II DATA LINK LAYER
MAC protocols –fundamentals of wireless MAC protocols, low duty cycle protocols and wakeup
concepts, contention-based protocols, Schedule-based protocols, Link Layer protocols –
fundamentals task and requirements ,error control ,framing, link management

UNIT IV NETWORK LAYER
Gossiping and agent-based uni-cast forwarding , Energy-efficient unicast, Broadcast and
multicast, geographic routing , mobile nodes, Data –centric and content-based networking –
Data –centric routing, Data aggregation, Data-centric storage, Higher layer design issue
UNIT V CASE STUDIES
Target detection and tracking, Habitat monitoring, Environmental disaster monitoring, Practical implementation issues, IEEE 802.15.4 low rate WPAN, Sensor Network Platforms and tools-Sensor node hardware, Node-level software platforms, node-level simulators.

TOTAL : 45PERIODS

REFERENCES

ET7014 APPLICATION OF MEMS TECHNOLOGY L T P C
Pre-requisites: Basic Instrumentation, Material Science, Programming

OBJECTIVES
- To teach the students properties of materials, microstructure and fabrication methods.
- To teach the design and modeling of Electrostatic sensors and actuators.
- To teach the characterizing thermal sensors and actuators through design and modeling.
- To teach the fundamentals of piezoelectric sensors and actuators.
- To give exposure to different MEMS and NEMS devices.

UNIT I MEMS: MICRO-FABRICATION, MATERIALS AND ELECTRO-MECHANICAL CONCEPTS
Overview of micro fabrication – Silicon and other material based fabrication processes – Concepts: Conductivity of semiconductors-Crystal planes and orientation-stress and strain-flexural beam bending analysis-torsional deflections-Intrinsic stress- resonant frequency and quality factor.

UNIT II ELECTROSTATIC SENSORS AND ACTUATION
Principle, material, design and fabrication of parallel plate capacitors as electrostatic sensors and actuators-Applications

UNIT III THERMAL SENSING AND ACTUATION
Principle, material, design and fabrication of thermal couples, thermal bimorph sensors, thermal resistor sensors - Applications.

UNIT IV PIEZOELECTRIC SENSING AND ACTUATION 9
Piezoelectric effect - cantilever piezoelectric actuator model-properties of piezoelectric materials - Applications.

UNIT V CASE STUDIES 9
Piezoresistive sensors, Magnetic actuation, Micro fluidics applications, Medical applications, Optical MEMS - NEMS Devices

TOTAL : 45 PERIODS

REFERENCES

CL7004 ROBOTICS AND CONTROL LT P C
3 0 0 3

OBJECTIVES
• To introduce robot terminologies and robotic sensors
• To educate direct and inverse kinematic relations
• To educate on formulation of manipulator Jacobians and introduce path planning techniques
• To educate on robot dynamics
• To introduce robot control techniques

UNIT I INTRODUCTION AND TERMINOLOGIES 9
Definition-Classification-History- Robots components-Degrees of freedom-Robot joints-coordinates- Reference frames-workspace-Robot languages-actuators-sensors- Position, velocity and acceleration sensors-Torque sensors-tactile and touch sensors- proximity and range sensors- vision system-social issues

UNIT II KINEMATICS 9
Mechanism-matrix representation-homogenous transformation-DH representation- Inverse kinematics-solution and programming-degeneracy and dexterity

UNIT III DIFFERENTIAL MOTION AND PATH PLANNING 9
Jacobian-differential motion of frames-Interpretation-calculation of Jacobian- Inverse Jacobian- Robot Path planning

UNIT IV DYNAMIC MODELLING 9
Lagrangian mechanics- Two-DOF manipulator- Lagrange-Euler formulation – Newton-Euler formulation – Inverse dynamics

28
UNIT V  ROBOT CONTROL SYSTEM
Linear control schemes- joint actuators- decentralised PID control- computed torque control – force control- hybrid position force control- Impedance/ Torque control

REFERENCES
3. Fu, Gonzalez and Lee Mcgrahill ,”Robotics “, international

CL7005  OPTIMAL CONTROL AND FILTERING  L T P C
3 0 0 3

OBJECTIVES
• To educate on formulation of optimal control problems and introduce the minimum principle
• To educate on Linear Quadratic tracking problems- in continuous and discrete domain
• To introduce the numerical techniques used for solving optimal control problems
• To educate on the concepts of filtering in the presence of noise
• To educate on the theory and design of Kalman filter

UNIT I  INTRODUCTION

UNIT II  LINEAR QUADRATIC TRACKING PROBLEMS

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
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**


**REFERENCES:**

**CL7006  ADVANCED TOPICS IN NONLINEAR CONTROL**  

**OBJECTIVES**
- To educate on the theory of perturbation
- To educate on stability analysis and theory of singular perturbation
- To educate on gain scheduling and feedback linearization techniques
- To educate on the concepts input-output stability and passivity
- To educate on the theory and design of back stepping controllers

