CURRICULUM AND SYLLABI FOR AUTONOMOUS STREAM

M.TECH. (INSTRUMENTATION ENGINEERING) COURSE
( FOR STUDENTS ADMITTED FROM ACADEMIC YEAR 2015-16 ONWARDS )

CURRICULUM

I SEMESTER

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subjects</th>
<th>Category*</th>
<th>Periods</th>
<th>Marks</th>
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II SEMESTER

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* Approved in 3rd Academic Council Meeting
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Total Credits 16

A representative list of the Professional Development Courses is given below:

a) Industrial Training (*Limited to one credit*)
b) Specific Field Knowledge Training
c) Seminar related with Directed Study
d) Paper Publication in SCI Journal (*Limited to one credit*)

#CA – Continuous Assessment, SE – Semester Examination, TM - Total Marks
*TY – Theory, TCM – Theory with a Mini Project, LB – Laboratory, PR - Practice
TY® – Lecture and Tutorial hours depends on Elective.
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<td>MA153</td>
<td>Applied Mathematics for Instrumentation Engineers</td>
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Prerequisite:
- To acquaint with the ideas of Linear Algebra & Transformations

Objective:
- To learn Linear, quadratic and dynamic programming
- To solve Calculus of variation

Outcome:
- Able to solve Linear algebra
- Able to solve Linear, quadratic and dynamic programming problems
- Able to solve Calculus of variation ideas

UNIT – I  Linear Algebra  Hours: 12
- Vector spaces, subspaces, span of a set, linear independence and dependence, Dimension and Bases, inner product spaces - Gram-Schmidt orthogonalization.

UNIT – II  Linear Transformations  Hours: 12
- Definition and examples, Range and Kernel of a linear map, rank and nullity, Inverse of a linear transformation, consequences of Rank-Nullity theorem, the space L(U, V), composition of linear maps, Matrix associated with a linear map and linear map associated with a matrix

UNIT – III  Linear Programming Problem  Hours: 12
- Basic concepts of Graphical and Simplex methods - Big M-techniques - Two Phase methods.

UNIT – VI  Dynamic and Quadratic Programming  Hours: 12
- Dynamic programming - Solutions of Problems using dynamic programming techniques - Definitions of convex programming - Kuhn Tucker conditions - Quadratic Programming - Wolf’s Method.

UNIT – V  Calculus of Variation  Hours: 12
- Introduction- Euler’s equation- Several dependent variables Lagrange’s equations of Dynamics- Integrals involving derivatives higher than the first- Problems with constraints Direct methods and eigen value problems.

Total contact Hours: 45  Total Tutorials: 15  Total Practical Classes:  Total Hours: 60

Reference books:
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<th>Subject</th>
<th>Hours / Week</th>
<th>Credit</th>
<th>Maximum Marks</th>
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<td>Transducers and Smart Instruments</td>
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**Objectives**

- To study sensors for spatial, optical, chemical variable and environmental measurement
- To study smart sensors, microsensors and actuators
- To study recent trends in sensor technology

**Outcomes**

- The students will know the sensors used for spatial, optical, chemical variable and environmental measurement
- Get knowledge about smart sensors, micro sensors and actuators
- Understand the recent trends in sensor technology

**UNIT – I Review of Measurement Science and Conventional Transducers**


**UNIT – II Sensors for Spatial Variables, Optical Variables, Chemical Variables & Environmental Measurement**

Spatial variable measurement: Laser Interferometer Displacement sensor-syncho /Resolver displacement transducer. Optical variables measurement: Vision and image sensors. Chemical variables measurement: Thermal composition measurement – Kinetic methods. Environmental measurement: Meteorological measurement – Air pollution measurement – Water quality measurement – Satellite imaging and sensing...

**UNIT – III Smart Sensors**

Introduction to smart sensor –Types: Primary and Secondary sensors – Amplification – Filters – Converters – Compensation – Information coding / processing – Data communication, standards for smart sensor interface – Smart transmitter with HART communicator – Smart sensor for flow and temperature measurement.

**UNIT – IV Micro Sensors and Actuators**


**UNIT – V Recent Trends in Sensor Technologies**


**Total teaching Hours: 60**

**Reference books:**

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<td>L  T  P  C</td>
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<td>3  1   -  4</td>
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**Objectives**
- To understand the dynamics of processes
- To understand various control actions and advanced control schemes
- To understand the tuning of controllers and to understand model based control schemes

**Outcomes**
- to tune the controllers for various processes
- to understand model based control schemes

**UNIT – I Process Dynamics Hours: 12**

**UNIT – II Control Actions & Final Control Elements Hours: 12**

**UNIT – III Controller Tuning – Single Loop Control Hours: 12**

**UNIT – IV Enhancement to Single Loop Control Hours: 12**

**UNIT – V Model Based Control Schemes Hours: 12**
Dead-time compensation; - Smith predictor control scheme- Internal Model Controller-IMC PID controller - Single variable Model predictive control – Single Loop DMC - Introduction to Plant-wide Control and Batch Control - P&ID diagram.

**Reference books:**
### Objectives
- To enable the students to 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.

### Outcomes
- Ability to apply the instrumentation concepts in thermal and petroleum industry.
- Ability to get knowledge about instrumentation in intrinsic safety techniques adapted in industries.
- Ability to understand the working principle of special purpose instruments.

### UNIT – I
**Introduction**
Hours: 12

### UNIT – II
**Measurement in Thermal Power Plant**
Hours: 12
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**
Hours: 12
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 Energy Conservation & Management and Safety**
Hours: 12
Principle of energy audit, management & conservation and measurement techniques –Instrumentation for renewable energy systems – Energy management device (Peak load shedding) - Electrical and intrinsic safety - Explosion suppression and deluge systems – Flame arrestors, conservation vents and emergency vents – Flame, fire and smoke Detectors- Metal detectors.

### UNIT – V
**Special Purpose Instrumentation**
Hours: 12

**Total contact Hours: 60**
**Total Tutorials:**
**Total Practical Classes:**
**Total Hours: 60**

### Reference books:
**Department**: Electronics and Instrumentation Engineering  
**Programme**: M.Tech. (Instrumentation Engineering)

**Semester**: One  
**Category**: LB

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**List of Experiments**

1. Identification of linear dynamic model of a process using non parametric methods.
2. (a) Design and implementation PID Control scheme on simulated process.  
   (b) PID Implementation issues
3. Level and pressure control (with and without Interaction) in process control Test Rig.
4. (a) Auto- Tuning of PID controller  
   (b) Design and implementation of gain scheduled Adaptive controller on the simulated model of variable area tank process.
5. Design and implementation of Feed forward and Cascade control schemes on the simulated model of CSIR process.
6. (a) Analysis of MIMO system.  
   (b) Design and implementation of Multi-loop PID and Multivariable PID control schemes on the simulated model of two-tank systems.
7. Design and implementation of Robust PID control schemes on the simulated model of variable area tank process.
8. Design and implementation of Self tuning and Model Reference Adaptive Control schemes on the simulated model of variable area tank process.
9. Design and Implementation of Digital pH meter
10. Design and Implementation of Cold Junction Compensated Thermocouple
11. Design and Implementation of Digital Thermometer using RTD, Thermocouple and AD590
12. Design and Implementation of Smart Digital Energy meter
13. Design and Implementation of Single Board Function Generator
15. Design and testing of advanced measurement circuits.

**Total contact Hours**: -  
**Total Tutorials**: -  
**Total Practical Classes**: 45  
**Total Hours**: 45
**Department**: Electronics and Instrumentation Engineering  
**Programme**: M.Tech. (Instrumentation Engineering)

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**Objectives**
- To introduce system design concepts to students using microcontrollers.
- To introduce foundational concepts of microcontroller architecture and programming.
- To introduce hardware and software integration for real time systems using microcontrollers and thereby imparting real time system design knowledge to students.

**Outcomes**
- Foundational knowledge in activating and using a generic microcontroller. Preliminary design considerations for system level implementation.
- Knowledge of ARM Processor hardware features and internal peripherals. Programming knowledge of ARM Processors.
- Software design techniques to be followed for embedded system designing using real time operating systems for embedded systems.

**UNIT – I**
**Review of Embedded Systems**
Hours: 12

**UNIT – II**
**Introduction to LPC2148 MCU**
Hours: 12

**UNIT – III**
**System Design Using LPC2148 MCU**
Hours: 12

**UNIT – IV**
**Real Time Operating System**
Hours: 12
Concept of Scheduling – Round Robin and Preemptive scheduling – Implementing a simple scheduler in ‘C’ - Task and Task States, tasks and data, semaphores and shared Data Operating system Services-Message queues- Events-Memory Management, Interrupt Routines in an RTOS environment, Examples using RTOS.

**UNIT – V**
**Case Studies**
Hours: 12
Case studies of sector specific, time critical and safety critical real time embedded systems- Typical applications in automotives, engine controls and antilock braking systems, Patient monitoring systems, Robotics and Control systems.

**Total contact Hours**: 60  
**Total Tutorials**: -  
**Total Practical Classes**: -  
**Total Hours**: 60

**Reference books:**
Department: Electronics and Instrumentation Engineering  
Programme: M.Tech. (Instrumentation Engineering)

Semester: Two  
Category: TCM

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Objectives:
- To Design Signal conditioning circuits and transmitter
- To design data loggers, alarms, annunciators and control valves

Outcomes:
- Capable of Design and developing the Instrumentation design to cater the industrial requirements

UNIT – I  
Design of Signal Conditioning Circuits  
Hours: 9

- Design of V/I Converter and I/V Converter - Analog and Digital Filter design
- Signal conditioning circuit for pH measurement
- Compensation circuit
- Signal conditioning circuit for Temperature measurement
- Cold Junction Compensation
- Thermocouple Linearization
- Software and Hardware approaches

UNIT – II  
Design of Transmitters  
Hours: 9

- Design of Temperature Transmitters - using RTD, Thermocouple
- Design of Capacitance based Level Transmitter
- Air-purge Level Measurement
- Design of Smart Flow Transmitters.

UNIT – III  
Design of Data Logger and Controller  
Hours: 9

- Design of Electronic Controllers: ON / OFF and PID Controller
- Microcontroller Based Digital PID Controller and Data Logger
- Design of PC based Data Acquisition Cards

UNIT – IV  
Flow meters and Control Valve Sizing  
Hours: 9

- Orifice Sizing and design: Liquid, Gas and steam services
- Rotameter Design. Control Valves – types
- Valve body: Commercial valve bodies
- Control valve sizing
- Liquid, Gas and steam Services
- Cavitation and flashing
- Selection criteria.

UNIT – V  
Design of Alarm and Annunciation Circuit  
Hours: 9

- Alarm: Fire alarm circuit, Fire alarm control panel and annunciator control panel
- Alarm and Annunciation circuits using Analog and Digital Circuits
- Design Alarm and annunciator circuits using Relays and Programmable Logic Controller.

Total contact Hours: 45  
Total Tutorials: -  
Total Practical Classes: 30  
Total Hours: 75

Reference books:
**Department:** Electronics and Instrumentation Engineering  
**Programme:** M.Tech. (Instrumentation Engineering)

**Semester:** Two  
**Category:** LB

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**Objectives**
- To Design microcontroller based Embedded systems.
- To develop firmware for the systems and to validate the same through functional simulation and hardware verification.
- To understand practical issues of applications of PLC hardware and programming a PLC.
- To get adequate knowledge about practical issues of implementations of PLC and DCS.
- To get adequate knowledge about practical issues of calibration of Process instruments.

**Outcomes**
- The students get exposure to the system design aspects of Microcontrollers.
- Will be able to design applications for customized requirements
- Calibrate different instruments used in industries
- Design and implement computer based control schemes for different processes

**List of Experiments**

**Part-A Embedded Systems**
1. Parallel Port Interfacing Using MCS51
2. Design of Real Time Clock using MCS 51 using segment Displays
3. Design of PC interface Hardware with MCS51
4. Interfacing LCD Display using MCS51
5. Design of Single Channel Data Acquisition System Using MCS51
6. Implementation of GPIO and Timer using ARM LPC2148
7. Implementation of UART features of ARM LPC2148
8. Implementation of Data Acquisition and Signal Generation using LPC2148
9. Interfacing SD card and Graphical LCD using LPC2148
10. Implementation of USB communication using LPC2148

**Part-B Industrial Automation**
1. Design and simulation of digital controller using Kalman’s algorithm
2. PC based PID Control of 4th order electronic process using C program
3. Study of basic programming of PLC
4. Analog operation in PLC
5. Arithmetic operation, Timer, Counter operation using PLC
6. Annunciator design using PLC
7. PC based control of Level Process, Temperature Process

**Total contact Hours:** | **Total Tutorials:** - | **Total Practical Classes:** 45 | **Total Hours:** 45
Subject code | Subject                            | Hours/week | Credit | Maximum marks |
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Prerequisite
- To educate students to methods of selection of research problems
- To expose students to different research methods

Objectives
- Students will be capable to identify and narrow down to the area of research on the basis of the requirements of industrial and global requirements
- Students will exhibit the domain skill to choose suitable research methods to execute research effectively
- Students will possess knowledge to further their academic program, namely, Ph.D program.

Outcomes
- Characteristics of research: Various functions that describe characteristics of research such as systematic, valid, verifiable, empirical and critical approach.
- Types of research: Pure and applied research. Descriptive and explanatory research. Qualitative and quantitative approaches.
- Research procedure: Formulating the Research Problem, Literature Review, Developing the objectives, Preparing the research design including sample. Design, Sample size.
- Considerations in selecting research problem: Relevance, interest, available data, choice of data, Analysis of data, Generalization and interpretation of analysis.

Total contact hours: - Total tutorials: - Total practical classes: 15 Total hours: 15

Reference books:
1. Dawson, Catherine, Practical Research Methods, UBS Publishers and Distributors, New Delhi, 2002
**Department:** Electronics and Instrumentation Engineering

**Programme:** M.Tech. (Instrumentation Engineering)

**Semester:** Three

**Category:** PR

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<th>Credit</th>
<th>Maximum marks</th>
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<tbody>
<tr>
<td>EI159</td>
<td>Project work (Phase I)</td>
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</table>

**Prerequisite:**

**Objectives:** To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes.

**Outcomes:**

The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research. The project work should be a project in control and Instrumentation stream. The project work is allotted individually on different topics. The students shall be encouraged to do their project work in the parent institute itself. Department will constitute an Evaluation Committee to review the project work. The student is required to undertake project phase-I during the third semester and the same is continued in the 4th semester (Phase-II).
<table>
<thead>
<tr>
<th>Subject code</th>
<th>Subject</th>
<th>Hours/week</th>
<th>Credit</th>
<th>Maximum marks</th>
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<tbody>
<tr>
<td>EI160</td>
<td>Project work (Phase II)</td>
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</table>

**Prerequisite**

- 

**Objectives**

To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes.

**Outcomes**

The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research. Masters Research project phase-II is a continuation of project phase-I started in the third semester. Department will constitute an Evaluation Committee to review the progress of the project work. Before the end of the fourth semester the student has to submit the thesis which will be evaluated by internal examiner and external examiner. At least one technical paper is to be prepared for possible publication in journal or conferences. The technical paper is to be submitted along with the thesis.
Department: Electronics and Instrumentation Engineering
Programme: M.Tech. (Instrumentation Engineering)

Semester: Category: TY

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
<th>Credit</th>
<th>Maximum Marks</th>
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<tbody>
<tr>
<td>EIE51</td>
<td>Thermal Power Plant Instrumentation</td>
<td>4 0 - 4</td>
<td>40 60 100</td>
<td></td>
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</tbody>
</table>

Objectives
- To study the concept of power generation using various resources.
- To study the role of Instrumentation in Thermal power plants.
- To study various control and optimization techniques in power plants

Outcomes
- The students get well versed with all power generation plants.
- Students also get thorough knowledge of Instrumentation and control techniques involved in power plants

UNIT – I Basics of Thermal Power Plant | Hours: 12

UNIT – II Boiler Control | Hours: 12

UNIT – III Turbine Monitoring and Control | Hours: 12
Measurement of speed, vibration, shell temperature of steam turbine – Steam pressure Control – Speed control of turbine – Alternator- Monitoring voltage and frequency – Operation of several units in parallel- Synchronization.

UNIT – IV Boiler Modeling and Advanced Control | Hours: 12
Development of mathematical model of combustion chamber, boiler drum and superheater – ANN based model – Model predictive control of superheater – control of drum level using AI techniques.

UNIT – V Optimization of Thermal Power Plant | Hours: 12
Operation
Determination of Boiler efficiency – Heat losses in Boiler – Effect of excess air – Optimizing total air supply- Combustible material in ash- Reduction of turbine losses-Choice of optimal plant parameters- Economics of operation

Total contact Hours: 60 | Total Tutorials: -- | Total Practical Classes: - | Total Hours: 60

Reference books:
Department: Electronics and Instrumentation Engineering
Programme: M.Tech. (Instrumentation Engineering)

Semester: Category: TY

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
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<tr>
<td>EIES2</td>
<td>Systems Theory</td>
<td>L T P C CA SE TM</td>
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<td></td>
<td></td>
<td>3 1 - 4 40 60 100</td>
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</tbody>
</table>

Objectives
- To review of frequency domain descriptions and to understand the behavior of systems using state space approach
- To design state estimator & state feedback control and to analyse the nonlinear system using describing function
- To analyse the stability of a nonlinear system

Outcomes
- On completion students will be able
  - To analyse the systems using state space approach
  - To analyse the nonlinear system

UNIT – I Frequency Domain Descriptions Hours: 12
Properties of transfer functions - poles and zeros of transfer function matrices – singular value analysis – Multivariable Nyquist plots.

UNIT – II State Space Approach Hours: 12

UNIT – III State Feedback Control and State Estimator Hours: 12

UNIT – IV Non-Linear Systems Hours: 12

UNIT – V Stability of Non-Linear Systems Hours: 12

Total contact Hours: 45 Total Tutorials: 15 Total Practical Classes: - Total Hours: 60

Reference books:
**Department** : Electronics and Instrumentation Engineering  
**Programme** : M.Tech. (Instrumentation Engineering)

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
<th>Credit</th>
<th>Maximum Marks</th>
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<tbody>
<tr>
<td>EIE53</td>
<td>Applied Biomedical Instrumentation</td>
<td>4 0 - 4</td>
<td>40</td>
<td>60 100</td>
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</tbody>
</table>

**Objectives**
- To introduce the principles and design issues of biomedical instrumentation
- To understand the nature and complexities of biomedical measurements

**Outcome**
- Ability to apply fundamental principles for designing and modelling biomedical systems.
- Ability to use mathematical/computational tools for biomedical image and signal analysis

**UNIT – I**  
Introduction to Biomedical Measurements  
*Hours: 12*
- Physiological systems and measurable variables
- Nature and complexities of biomedical measurements
- Medical equipment standards
- Organization, classification and regulation
- Biocompatibility
- Human and Equipment safety
- Physiological effects of electricity, Micro and macro shocks, thermal effects.

**UNIT – II**  
Advances In Modeling and Simulations in Biomedical Instrumentation  
*Hours: 12*
- Modeling and simulation in Biomedical instrumentation
- Difference in modeling engineering systems and physiological systems
- Model based analysis of Action Potentials
- cardiac output
- respiratory mechanism
- Blood glucose regulation and neuromuscular function.

**UNIT – III**  
Biomedical Signals and Their Acquisitions  
*Hours: 12*
- Types and Classification of biological signals
- Noise and artifacts and their management
- Biopotential electrodes
- types and characteristics
- Origin, recording schemes and analysis of biomedical signals with typical examples of Electrocardiography (ECG), Electroencephalography (EEG), and Electromyography (EMG)
- Processing and transformation of signals
- applications of wavelet transforms in signal compression and denoising.

**UNIT – IV**  
Instrumentation for Diagnosis and Monitoring  
*Hours: 12*
- Advanced medical imaging techniques and modalities
- Instrumentation and applications in monitoring and diagnosis
- Computed tomography, Magnetic Resonance Imaging and ultrasound
- Algorithms and applications of artificial intelligence in medical image analysis and diagnosis
- Telemedicine and its applications in telemonitoring.

**UNIT – V**  
Biomedical Implants and Microsystems  
*Hours: 12*
- Implantable medical devices: artificial valves, vascular grafts and artificial joints
- Cochlear implants
- Cardiac pacemakers
- Microfabrication technologies for biomedical Microsystems
- Microsensors for clinical applications
- Biomedical microfluid systems.

**Total contact Hours: 60**  
**Total Tutorials: -**  
**Total Practical Classes: -**  
**Total Hours: 60**

**Reference books:**
5. Rangaraj M. Rangayan, Biomedical signal analysis, John Wiley & Sons (ASIA) Pvt. Ltd.,
**Department**: Electronics and Instrumentation Engineering  
**Programme**: M.Tech. (Instrumentation Engineering)

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
<th>Credit</th>
<th>Maximum Marks</th>
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<tbody>
<tr>
<td>EIE54</td>
<td>Cryptography and Network Security</td>
<td>4</td>
<td>0</td>
<td>4</td>
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</tbody>
</table>

**Objectives**
- To introduce information security and Cryptography to students.
- Implementation of Cryptography using diverse algorithms.

**Outcome**
- Students would learn the basic principles of cryptography.
- Usage of private and public keys in cryptography.
- Understanding Cryptography in wireless systems.
- Learning of Firewalls.

**UNIT – I**  
**Introduction and Number Theory**  
Hours: 12

**UNIT – II**  
**Single and Public Key Ciphers**  
Hours: 12

**UNIT – III**  
**Message Authentication, Digital Signatures and Certificates**  
Hours: 12

**UNIT – IV**  
**Trusted Identity and Wireless Security**  
Hours: 12

**UNIT – V**  
**Protocols and Firewalls**  
Hours: 12

**Total contact Hours**: 60  
**Total Tutorials**: -  
**Total Practical Classes**: -  
**Total Hours**: 60

**Reference books**:
**Department**: Electronics and Instrumentation Engineering  | **Programme**: M.Tech. (Instrumentation Engineering)

<table>
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<th>Semester</th>
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<tr>
<td>TY</td>
<td></td>
<td>EIE55</td>
<td>Industrial Data Networks</td>
<td>4 0 -</td>
<td>4</td>
<td>40 60 100</td>
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</tbody>
</table>

**Objectives**
- To educate on the basic concepts of data networks
- To introduce the basics of PLC, SCADA and DCS
- To provide details on HART and Field buses
- To educate on MODBUS, PROFIBUS and other communication protocol

**Outcomes**
- Ability to understand and analyze Instrumentation systems and their applications to various industries

**UNIT – I**
**Data Network Fundamentals**


**UNIT – II**
**PLC, PLC Programming & SCADA**

- Evolutions of PLCs – Programmable Controllers – Architecture – Comparative study of Industrial PLCs. –PLC Programming:– Ladder logic, Functional block programming, Sequential function chart, Instruction list and Structured text programming. SCADA:– Remote terminal units, Master station, Communication architectures and Open SCADA protocols

**UNIT – III**
**Distributed Control System & Hart**

- 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 – Case studies in DCS.

**UNIT – IV**
**Profibus and FF**

- Fieldbus:– Introduction, General Fieldbus architecture, Basic requirements of Fieldbus standard, Fieldbus topology, Interoperability and Interchangeability Profibus:– Introduction, Profibus protocol stack, Profibus communication model, Communication objects, System operation and Troubleshooting – Foundation fieldbus versus Profibus

**UNIT – V**
**AS – Interface (AS-I), Devicenet and Industrial Ethernet**

- AS interface:– Introduction, Physical layer, Data link layer and Operating characteristics. Devicenet:– Introduction, Physical layer, Data link layer and Application layer. Industrial Ethernet:– Introduction, 10Mbps Ethernet and 100Mbps Ethernet - Introduction to OLE for process control (OPC).

**Reference books:**
**Department:** Electronics and Instrumentation Engineering  
**Programme:** M.Tech. (Instrumentation Engineering)

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<th>Semester</th>
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<td>Subject Code</td>
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<tr>
<td>EIE56</td>
<td>Applied Soft Computing</td>
<td>4</td>
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</table>

**Prerequisite:**
- To expose the students to the concepts of feed forward neural networks.
- To provide adequate knowledge about feedback neural networks
- To provide adequate knowledge about fuzzy and neuro-fuzzy systems
- To provide comprehensive knowledge of fuzzy logic control to real time systems.
- To provide adequate knowledge of genetic algorithms and its application to economic dispatch and unit commitment problems.

**Objectives**
- The students will be able to understand the applications of neural network and fuzzy logic in the area of control systems

**Outcome**
- The students will be able to understand the applications of neural network and fuzzy logic in the area of control systems

<table>
<thead>
<tr>
<th>UNIT – I</th>
<th>Artificial Neural Networks</th>
<th>Hours: 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Review of fundamentals – Biological neuron, Artificial neuron, activation function, single layer perceptron-limitation – multilayer perceptron - Back propagation algorithm –recurrent network- adaptive resonance theory based network – radial base function network- online learning algorithms, BP through time- RTRL algorithm reinforce learning</td>
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<table>
<thead>
<tr>
<th>UNIT – II</th>
<th>Neural Networks for Modeling and Control</th>
<th>Hours: 12</th>
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<tr>
<th>UNIT – III</th>
<th>Fuzzy Set Theory</th>
<th>Hours: 12</th>
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</thead>
<tbody>
<tr>
<td>Fuzzy set theory- fuzzy sets- operation on fuzzy sets- Scalar cardinality, fuzzy cardinality, union and intersection-complement (Yeger and sugeno), equilibrium points, aggregation, projection, composition, cylindrical extension, fuzzy relation- fuzzy membership functions</td>
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<tr>
<th>UNIT – IV</th>
<th>Fuzzy Logic for Modeling and Control</th>
<th>Hours: 12</th>
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<tr>
<th>UNIT – V</th>
<th>Hybrid Control Schemes</th>
<th>Hours: 12</th>
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**Total contact Hours: 60 | Total Tutorials: - | Total Practical Classes: - | Total Hours: 60**

**Reference books:**
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<th>Subject</th>
<th>Hours / Week</th>
<th>Credit</th>
<th>Maximum Marks</th>
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<tbody>
<tr>
<td>EIE57</td>
<td>VLSI System Design</td>
<td>4</td>
<td>0</td>
<td>4</td>
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</tbody>
</table>

| Prerequisite | Digital logic System Design |

| Objective | To introduce Digital VLSI design concepts and to introduce IC designing using Field Programmable Gate Arrays.  
To impart skill set in VHDL Hardware Description Language and understand real time modeling of ICs with test benches. |
| Outcome   | Foundational skill set in CMOS technology and logic implementation using CMOS.  
Basics of VHDL hardware description language and VHDL levels of abstraction.  
Working knowledge of VHDL programming using concurrent architecture |

UNIT – I Basic Device Characteristics | Hours: 12
NMOS, PMOS, enhancement and depletion mode transistor, MOSFET threshold voltage, linear and saturated operation, standard CMOS inverter, transit time and switching speed of NMOS and CMOS inverters, NMOS and CMOS gates, transistor sizing and power dissipation, noise margin calculations, Device models for simulation, CMOS device fabrication principles.

UNIT – II Design Rules and Layout | Hours: 12
Purpose of design rules, NMOS and CMOS design rules and layout, Design of NMOS and CMOS inverters, NAND and NOR gates. Interlayer contacts, butting and buried contacts, stick diagrams, layout of integrated circuits. Simulation of CMOS circuits.

UNIT – III Introduction to VHDL | Hours: 12
VHDL basics - VHDL levels of abstraction – Structural, Behavioral and dataflow modes of implementation - The VHDL design flow - VHDL design entities - Entity declarations - Architectures –Concurrent signal assignments - Signal assignments with delays – Signal and variable assignments -Sequential statements - VHDL processes - Processes sensitivity lists Conditional statements – loops - selective signal assignments.

UNIT – IV System Implementation Using VHDL | Hours: 12
Component declarations - Component instantiation - Named port mapping – Positional port mapping –Packages - Package declaration - Package body. Test Bench Development in VHDL- Simple Test Benches – Implementation of combinational and sequential circuits in VHDL.

UNIT – V FPGAs and CPLDs | Hours: 12
Introduction - FPGA Architecture – FPGA Configuration Types – MASK Programmed FPGAs. Introduction to CPLDs Comparison of FPGAs and CPLDs from Xilinx, Altera and Actel - Introduction to ASIC – FPGA based system design - High level synthesis - overview for floor planning, placement and routing.

Total contact Hours: 60  |  Total Tutorials: -  |  Total Practical Classes:  |  Total Hours: 60

Reference Books:
**Subject Code** | **Subject** | **Hours / Week** | **Credit** | **Maximum Marks**
--- | --- | --- | --- | ---
EIES58 | Optimal Control | 4 | 0 | 4 | 40 | 60 | 100

**Prerequisite**
- Engineering Mathematics and Control Systems

**Objective**
- To learn the basic mathematical tools required for designing an optimal control for a given process

**Outcome**
- The student will be able to design an optimal control for the given process

**UNIT – I Introduction**

**UNIT – II Dynamic Programming**

**UNIT – III The Calculus of Variations**
Fundamental concepts, Functionals of a single function and functionals involving several independent functions, Piecewise smooth extremals, Constrained extrema, Necessary condition for optimal control, Linear regulator problems.

**UNIT – IV The Minimum (Maximum) Principle**
Pontryagin’s minimum principle and state inequality constraints, Minimum time problem, Minimum control energy problems, Relationship between Dynamic Programming and Minimum Principle, Singular intervals in optimal control.

**UNIT – V Case Studies**
Optimal control in selected applications – distillation column, boiler and paper manufacturing plant.

**Reference books:**
Department: Electronics and Instrumentation Engineering  
Programme: M.Tech. (Instrumentation Engineering)

Semester: TY

<table>
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<tr>
<th>Subject Code</th>
<th>Subject</th>
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<td>CA</td>
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<tr>
<td>EIE59</td>
<td>Robust Control</td>
<td>4</td>
<td>0</td>
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</table>

Objectives
- To provide basic knowledge of theoretical foundation of robust control
- To develop the skill needed to design robust controller for practical systems

Outcome
- Use singular value techniques to analyse the robustness of control system
- Use H-infinity methods to design robust controller
- Incorporate frequency-domain based robust specifications

UNIT – I  
Hours: 12
Introduction—measure of robustness—robustness in stability and performance—plant uncertainty model—robustness of sampled-data control system.

UNIT – II  
Hours: 12
Analysis of robustness—stability analysis—gamma stability—testing sets—Kharitonov's theorem—stability radius.

UNIT – III  
Hours: 12

UNIT – IV  
Hours: 12
Robust control design using $\infty$ methods—$\infty$ control for linear and non-linear systems.

UNIT – V  
Hours: 12
Robust control for constrained systems—integral quadratic constraints and weighted quadratic constraints for linear systems—non-linear system with constraints—case study.

Total contact Hours: 60  
Total Tutorials:  
Total Practical Classes: -  
Total Hours: 60

Reference books:
**Department:** Electronics and Instrumentation Engineering  
**Programme:** M.Tech. (Instrumentation Engineering)

**Semester:**  
**Category:** TY

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<tr>
<td>EIE60</td>
<td>Robotics and Automation</td>
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**Prerequisite:**  
- To Introduce the design of multi degree-of-freedom robots and mobile platforms.
- To review the latest technology available to design robotic systems.
- To design robots using professional engineering tools.
- To learn programming of microcontrollers to control a robotic system.
- To have Hands-on experience to design a robotic system.

**Objectives:**
- Students will be able to design a robot starting with the conceptual design,
- develop the concept into a model, analyze the model on computer using engineering software packages,
- complete the structural design,
- able to build a prototype, present results in terms of a PowerPoint presentation,
- Develop an engineering report and demonstrate the robot’s performance.

**Outcomes:**
- Students will be able to design a robot starting with the conceptual design,
- develop the concept into a model, analyze the model on computer using engineering software packages,
- complete the structural design,
- able to build a prototype, present results in terms of a PowerPoint presentation,
- Develop an engineering report and demonstrate the robot’s performance.

**UNIT – I**  
**Introduction and Robot Kinematics**  
Basic concepts of Robots and automation-classification—specifications—Application—Notation—Direct Kinematics—Co-ordinate frames—rotations—Homogeneous coordinates—The Arm equation—Kinematic analysis of a typical Robot—Inverse Kinematics—Tool configuration—Inverse kinematics of a typical Robot—Workspace analysis and trajectory planning—Work envelope of different robots—The pick and place operation.

**UNIT – II**  
**Dynamic of Robots**  
Continuous path motion—interpolated motion—Straight line motion—Tool configuration—Jacobian matrix and manipulator Jacobian—Manipulator Dynamics—Kinetic of potential energy—Energized forces—Lagrange’s Equation—Euler Dynamic model.

**UNIT – III**  
**Robot Control**  

**UNIT – IV**  
**Robot Vision & Micro Robotics**  

**UNIT – V**  
**Mobile Robots and Control Issues**  
Industrial automation—General layout—general configuration of an automated flow line—conveyor systems—major features—types—Roller, State wheel, Belt, Chain and overhead trolley—Inspection station with feedback loops to up steam workstations—shop floor control—3 phases—order scheduling.

**Total contact Hours:** 60  
**Total Tutorials:** -  
**Total Practical Classes:** -  
**Total Hours:** 60

**Reference books:**
Department: Electronics and Instrumentation Engineering  
Programme: M.Tech. (Instrumentation Engineering)

<table>
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<tr>
<th>Subject Code</th>
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<tr>
<td>EIE61</td>
<td>System Identification</td>
<td>3</td>
<td>1</td>
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</table>

Prerequisite: Engineering Mathematics and Control Systems

Objectives:
- To have an exposure of various system and their models.
- To get basic knowledge of system identification concepts.
- To solve estimation problems in Instrumentation and control

Outcomes:
- Students will have an exposure on various system and their models.
- Students will have the knowledge of system identification concepts.
- Students will be able to do estimation problems in Instrumentation and control

UNIT – I  
Introduction  
Hours: 12  
Dynamic systems, Models for Linear Time-invariant Systems, time varying systems and nonlinear systems, The system identification procedure, Non-parametric methods-Transient analysis, Frequency analysis, correlation analysis and spectral analysis.

UNIT – II  
Parameter Estimation Methods  
Hours: 12  

UNIT – III  
Recursive Identification Methods  
Hours: 12  
The recursive least square method – the recursive instrumental variable methods- the recursive prediction error methods – Maximum likelihood

UNIT – IV  
Closed-Loop Identification  
Hours: 12  

UNIT – V  
Practical Aspects of Identification  
Hours: 12  

Total contact Hours: 45  
Total Tutorials: 15  
Total Practical Classes: -  
Total Hours: 60

Reference books:
## Subject: Advanced Operating Systems

**EIE62**

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
<th>Credit</th>
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<tr>
<td></td>
<td>Advanced Operating Systems</td>
<td>L 0 T</td>
<td>4</td>
<td>40</td>
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<td></td>
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</table>

**Prerequisite:** Operating Systems

### Objectives

- To introduce operating system concepts to students.
- Study of Centralized Vs Distributed systems.
- To introduce resource and fault management in operating systems.

### Outcomes

- Foundational knowledge in operating systems and CPU scheduling.
- Understanding distributed and centralized systems.
- Task management and synchronization in Operating systems.
- Understanding fault management in operating systems.

### Outline

#### UNIT – I: Operating System

**Hours: 12**

- Introduction - operating systems and services
- CPU Scheduling approaches
- Process synchronization Semaphores
- Deadlocks – Handling deadlocks – Multithreading

#### UNIT – II: Distributed Systems

**Hours: 12**

- Introduction - Advantages of distributed system over centralized system, Limitations of Distributed system
- Communication in Distributed systems – ATM, Client-Server model
- Distributed operating system – Issues, Communication primitives – Message Passing Model, Remote Procedure Call

#### UNIT – III: Synchronization in Distributed Systems

**Hours: 12**

- Clock synchronization – Lamport’s logical clock, Vector clock, Causal ordering of messages, Causal Ordering of Messages
- Mutual exclusion – Non token based and token based algorithm; atomic transactions
- Distributed deadlock detection and prevention

#### UNIT – IV: Distributed Resource Management

**Hours: 12**

- Distributed file system – Trend, Design and Implementation
- Distributed Shared Memory (DSM) – Memory coherence, Page based DSM, Shared variable DSM, Object based DSM
- Distributed Scheduling

#### UNIT – V: Failure Recovery and Fault Tolerance

**Hours: 12**

- Recovery – Classification, Backward and forward error recovery
- Recovery in concurrent systems, synchronous check pointing and recovery
- Check pointing for Distributed database system
- Fault tolerant – commit protocols, Voting protocols, Dynamic vote reassignment protocol

### Total contact Hours: 60

### Total Tutorials: 60

### Total Practical Classes: 60

### Total Hours: 60

### Reference books:

### Course Information

**Department:** Electronics and Instrumentation Engineering  
**Programme:** M.Tech. (Instrumentation Engineering)

<table>
<thead>
<tr>
<th>Subject Code</th>
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<th>Credit</th>
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<tr>
<td>EIE63</td>
<td>Advanced Process Control</td>
<td>4</td>
<td>0</td>
<td>4</td>
</tr>
</tbody>
</table>

**Prerequisite:** Process control

**Objectives:**
- To understand the behavior of multivariable systems
- To understand the interaction among multiple loops
- To design controllers for multivariable systems
- To understand behavior of nonlinear process
- To study about various process control schemes

**Outcomes:**
- To design controllers for MIMO processes
- Can understand behavior of nonlinear systems

### Course Content

#### UNIT – I  Multivariable Systems  | Hours: 12

#### UNIT – II  Multi-Loop Regulatory Control  | Hours: 12

#### UNIT – III  Multivariable Regulatory Control  | Hours: 12

#### UNIT – IV  Control of Time-Varying and Nonlinear Systems  | Hours: 12

#### UNIT – V  Case –Studies  | Hours: 12
- Control Schemes for Distillation Column, CSTR, Bioreactor, Three-tank hybrid system, Four-tank system, pH, and polymerization reactor.

**Total contact Hours:** 60  
**Total Tutorials:**  
**Total Practical Classes:** -  
**Total Hours:** 60

**Reference books:**
Department: Electronics and Instrumentation Engineering
Programme: M.Tech. (Instrumentation Engineering)

Subject Code  | Subject               | Hours / Week | Credit | Maximum Marks
-------------|-----------------------|--------------|--------|----------------|
EIE64        | State Estimation      | 4 0-4        | 4 40   | 60 100

Prerequisite: Mathematics and control systems

Objective:
- To provide fundamental background to state estimation and kalman filter.
- Impart an understanding of the applicability of various kalman filters in finding state estimates
- Provide the students the theory and applications of H-infinity and particle filter.

Outcome:
- Students will have an exposure to various state estimation methods

UNIT – I  Introduction to State Estimation and Kalman Filter  | Hours: 12

UNIT – II  Extended Kalman Filter  | Hours: 12

UNIT – III  Unscented Kalman Filter  | Hours: 12

UNIT – IV  The H-Infinity Filter  | Hours: 12

UNIT – V  Particle Filter  | Hours: 12
Bayesian state Estimation -Particle filtering -Implementation issues- Sample Impoverishment - Particle filter with EKF as proposal - Unscented Particle filter - Case Studies

Total contact Hours: 60  Total Tutorials: -  Total Practical Classes: -  Total Hours: 60

Reference books:
Department : Electronics and Instrumentation Engineering
Programme : M.Tech. (Instrumentation Engineering)

Semester : TY

<table>
<thead>
<tr>
<th>Subject Code</th>
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<th>Credit</th>
<th>Maximum Marks</th>
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<tbody>
<tr>
<td>EIE65</td>
<td>Advanced Digital Signal Processing</td>
<td>4 0 - 4</td>
<td>40 60 100</td>
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</tbody>
</table>

Prerequisite : Digital Signal Processing

Objective
- To learn methods of power spectral estimation using nonparametric and parametric methods
- Provide the students the fundamentals of estimation
- Impart an understanding of adaptive filters
- Introduce Multirate signal Processing and wavelet transforms

Outcome
- Students will have an understanding in analysis of signals and systems using advanced techniques in digital signal processing

UNIT – I Random Signal Processing and Spectrum Estimation
Hours: 12

UNIT – II Linear Estimation and Prediction
Hours: 12

UNIT – III Adaptive Filters
Hours: 12

UNIT – IV Multirate Digital Signal Processing
Hours: 12
Mathematical description of change of sampling rate - Interpolation and Decimation - continuous time model - Direct digital domain approach - Decimation by an integer factor - Interpolation by an integer factor - Single and multistage realization - poly phase realization - Application to sub band coding.

UNIT – V Wavelet Transforms
Hours: 12
Continuous Wavelet Transform, Introduction, Continuous-time wavelets, Definition of the CWT- Introduction to Discrete Wavelet Transform And Orthogonal Wavelet Decomposition MRA-Types of wavelets-Wavelet denoising-Wavelet applications

Total contact Hours: 60
Total Tutorials: -
Total Practical Classes: -
Total Hours: 60

Reference books:
<table>
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<tbody>
<tr>
<td>EIE66</td>
<td>Adaptive Control</td>
<td>4 L 0 T -</td>
<td>4 C</td>
<td>40 60 100</td>
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</tbody>
</table>

**Prerequisite**

**Objective**

- To provide basic knowledge in adaptive control
- To develop the skill needed to design adaptive controller for practical systems

**Outcome**

- The student will be able to design adaptive controller for practical applications

**UNIT – I**

**Introduction**

Hours: 12


**UNIT – II**

**Gain Scheduling**

Hours: 12

Introduction- The principle - Design of gain scheduling controllers- Nonlinear transformations -application of gain scheduling - Auto-tuning techniques - Methods based on Relay feedback.

**UNIT – III**

**Deterministic Self-Tuning Regulators**

Hours: 12

Introduction- Pole Placement design - Indirect Self-tuning regulators - direct self-tuning regulators – Disturbances with known characteristics.

**UNIT – IV**

**Stochastic and Predictive Self-Tuning Regulators**

Hours: 12


**UNIT – V**

**Model – Reference Adaptive System**

Hours: 12


**References books:**

### Subject Code: EIE67  
**Process Optimization**

<table>
<thead>
<tr>
<th>Subject Code</th>
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<th>Credit</th>
<th>Maximum Marks</th>
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<tr>
<td>EIE67</td>
<td>Process Optimization</td>
<td>4 L 0 T 0 P 4 C</td>
<td>4</td>
<td>40 CA 60 SE 100 TM</td>
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</table>

#### Prerequisite
- To study one dimensional optimization techniques
- To study unconstrained gradient based optimization methods
- To study linear programming and its applications
- To study constrained optimization methods

#### Objectives
- Able to find an optimal solution to any process
- Apply optimization theory and methods in control theory

#### Outcome

<table>
<thead>
<tr>
<th>UNIT – I</th>
<th>Mathematical Preliminaries</th>
<th>Hours: 12</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vector Spaces, Vector Space Operations, Data Fitting, Eigenvalues and Eigenvectors Convergence in $\mathbb{R}^n$, Calculus on $\mathbb{R}$ and $\mathbb{R}^n$, Calculus for a Function of One Variable Calculus for a Function of Several Variables, Convex Analysis, Convex sets, Convex Functions</td>
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<thead>
<tr>
<th>UNIT – II</th>
<th>One-Dimensional Optimization</th>
<th>Hours: 12</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Function Comparison Methods, Polynomial Interpolation Methods, Iterative Methods, Function Comparison Methods, Two Point Equal Interval Search Method of Bisection, Fibonacci Method, Golden Section Search, Polynomial Interpolation, Quadratic Interpolation, Cubic Interpolation, Iterative Methods, Newton’s Method, Secant Method, Case studies</td>
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<table>
<thead>
<tr>
<th>UNIT – III</th>
<th>Unconstrained Gradient Based Optimization Methods</th>
<th>Hours: 12</th>
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<tbody>
<tr>
<td></td>
<td>Gradient and Conjugate Gradient Type Algorithms, Method of Steepest Descent-Conjugate Gradient Method (Method of Fletcher and Reeves), Newton Type Methods Newton’s Method, Marquardt’s Method, Quasi-Newton Algorithms, Case studies</td>
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<thead>
<tr>
<th>UNIT – IV</th>
<th>Linear Programming</th>
<th>Hours: 12</th>
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<tbody>
<tr>
<td></td>
<td>Simplex Method, Movement from One Extreme Point to another Algorithm, Revised Simplex Method, Finding Initial Solution, Two Phase Simplex Method, Duality Theory, Dual Simplex Method, Case studies</td>
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<thead>
<tr>
<th>UNIT – V</th>
<th>Constrained Optimization Methods and Evolutionary Algorithms</th>
<th>Hours: 12</th>
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</thead>
</table>

#### EVOLUTIONARY ALGORITHMS:
- Box Complex Method, Genetic Algorithm, Case studies.

#### Total contact Hours: 45  | Total Tutorials: 15  | Total Practical Classes: -  | Total Hours: 60

#### Reference books:
<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Hours / Week</th>
<th>Credit</th>
<th>Maximum Marks</th>
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<tbody>
<tr>
<td>EIE68</td>
<td>Micro-Electro-Mechanical Systems</td>
<td>4 0 -</td>
<td>4 40 60</td>
<td>100</td>
</tr>
</tbody>
</table>

**Prerequisite:**
- Should know the basics of VLSI fabrication.

**Objectives:**
- Study about MEMS and parts of MEMS
- Study the MEMS material and Fabrication methods.
- Study about MEMS mechanics, modelling.
- Study about advanced MEMS for sensing and actuation.
- Study about pressure sensor and accelerometer.

**Outcome:**
- Understand the concepts of micro systems.
- Knowledgeable about materials and fabrication methods
- Conceptual understanding of mechanics and modelling
- Understanding of the sensing and actuating principles for design
- Able to design simple micropressure sensor or accelerometer

**UNIT – I Introduction to MEMS**

**UNIT – II MEMS materials Fabrication Methods**
- Silicon material system: Substrates and material properties-Doping– Oxidation – Concepts of Bulk Micro machining and Surface Micro machining
- Additive Processes: Evaporation and sputtering – Chemical vapor deposition (CVD) Lithography- Wet etching: Isotropic– Anisotropic – Etch stops-

**UNIT – III MEMS mechanics, Modelling, Dynamics, Structures and Electrostatics**
- Mechanics of materials: Stress and strain - Plane stress -. Anisotropic materials - Thermal expansion Thin film stress - Material properties - Typical values of MEMS materials- Design limits and safety factors - Lumped element modelling: Conjugate power variables, co-energy, mapping to electrical circuits- Dynamics : Linear first order systems -Linear second order systems -
- Structures : Bending of beams -Torsion of beams - Axial load and buckling of beams - Effect of residual stress and stress gradient Bending of Plates - Stiffness and natural frequencies -
- Electrostatics: Parallel plate capacitor -electrostatic actuator - Pull-in.

**UNIT – IV Advanced MEMS for Sensing and Actuation**
<table>
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<tr>
<th>UNIT – V</th>
<th>Design of Pressure Sensors and Accelerometers</th>
<th>Hours: 12</th>
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</table>

**Piezoresistive Pressure Sensor:** Sensing Pressure, Piezoresistance- Analytic Formulation in Cubic Materials-Longitudinal and Transverse Piezoresistance - Piezoresistive Coefficients of Silicon-Structural Examples- Signal Conditioning and Calibration.

**Capacitive Accelerometer:** Fundamentals of Quasi-Static Accelerometers, Position Measurement with Capacitance- Circuits for Capacitance Measurement-Demodulation Methods- Case Study-Specifications- Sensor Design and Modeling- Fabrication and Packaging.

<table>
<thead>
<tr>
<th>Total contact Hours: 45</th>
<th>Total Tutorials: -15</th>
<th>Total Practical Classes:</th>
<th>Total Hours: 60</th>
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</thead>
</table>

**Text Books:**


**Reference Books:**