**UNIT I  PERTURBATION THEORY**

**UNIT II  SINGULAR PERTURBATIONS**
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**

**UNIT IV  INPUT-OUTPUT STABILITY**
UNIT V  BAKSTEPPING CONTROL ALGORITHMS  
Passivity based control – High gain observers – stabilization – Regulation via integral control - exercises

TOTAL : 45 PERIODS

REFERENCES
1. Hasan Khalil," Nonlinear systems and control", 3rd ed, PHI,

CL7007  SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL  L T P C  3 0 0 3

OBJECTIVES
- To introduce various model structures for system identification
- To impart knowledge on parametric and non-parametric identification
- To introduce non-linear identification techniques
- To introduce the concept of adaptation techniques and control
  To illustrate the identification and adaptive control techniques through case studies

UNIT I  MODELS FOR IDENTIFICATION  

UNIT II  NON-PARAMETRIC AND PARAMETRIC IDENTIFICATION  

UNIT III  NON-LINEAR IDENTIFICATION  

UNIT IV  ADAPTIVE CONTROL AND ADAPTATION TECHNIQUES  

UNIT V  CASE STUDIES  
Inverted Pendulum, Robot arm, process control application: heat exchanger, Distillation column, application to power system, Ship steering control.
REFERENCES
3. Astrom and Wittenmark,” Adaptive Control “, PHI

CL7008 FAULT TOLERANT CONTROL L T P C
3 0 0 3

OBJECTIVES
- To give an overview of different Fault Detection and Diagnosis methods
- To impart knowledge and skills needed to design and detect sensor and actuators faults using structured residual approach as well as directional structured residual approach
- To impart knowledge and skills needed design and detect faults in sensor and actuators using GLR and MLR based Approaches
- To present an overview of various types of fault tolerant control schemes such as Passive and active approaches
- To impart knowledge and skills needed to detect and quantify and compensate stiction in Control valves

COURSE OUTCOMES
- Ability to Explain different approaches to Fault Detection and Diagnosis
- Ability to design and detect sensor and actuators faults using structured residual approach as well as directional structured residual approach
- Ability to design and detect faults in sensor and actuators using GLR and MLR based Approaches
- Ability to explain various types of fault tolerant control schemes such as Passive and active approaches
- Ability to Design fault-tolerant control scheme in the presence of actuator failures
  Ability to detect and quantify and compensate stiction in Control valves

UNIT I INTRODUCTION & ANALYTICAL REDUNDANCY CONCEPTS
Introduction - Types of faults and different tasks of Fault Diagnosis and Implementation - Different approaches to FDD: Model free and Model based approaches-Introduction-Mathematical representation of Faults and Disturbances: Additive and Multiplicative types – Residual Generation: Detection, Isolation, Computational and stability properties – Design of Residual generator – Residual specification and Implementation

UNIT II DESIGN OF STRUCTURED RESIDUALS & DIRECTIONAL STRUCTURED RESIDUALS
Introduction- Residual structure of single fault Isolation: Structural and Canonical structures- Residual structure of multiple fault Isolation: Diagonal and Full Row canonical concepts – Introduction to parity equation implementation and alternative representation
- Directional Specifications: Directional specification with and without disturbances – Parity Equation Implementation

UNIT III FAULT DIAGNOSIS USING STATE ESTIMATORS

UNIT IV FAULT TOLERANT CONTROL

UNIT V CASE STUDIES
Fault tolerant Control of Three-tank System – Diagnosis and Fault-tolerant control of chemical process – supervision of steam generator – Different types of faults in Control valves – Automatic detection, quantification and compensation of valve stiction

REFERENCE BOOKS

TOTAL: 45PERIODS
Pre-requisites: Basics in Instrumentation, Power system and communication

OBJECTIVES
- To teach the fundamentals of automated meters and Grids.
- To teach on functional components of Smart meters
- To discuss on need of smart grid for power systems
- To teach the significance of microgrid and its needs
- To teach the communication and protocols for power system

UNIT I INTRODUCTION
Introduction to Smart grid and metering technology- Smart energy management technical architecture-Functions of Smart Grid and smart meters, Opportunities and challenges-Difference between conventional and smart grid-meters, Concept of Resilient and Self Healing Grid, recent developments and International policies in Smart Grid. IEC 61850 protocol standards.

UNIT II SMART METERS
Smart metering-Smart Meters types- hardware architecture- software architecture-requirements- communication protocols- Real Time Prizing, Smart Appliances, Automatic Meter Reading- MEMS, Smart Sensors- Smart actuators- Advanced metering infrastructure- spectrum analyzer.

UNIT III SMART GRID AND APPLICATIONS

UNIT IV MICROGRIDS
Concept of microgrid, need and applications of microgrid, formation of microgrid, Issues of interconnection, protection and control of microgrid. Plastic and Organic solar cells, Thin film solar cells, Variable speed wind generators, fuelcells, microturbines, Captive power plants, Integration of renewable energy sources.

UNIT V INFORMATION AND COMMUNICATION TECHNOLOGY FOR SMART GRID AND METERS
TEXT BOOKS:

REFERENCES: