PONDICHERRY ENGINEERING COLLEGE, PUDUCHERRY – 605 014

CURRICULUM AND SYLLABI FOR AUTONOMOUS STREAM

M.TECH. (INSTRUMENTATION ENGINEERING) COURSE

(FOR STUDENTS ADMITTED FROM ACADEMIC YEAR 2015-16 ONWARDS)

CURRICULUM[a]

I SEMESTER

Subject Code	Subjects	Category*	Periods			Marks			Credits
			L	T	P	CA	SE	TM	
MA153	Applied Mathematics for Instrumentation Engineers	TY	3	1	-	40	60	100	4
EI151	Transducers and Smart Instruments	TY	4	-	-	40	60	100	4
EI152	Process Control	TY	3	1	-	40	60	100	4
EI153	Applied Industrial Instrumentation	TY	4	0	-	40	60	100	4
--	Elective – I	TY	-	-	-	40	60	100	4
---	Elective – II	TY@	-	-	-	40	60	100	4
EI154	Process control and Instrumentation Laboratory	LB	0	-	3	60	40	100	2
Total Credits									**26**

II SEMESTER

Subject Code	Subjects	Category*	Periods			Marks			Credits
			L	T	P	CA	SE	TM	
EI155	Real Time Embedded System Design	TY	4	-	-	40	60	100	4
EI156	Instrumentation System Design	TCM	3	-	2	50	50	100	4
---	Elective – III	TY@	-	-	-	40	60	100	4
---	Elective – IV	TY@	-	-	-	40	60	100	4
---	Elective – V	TY@	-	-	-	40	60	100	4
---	Elective – VI	TY@	-	-	-	40	60	100	4
EI157	Embedded Systems and Industrial Automation Laboratory	LB	-	-	3	60	40	100	2
EI158	Research Methodology	PR	-	-	3	100	-	100	1
Total Credits									**27**

[a] ***Approved in 3rd Academic Council Meeting***

III SEMESTER

Subject Code	Subjects	Category*	Periods			Marks			Credits
			L	T	P	CA	SE	TM	
EI159	Project phase I	PR	-	-	-	150	150	300	9
Total Credits									**9**

IV SEMESTER

Subject Code	Subjects	Category*	Periods			Marks			Credits
			L	T	P	CA	SE	TM	
EI160	Project phase II	PR	-	-		200	200	400	14
	Professional Development Courses (Two one credit courses)		-	-	-	200		200	2
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.

LIST OF ELECTIVES

Sl.No.	Subject Code	Subjects	Category
1	**EIE51**	Thermal Power Plant Instrumentation	TY
2	**EIE52**	Systems Theory	TY
3	**EIE53**	Applied Biomedical Instrumentation	TY
4	**EIE54**	Cryptography and Network Security	TY
5	**EIE55**	Industrial Data Networks	TY
6	**EIE56**	Applied Soft Computing	TY
7	**EIE57**	VLSI System Design	TY
8	**EIE58**	Optimal Control	TY
9	**EIE59**	Robust Control	TY
10	**EIE60**	Robotics and Automation	TY
11	**EIE61**	System Identification	TY
12	**EIE62**	Advanced Operating Systems	TY
13	**EIE63**	Advanced Process Control	TY
14	**EIE64**	State Estimation	TY
15	**EIE65**	Advanced Digital Signal Processing	TY
16	**EIE66**	Adaptive Control	TY
17	**EIE67**	Process Optimization	TY
18	**EIE68**	Micro-Electro Mechanical Systems	TY

Department : Mathematics		**Programme :** M. Tech. (Instrumentation Engineering)						
Semester : One		**Category : TY**						
Subject Code	**Subject**	**Hours / Week**			**Credit**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**
MA153	Applied Mathematics for Instrumentation Engineers	3	1		4	40	60	100
Prerequisite	-							
Objective	• To acquaint with the ideas of Linear Algebra & Transformations • 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- Wolfís 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:

1. Taha, H.A. Operations, Research, An Introduction, Seventh edition, Pearson Education Edition, New Delhi, 2003.
2. Guptha., A.S.Calculus of variations with applications, Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
3. Stephenson, G.Radmore, P.M., Advanced Mathematical Methods for Engineering and Science students, Cambridge University Press1999.
4. Bronson, R., Matrix Operations, Schaum’s outline series, McGraw Hill, New York., 1989.

<table>
<tr><td colspan="3">Department : Electronics and Instrumentation Engineering</td><td colspan="7">Programme : M.Tech. (Instrumentation Engineering)</td></tr>
<tr><td colspan="3">Semester : One</td><td colspan="7">Category : TY</td></tr>
<tr><td rowspan="2">Subject Code</td><td rowspan="2" colspan="2">Subject</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>EI151</td><td colspan="2">Transducers and Smart Instruments</td><td>4</td><td>-</td><td>-</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Objectives</td><td colspan="9">• 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</td></tr>
<tr><td>Outcomes</td><td colspan="9">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</td></tr>
<tr><td>UNIT – I</td><td colspan="5">Review of Measurement Science and Conventional Transducers</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="10">Types of errors – Limiting error – probable error – propagation of error – odds and uncertainty – static and dynamic characteristics – strain gauges – LVDT – capacitive transducers – piezo-electric transducers</td></tr>
<tr><td>UNIT – II</td><td colspan="5">Sensors for Spatial Variables, Optical Variables, Chemical Variables & Environmental Measurement</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="10">Spatial variable measurement: Laser Interferometer Displacement sensor-synchro /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..</td></tr>
<tr><td>UNIT – III</td><td colspan="5">Smart Sensors</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="10">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.</td></tr>
<tr><td>UNIT – IV</td><td colspan="5">Micro Sensors and Actuators</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="10">Micro system design and fabrication – Micro pressure sensors (piezo resistive and capacitive) – Resonant sensors – Acoustic wave sensors – Bio micro sensors – Micro actuators – Micro mechanical motors and pumps.</td></tr>
<tr><td>UNIT – V</td><td colspan="5">Recent Trends in Sensor Technologies</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="10">Film sensors : Thick film and thin film – Integrated image sensors – Bio sensors – Integrated micro arrays– Sensor arrays – Sensor network – Multisensor data fusion – Soft sensor – RFID based instrumentation</td></tr>
<tr><td colspan="2">Total teaching Hours: 60</td><td>Total Tutorials: -</td><td colspan="3">Total Practical Classes: -</td><td colspan="4">Total Hours: 60</td></tr>
<tr><td colspan="10">Reference books:</td></tr>
<tr><td colspan="10">1. John G Webster , Measurement , Instrumentation and Sensors Handbook , CRC press IEEE press, 1998.
2. Bela G Liptak , Instruments Engineers’ Handbook Process Measurement and Analysis , Elsevier , 2005.
3. D.Patranabis, Sensors and Transducers, PHI, 2006.
4. Tai Ran Hsu , MEMS and micro systems design & manufacture , Tata McGraw Hill, 2002.</td></tr>
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<tr><td rowspan="2">Subject Code</td><td rowspan="2">Subject</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>EI152</td><td>Process Control</td><td>3</td><td>1</td><td>-</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Objectives</td><td colspan="8">• 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</td></tr>
<tr><td>Outcomes</td><td colspan="8">On completion students will be able
• to tune the controllers for various processes
• to understand model based control schemes</td></tr>
<tr><td>UNIT – I</td><td colspan="4">Process Dynamics</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="9">Need for process control – Review of Laplace transform and z-transform – Modified of z-transform – Pulse transfer function - Continuous and batch processes – Self regulation – Servo and regulatory operations - Interacting and non-interacting systems – Degrees of freedom - Linearization of nonlinear systems- Mathematical model of Level and Thermal processes – Lumped and Distributed parameter models - Identification of Transfer function model parameters using non-parametric approaches- state space model representation.</td></tr>
<tr><td>UNIT – II</td><td colspan="4">Control Actions & Final Control Elements</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="9">Characteristic of ON-OFF, P, P+I, P+D and P+I+D control modes – Electronic PID controller –Digital PID algorithm – Auto/manual transfer - Reset windup – Practical forms of PID Controller - Pneumatic and electric actuators – Valve Positioner – Control Valves–Characteristic of Control Valves:- Inherent and Installed characteristics – Modeling of pneumatic control valve..</td></tr>
<tr><td>UNIT – III</td><td colspan="4">Controller Tuning –Single Loop Control</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="9">Evaluation criteria – IAE, ISE, ITAE and ¼ decay ratio - Tuning:- Process reaction curve method, Continuous cycling method and Damped oscillation method – Determination of optimum settings for mathematically described processes using time response and frequency response approaches –pole placement –lambda tuning- algebraic design – optimization methods – robust loop shaping.</td></tr>
<tr><td>UNIT – IV</td><td colspan="4">Enhancement to Single Loop Control</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="9">Feed-forward control – Ratio control – Cascade control – Inferential control – Split-range– override control–-selective control –Auto tuning.</td></tr>
<tr><td>UNIT – V</td><td colspan="4">Model Based Control Schemes</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="9">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.</td></tr>
<tr><td colspan="2">Total contact Hours: 45</td><td colspan="2">Total Tutorials: -15</td><td colspan="2">Total Practical Classes: -</td><td colspan="3">Total Hours: 60</td></tr>
<tr><td colspan="9">Reference books:</td></tr>
<tr><td colspan="9">1. Bequette, B.W., “Process Control Modeling, Design and Simulation”, Prentice Hall of India, 2004.
2. Stephanopoulos, G., “Chemical Process Control - An Introduction to Theory and Practice”, Prentice Hall of India, 2005.
3. Seborg, D.E., Edgar, T.F. and Mellichamp, D.A., “Process Dynamics and Control”, Wiley John and Sons, 2nd Edition, 2003.
4. Coughanowr, D.R., “Process Systems Analysis and Control”, McGraw - Hill International Edition, 2004.</td></tr>
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<tr><td colspan="2">Department : Electronics and Instrumentation Engineering</td><td colspan="7">Programme : M.Tech. (Instrumentation Engineering)</td></tr>
<tr><td colspan="2">Semester : One</td><td colspan="7">Category : TY</td></tr>
<tr><td rowspan="2">Subject Code</td><td rowspan="2">Subject</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>EI153</td><td>Applied Industrial Instrumentation</td><td>4</td><td>0</td><td>-</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Objectives</td><td colspan="8">• 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.</td></tr>
<tr><td>Outcomes</td><td colspan="8">• 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.</td></tr>
<tr><td>UNIT – I</td><td colspan="3">Introduction</td><td colspan="5">Hours: 12</td></tr>
<tr><td colspan="9">Measurement of Force, Torque, Velocity, Acceleration, Pressure, Temperature, Flow, Level, Viscosity, Humidity & Moisture (Qualitative Treatment Only).</td></tr>
<tr><td>UNIT – II</td><td colspan="3">Measurement in Thermal Power Plant</td><td colspan="5">Hours: 12</td></tr>
<tr><td colspan="9">Selection, Installation and maintenance of Instruments used for the measurement of fuel flow, Air flow, Drum level, Steam pressure, Steam temperature and other parameters in thermal power plant – Analyzers-Dissolved Oxygen Analyzers- Flue gas Oxygen Analyzers-pH measurement- Coal/Oil Analyzer – Pollution Controlling Instruments.</td></tr>
<tr><td>UNIT – III</td><td colspan="3">Measurement in Petrochemical Industry</td><td colspan="5">Hours: 12</td></tr>
<tr><td colspan="9">Parameters to be measured in refinery and petrochemical industry-Temperature, Flow and Pressure measurements in Pyrolysis, catalytic cracking, reforming processes-Selection and maintenance of measuring instruments – Intrinsic safety.</td></tr>
<tr><td>UNIT – IV</td><td colspan="3">Instrumentation for Energy Conservation & Management and Safety</td><td colspan="5">Hours: 12</td></tr>
<tr><td colspan="9">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.</td></tr>
<tr><td>UNIT – V</td><td colspan="3">Special Purpose Instrumentation</td><td colspan="5">Hours: 12</td></tr>
<tr><td colspan="9">Toxic gas monitoring- Detection of Nuclear radiation – Water quality monitoring-Monitor measurement by neutron-Thermo-luminescent detectors – Measurement of length, mass, thickness, flow, level using nuclear radiation.</td></tr>
<tr><td colspan="2">Total contact Hours: 60</td><td colspan="2">Total Tutorials: -</td><td colspan="3">Total Practical Classes: -</td><td colspan="2">Total Hours: 60</td></tr>
<tr><td colspan="9">Reference books:</td></tr>
<tr><td colspan="9">1. D.Patranabis, Principles of Industrial Instrumentation, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1999.
2. John G Webster, Measurement, Instrumentation and Sensors Handbook, CRC press IEEE press
3. Liptak B.G, Instrumentation Engineers Handbook (Measurement), Chilton Book Co., 1994.
4. Reay D.A, Industrial Energy Conservation, Pergamon Press,1977.
5. Hodge B.K, Analysis and Design of energy systems, Prentice Hall, (1988).</td></tr>
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Department : Electronics and Instrumentation Engineering		**Programme :** M.Tech. (Instrumentation Engineering)						
Semester : One		**Category : LB**						
Subject Code	**Subject**	**Hours / Week**			**Credit**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**
EI154	Process Control and Instrumentation Laboratory	-	-	3		60	40	100

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
14. Design, testing and calibration of programmable Timers.
15. Design and testing of advanced measurement circuits.

Total contact Hours: -	**Total Tutorials: -**	**Total Practical Classes: 45**	**Total Hours: 45**

<table>
<tr><td colspan="2">Department : Electronics and Instrumentation Engineering</td><td colspan="7">Programme : M.Tech. (Instrumentation Engineering)</td></tr>
<tr><td colspan="2">Semester : Two</td><td colspan="7">Category : TY</td></tr>
<tr><td rowspan="2">Subject Code</td><td rowspan="2">Subject</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>EI155</td><td>Real Time Embedded System Design</td><td>4</td><td>0</td><td>-</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Objectives</td><td colspan="8">• 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.</td></tr>
<tr><td>Outcomes</td><td colspan="8">• 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.</td></tr>
<tr><td>UNIT – I</td><td colspan="2">Review of Embedded Systems</td><td colspan="6">Hours: 12</td></tr>
<tr><td colspan="9">Review of Embedded Systems – Role of Microcontrollers in Embedded System design – Features of Microcontrollers –Processor Selection criteria –Word length – Performance Issues - Power consumption – Package Types – Electrical requirements – Reset Hardware – oscillator Design – power Consideration -Development Tools – Firmware Development options – Assembly Language Vs High level Language Programming- Intel Hex File Format.</td></tr>
<tr><td>UNIT – II</td><td colspan="2">Introduction to LPC2148 MCU</td><td colspan="6">Hours: 12</td></tr>
<tr><td colspan="9">ARM 7 Architecture – LPC2148 microcontroller introduction – Internal memory map - Peripheral details – Implementation of GPIO, Timer/Counter, UART, Interrupt architecture – ADC and DAC - Firmware development using Embedded ‘C’ – introduction to data types – conditional statements – loops – simple programs using embedded ‘C’.</td></tr>
<tr><td>UNIT – III</td><td colspan="2">System Design Using LPC2148 MCU</td><td colspan="6">Hours: 12</td></tr>
<tr><td colspan="9">Design of Simple I/O systems, Current source and sink concepts - Interfacing Character and Graphical LCD Displays – DC Motor Speed Control System – Speed Measurement – Design of Digital Frequency meter - Interfacing SD cards and touch screens–PC based Control systems</td></tr>
<tr><td>UNIT – IV</td><td colspan="2">Real Time Operating System</td><td colspan="6">Hours: 12</td></tr>
<tr><td colspan="9">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.</td></tr>
<tr><td>UNIT – V</td><td colspan="2">Case Studies</td><td colspan="6">Hours: 12</td></tr>
<tr><td colspan="9">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.</td></tr>
<tr><td colspan="2">Total contact Hours: 60</td><td colspan="3">Total Tutorials: -</td><td colspan="2">Total Practical Classes: -</td><td colspan="2">Total Hours: 60</td></tr>
<tr><td colspan="9">Reference books:</td></tr>
<tr><td colspan="9">1. David E Simon, " An embedded software primer ", Pearson education Asia, 2001.
2. Trevor Martin,”The Insider's Guide to the Philips ARM7-Based Microcontrollers”,Hitex Pubications(UK),2005.
3. Michael J Pont,"Patterns for Time-Triggered Embedded Systems",Addison-Wesley Professional,2001.
4. Phillip A. Laplante, “Real-Time Systems Design and Analysis: An Engineer's Handbook”, Wiley Publications, 2004.
5. Raymond J.A.Buhr Donaid L. Balley, “An introduction to real time Embedded Systems”, Prentice Hall International, 1999.</td></tr>
</table>

Department : Electronics and Instrumentation Engineering		**Programme :** M.Tech. (Instrumentation Engineering)						
Semester : Two		**Category :** TCM						
Subject Code	**Subject**	**Hours / Week**			**Credit**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**
EI156	Instrumentation System Design	3	-	2	4	50	50	100

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- 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:

1. C. D. Johnson, “Process Control Instrumentation Technology”, 8th Edition, Prentice Hall, 2006.
2. Control Valve Handbook, 4th Edition, Emerson Process Management, Fisher Controls International, 2005.
3. R.W. Miller, “Flow Measurement Engineering Handbook”, Mc-Graw Hill, New York, 1996.

Department : Electronics and Instrumentation Engineering			**Programme :** M.Tech. (Instrumentation Engineering)						
Semester : Two			**Category : LB**						
Subject Code	**Subject**		**Hours / Week**			**Credit**	**Maximum Marks**		
			L	**T**	**P**	**C**	**CA**	**SE**	**TM**
EI157	Embedded Systems and Industrial Automation Laboratory		-	-	3	2	60	40	100

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 4^{th} 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**

Department : Electronics and Instrumentation Engineering		**Programme :** M.Tech. (Instrumentation Engineering)						
**Semester : ** Two		**Category : ** PR						
Subject code	**Subject**	**Hours/week**			**Credit**	**Maximum marks**		
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**
EI158	Research Methodology	-	-	3	1	100	-	100
Prerequisite	-							
Objectives	• To educate students to methods of selection of research problems • To expose students to different research methods							
Outcomes	• 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.							

- **Definition of research:** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Definition and Dimension of a Theory, Functions and Characteristics; Types of Theory: General Theory and Particular/ Empirical Theory. Cases and their Limitations; Causal Relations. Philosophy and validity of research. Objective of research.
- **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.
- **Outcome of research:** Significance of report writing – Layouts of the research report – Types of reports – Oral presentation – Mechanics of writing research report – Precautions for writing research reports – Plagiarism and copy right violation – Patent writing and filing.

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
2. Kothari, C.R., Research Methodology-Methods and Techniques, Wiley Eastern Limited, New Delhi, 1985.
3. Kumar, Ranjit, Research Methodology, A Step-by-Step Guide for Beginners, (2nd Ed.), Pearson Education, Singapore, 2005.

Department : Electronics and Instrumentation Engineering		**Programme :** M.Tech. (Instrumentation Engineering)						
**Semester : ** Three		**Category : ** PR						
Subject code	**Subject**	**Hours/week**			**Credit**	**Maximum marks**		
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**
EI159	Project work (Phase I)	-	-	-	9	150	150	300
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).

Department : Electronics and Instrumentation Engineering		Programme : M.Tech. (Instrumentation Engineering)						
Semester : Four		**Category : PR**						
Subject code	**Subject**	**Hours/week**			**Credit**	**Maximum marks**		
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**
EI160	Project work (Phase II)	-	-	-	14	200	200	400
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.

<table>
<tr><td colspan="2">Department : Electronics and Instrumentation Engineering</td><td colspan="7">Programme : M.Tech. (Instrumentation Engineering)</td></tr>
<tr><td colspan="2">Semester :</td><td colspan="7">Category : TY</td></tr>
<tr><td rowspan="2">Subject Code</td><td rowspan="2">Subject</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>EIE51</td><td>Thermal Power Plant Instrumentation</td><td>4</td><td>0</td><td>-</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Objectives</td><td colspan="8">• 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</td></tr>
<tr><td>Outcomes</td><td colspan="8">• The students get well versed with all power generation plants.
• Students also get thorough knowledge of Instrumentation and control techniques involved in power plants</td></tr>
<tr><td>UNIT – I</td><td colspan="4">Basics of Thermal Power Plant</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="9">Process of power generation in coal – fired and oil-fired thermal power plants- Types of Boilers- Combustion process – Superheater – Turbine – Importance of Instrumentation in thermal power plants.</td></tr>
<tr><td>UNIT – II</td><td colspan="4">Boiler Control</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="9">Combustion control-Air/fuel ratio control-furnace draft control –Drum level control – Steam temperature Control – Attemperator – DCS in power plant – Interlocks in Boiler operation.</td></tr>
<tr><td>UNIT – III</td><td colspan="4">Turbine Monitoring and Control</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="9">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.</td></tr>
<tr><td>UNIT – IV</td><td colspan="4">Boiler Modeling and Advanced Control</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="9">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.</td></tr>
<tr><td>UNIT – V</td><td colspan="4">Optimization of Thermal Power Plant Operation</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="9">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</td></tr>
<tr><td colspan="2">Total contact Hours: 60</td><td colspan="2">Total Tutorials: --</td><td colspan="3">Total Practical Classes: -</td><td colspan="2">Total Hours: 60</td></tr>
<tr><td colspan="9">Reference books:</td></tr>
<tr><td colspan="9">1. Sam G. Duke low -The Control of Boiler, ISA press, 1991.
2. A.B.Gill –Power Plant performance, Elsevier India, New Delhi,2003.
3. S.M.Elonko and A.L.Kohal –Standard Boiler Operations, McGraw Hill, New Delhi, 1994.
4. R.K.Jain -Mechanical and Industrial Measurements, Khanna publishers, New Delhi, 1995.</td></tr>
</table>

Department : Electronics and Instrumentation Engineering			**Programme :** M.Tech. (Instrumentation Engineering)					
Semester :			**Category : TY**					
Subject Code	**Subject**	**Hours / Week**			**Credit**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**
EIE52	Systems Theory	3	1	-	4	40	60	100

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**

Review of state model for systems – State transition matrix and its properties – free and forced responses – controllability and observability – Kalman decomposition – minimal realization – balanced realization.

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

State Feedback – Output Feedback – Pole placement technique – Full order and Reduced Order Observers – Deadbeat Observers – Dead beat Control.

UNIT – IV **Non-Linear Systems** **Hours: 12**

Types of Non-Linearity – Typical Examples – Phase plane analysis (analytical and graphical methods) – Limit cycles – Equivalent Linearization – Describing Function Analysis, Derivation of Describing Functions for different non-linear elements.

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

Stability concepts – Equilibrium points – BIBO and Asymptotic stability – Stability Analysis by DF method – Lyapnov Stability Criteria – Krasovskil's method – Variable Gradient Method – Popov's Stability Criterion.

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

Reference books:

1. M.Gopal, "Modern Control System Theory", Wiley Eastern Limited, 2nd edition, 1996.
2. K.Ogata, "Modern Control Engineering", PHI, 3rd Edition, 1997.
3. M.Gopal, "Control System Principles and Design", 2nd Edition, 2002.
4. W. L. Luyben, "Process Modeling, simulation and control for Chemical Engineers", 2nd edition, McGraw Hill.
5. D.P.Atherton, "Stability of non linear systems", Prentice Hall, 1986.

Department : Electronics and Instrumentation Engineering		**Programme :** M.Tech. (Instrumentation Engineering)						
Semester :		**Category : TY**						
Subject Code	**Subject**	**Hours / Week**			**Credit**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**
EIE53	Applied Biomedical Instrumentation	4	0	-	4	40	60	100
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), Electroencephalograhy(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 – Microfabriation 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:								

1. John G.Webster (editor), Bioinstrumentation, John Wiley & Sons, 2004.
2. Shayne Cox Gad, Safety Evaluation of Medical Devices, Marcel Deckle Inc, 2002.
3. Michael C. K. Khoo, Physiological Control Systems- Analysis Simulation and Estimation, 2001.
4. Cromwell l., Biomedical Instrumentation and Measurements, Prentice Hall of India, 1995.
5. Rangaraj M.Rangayan, Biomedical signal analysis, John Wiley & Sons (ASIA) Pvt. Ltd.,

<table>
<tr><td colspan="2">Department : Electronics and Instrumentation Engineering</td><td colspan="7">Programme : M.Tech. (Instrumentation Engineering)</td></tr>
<tr><td colspan="2">Semester :</td><td colspan="7">Category : TY</td></tr>
<tr><td rowspan="2">Subject Code</td><td rowspan="2">Subject</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>EIE54</td><td>Cryptography and Network Security</td><td>4</td><td>0</td><td>-</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Objectives</td><td colspan="8">• To introduce information security and Cryptography to students.
• Implementation of Cryptography using diverse algorithms.</td></tr>
<tr><td>Outcome</td><td colspan="8">• Students would learn the basic principles of cryptography.
• Usage of private and public keys in cryptography.
• Understanding Cryptography in wireless systems.
• Learning of Firewalls.</td></tr>
<tr><td>UNIT – I</td><td colspan="6">Introduction and Number Theory</td><td colspan="2">Hours: 12</td></tr>
<tr><td colspan="9">Classic Cipher Techniques – Substitution Ciphers, Mono-alphabetic Substitution and Poly-alphabetic Substitution – Transposition Ciphers. Number Theory and Finite Arithmetic, Counting in Modulus ρ Arithmetic, Congruence Arithmetic, Fermat’s Theorem and Euler’s Theorem- Exponentiation.</td></tr>
<tr><td>UNIT – II</td><td colspan="6">Single and Public Key Ciphers</td><td colspan="2">Hours: 12</td></tr>
<tr><td colspan="9">DES - 3DES – AES – RSA Algorithm, ElGamal Algorithm – Key Management using Exponential Ciphers - Diffie-Hellman.</td></tr>
<tr><td>UNIT – III</td><td colspan="6">Message Authentication, Digital Signatures and Certificates</td><td colspan="2">Hours: 12</td></tr>
<tr><td colspan="9">Security Services and Mechanisms – Message Authentication (Integrity) – MAC – Hash Functions – Digital Signature: Digital Signature Standards (FIPS 186-2), DSA (ANSI X9.30), RSA (ANSI X9.31) – RSA Certification –PKI Certificates.</td></tr>
<tr><td>UNIT – IV</td><td colspan="6">Trusted Identity and Wireless Security</td><td colspan="2">Hours: 12</td></tr>
<tr><td colspan="9">Security Concerns – Password System: Fixed and One time Passwords (S/Key) RFC 2289 – Callback Systems, Challenge and Response Systems – RADIUS – Kerberos v4 & v5 – Needham Schroeder Protocol – ITU-T X.509 – Authentication: Framework, Simple, Protected, Strong – PKI Life Cycle Management - Current Wireless Technology - Wireless Security WEP Issues.</td></tr>
<tr><td>UNIT – V</td><td colspan="6">Protocols and Firewalls</td><td colspan="2">Hours: 12</td></tr>
<tr><td colspan="9">SSL/TLS - SSH - IPSec – Firewall Concepts, Architecture, Packet Filtering, Proxy Services and Bastion Hosts – Electronic Mail Security – PGP, S/MIME.</td></tr>
<tr><td colspan="2">Total contact Hours: 60</td><td colspan="2">Total Tutorials: -</td><td colspan="3">Total Practical Classes: -</td><td colspan="2">Total Hours: 60</td></tr>
<tr><td colspan="9">Reference books:</td></tr>
<tr><td colspan="9">1. Cryptography and Network Security: Principles and Practice”, William Stallings, 3rd Edition, Pearson Education, 2002.
2. “Network Security Essentials: Applications and Standards”, William Stallings, 2nd Edition, Pearson Education, 2000.
3. “Cryptography and Network Security”, Behrouz A.Forouzan, special edition, Tata McGraw Hill, 2007.
4. “Applied Cryptography”, Bruce Scheneier, John Wiley & Sons, 1994.</td></tr>
</table>

Department : Electronics and Instrumentation Engineering		**Programme :** M.Tech. (Instrumentation Engineering)						
Semester :		**Category :** TY						
Subject Code	**Subject**	**Hours / Week**			**Credit**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**
EIE55	Industrial Data Networks	4	0	-	4	40	60	100
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**	**Hours: 12**

EIA 232 interface standard – EIA 485 interface standard – EIA 422 interface standard – Serial interface converters - ISO/OSI Reference model – Data link control protocol – Media access protocol:-Command/response, Token passing and CSMA/CD - TCP/IP – Bridges – Routers – Gateways –Standard ETHERNET Configuration.

UNIT – II	**PLC, PLC Programming & SCADA**	**Hours: 12**

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**	**Hours: 12**

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. Introduction- Evolution of signal standard – HART communication protocol – Communication modes – HART Networks – HART commands – HART applications – MODBUS protocol structure – Function codes– Troubleshooting

UNIT – IV	**Profibus and FF**	**Hours: 12**

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**	**Hours: 12**

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).

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

Reference books:

1. Hughes, T., “Programmable Logic Controllers”, ISA Press, 2000.
2. Petrezeulla, “Programmable Controllers”, McGraw-Hill, 2004.
3. Buchanan, W., “Computer Busses”, CRC Press, 2000.
4. Lucas, M.P., “Distributed Control System”, Van Nastrand Reinhold Company, New York, 1986
5. Bowden, R., “HART Application Guide”, HART Communication Foundation, 1999.
6. Mc-Millan, G.K., “Process/Industrial Instrument and Controls Handbook”, McGraw-Hill, NewYork, 1999.

Department : Electronics and Instrumentation Engineering		**Programme :** M.Tech. (Instrumentation Engineering)						
Semester :		**Category** : TY						
Subject Code	**Subject**	**Hours / Week**			**Credit**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**
EIE56	Applied Soft Computing	4	0	-	4	40	60	100
Prerequisite	-							
Objectives	• 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.							
Outcome	• The students will be able to understand the applications of neural network and fuzzy logic in the area of control systems							

UNIT – I **Artificial Neural Networks** **Hours: 12**

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

UNIT – II **Neural Networks for Modeling and Control** **Hours: 12**

Modeling of non-linear systems using ANN- generation of training data – optimal architecture – model validation – control of non- linear systems using ANN – direct and indirect neuro control schemes – adaptive neuro controller – familiarization with neural network toolbox

UNIT – III **Fuzzy Set Theory** **Hours: 12**

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

UNIT – IV **Fuzzy Logic for Modeling and Control** **Hours: 12**

Modeling of non linear systems using fuzzy models – TSK model – fuzzy logic controller- fuzzification – knowledge base- decision making logic – defuzzification – adaptive fuzzy systems – Familiarization with fuzzy logic toolbox

UNIT – V **Hybrid Control Schemes** **Hours: 12**

Fuzzification and rule base using ANN – Neuro fuzzy systems ANFIS – Fuzzy neuron – Introduction to GA – Optimization of membership function and rule base using Genetic algorithm – Introduction to support vector machine – particle swarm optimization – case study familiarization with ANFIS toolbox

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

Reference books:

1. Laurene V.Fausett, Fundamentals of Neural Networks, Architecture, Algorithms, and Applications, Pearson Education, 2008.
2. Timothy J.Ross, Fuzzy Logic with Engineering Applications, Wiley, Third Edition, 2010.
3. David E.Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning,Pearson Education, 2009
4. George J.Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall, First Edition, 1995.
5. W.T.Miller, R.S.Sutton and P.J.Webrose, Neural Networks for Control, MIT Press, 1996.
6. C.Cortes and V.Vapnik, Support-Vector Networks, Machine Learning, 1995.

Department : Electronics and Instrumentation Engineering		**Programme :** M.Tech. (Instrumentation Engineering)						
Semester :		**Category** : TY						
Subject Code	**Subject**	**Hours / Week**			**Credit**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**
EIE57	VLSI System Design	4	0	-	4	40	60	100
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:								

1. J. Bhasker ,VHDL Primer, Prentice Hall, 2006.
2. Chip Design for Submicron VLSI: CMOS Layout & Simulation, - John P.Uyemura, Thomson Learning, 2006.
3. Introduction to VLSI Circuits and Systems - John .P. Uyemura, JohnWiley, 2003.
4. Digital Integrated Circuits - John M. Rabaey, PHI, EEE, 1997.
5. Modern VLSI Design - Wayne Wolf, Pearson Education, 3rd Edition, 1997.

Department : Electronics and Instrumentation Engineering		**Programme :** M.Tech. (Instrumentation Engineering)						
Semester :		**Category : TY**						
Subject Code	**Subject**	**Hours / Week**			**Credit**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**
EIE58	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 process							
Outcome	• The student will be able to design an optimal control for the given process							
UNIT – I	**Introduction**					**Hours: 12**		
The performance measure and Linear Optimal Control, Standard regulator problem, The Hamilton-Jacobi-Bellman equation, Finite-time horizon problems, Regulators with a prescribed degree of stability, Asymptotic properties and quadratic weight selection.								
UNIT – II	**Dynamic Programming**					**Hours: 12**		
Principle of optimality - Recurrence relation of Dynamic programming, Computational procedure, The H-J-B equation and analytical results for discrete and continuous linear regulator problems.								
UNIT – III	**The Calculus of Variations**					**Hours: 12**		
Fundamental concepts, Functionals of a single function and functionals involving several independent functions, Piecewise smooth extremals, Constrained extrema, Necessary condition for optimal control, Liregulator problems.								
UNIT – IV	**The Minimum (Maximum) Principle**					**Hours: 12**		
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**					**Hours: 12**		
Optimal control in selected applications – distillation column, boiler and paper manufacturing plant.								
Total contact Hours: 60		**Total Tutorials: -**		**Total Practical Classes: -**		**Total Hours: 60**		

Reference books:

1. Donald Kirk, Optimal Control Theory, Prentice Hall, 1970.
2. B.D.O.Anderson and J.B.Moore, Optimal Control: Linear Quadratic Methods, Prentice Hall, 2007.
3. T.Basar and G.J.Olsder, Dynamic Noncorperative Game Theory, SIAM classics in Applied mathematics, 1999.
4. Andrew P.Sage and Chelsea C.White, Optimum Systems Control, 2nd edition, Prentice Hall, 1977.
5. D.P.Bertsekas, Dynamic Programming and Optimal Control,Vol.I, 2nd edition, Athena Scientific, 2000.
6. M.Athans and P.L.Falb, Optimal Control, McGraw Hill, 1966.
7. A.E.Bryson and Y.C.Ho, Applied Optimal Control, 2nd edition, Blaisdel, 1975.
8. L.B.Lee and L.Markus, Foundations of Optimal Control Theory, Wiley, 1967.

Department : Electronics and Instrumentation Engineering		**Programme :** M.Tech. (Instrumentation Engineering)						
Semester :		**Category : TY**						
Subject Code	**Subject**	**Hours / Week**			**Credit**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**
EIE59	Robust Control	4	0	-	4	40	60	100

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**

Design of robust control system –root locus method-frequency response method-ITAE method –robust IMC system –Pseudo-quantitative feedback theory based robust controller.

UNIT – IV **Hours: 12**

Robust control design using $H\infty$ methods – $H\infty$ 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:

1. S.P.Bhattacharyya, H.Chapellat and L.H.Keel, Robust Control (The Parametric approach), Prentice Hall, New Jersy, 1995.
2. J.Ackerman, Robust control systems with uncertain physical parameters, Springer –Verlag, London, 1993.
3. L.R.Petersen, V.A.Ugrinovskii and A.V.Savkin, Robust control design using $h\infty$ methods, Springer –London, 1993.
4. R.C.Dorf and R.H.Bishop, Modern Control Systems, Addison- Wesley, Delhi, 1999.

Department : Electronics and Instrumentation Engineering			**Programme :** M.Tech. (Instrumentation Engineering)						
Semester :			**Category :** TY						
Subject Code	**Subject**	**Hours / Week**			**Credit**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**
EIE60	Robotics and Automation	4	0	-	4	40	60	100
Prerequisite	---							

Objectives

- 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

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** | **Hours: 12**

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** | **Hours: 12**

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** | **Hours: 12**

The control problem-state equation-Single axis PID control-PD gravity control-Computed torque control-Variable Structure control-Impedance control

UNIT – IV | **Robot Vision & Micro Robotics** | **Hours: 12**

Fundamentals of Robot applications-Robot vision –Image representation-Template-matching-polyhedral objects-Shape analysis- Segmentation – Iterative processing - Robot cell design-Types of applications-material handling applications-Machine loading and unloading-spot welding-arc welding-spray painting-Micro Robotics and MEMS-Fabrication technology for micro robotics, Stability issues in legged robots, under actuated manipulators

UNIT – V | **Mobile Robots and Control Issues** | **Hours: 12**

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:

1. Koren, "Robotics for Engineers", McGraw Hill International Company. Tokyo 1995.
2. Vokotravotic, "Introduction to Robotics", Springer, 1985.
3. K.S.Fu, R.C.Gonzally, C.S.G. Lee , " Robotics Control, Sensing, Vision and Intelligent" , Mcgraw Hill Book Company,1997.
4. Robort J.Schilling, "Fundamentals of robotics- Analysis and Control, Prentice Hall of India Pvt. Ltd., 2002.
5. 5. Saeed B.Nniku, "Introduction to robotics- Analysis, Systems, Application" Prentice Hall of India Pvt. Ltd., 2003

Department : Electronics and Instrumentation Engineering			**Programme :** M.Tech. (Instrumentation Engineering)						
Semester :			**Category : TY**						
Subject Code	**Subject**		**Hours / Week**			**Credit**	**Maximum Marks**		
			L	**T**	**P**	**C**	**CA**	**SE**	**TM**
EIE61	System Identification		3	1	-	4	40	60	100
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**						
Least square estimation – best linear unbiased estimation under linear constraints – updating the parameter estimates for linear regression models – prediction error methods: description of prediction methods – optimal prediction – relation between prediction error methods and other identification methods – theoretical analysis - Instrumental variable methods: Description of instrumental variable methods – Input signal design for identification									
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**						
Identification of systems operating in closed loop: Identifiability considerations – direct identification – indirect identification – joint input / output identification - Subspace methods for estimating state space models.									
UNIT – V	**Practical Aspects of Identification**		**Hours: 12**						
Practical aspects: experimental conditions – drifts and de-trending – outliers and missing data – pre-filtering - robustness – Model validation and Model structure determination-case studies – Introduction to Nonlinear System Identification- Introduction to Control relevant System Identification.									
Total contact Hours: 45		**Total Tutorials: -15**		**Total Practical Classes: -**			**Total Hours: 60**		
Reference books:									

1. Soderstorm T and Peter Stoica, System Identification, Prentice Hall International, 1989.
2. Ljung L, System Identification: Theory for the user, Prentice Hall, Englewood Cliffs, 1987.
3. E. Ikonen and K. Najim, " Advanced Process Identification and Control", Marcel Dekker, Inc. Newyork, 2002.

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

Subject Code	Subject	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
EIE62	Advanced Operating Systems	4	0	-	4	40	60	100

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.

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, Failure Resilient processes

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

Reference books:

1. Andrew S. Tanenbaum, "Distributed Operating Systems", Pearson Education Asia, 1995.
2. Mukesh singhal and Niranjan G. Shivarathri, "Advanced Concepts in Operating Systems", Tata McGraw Hill, 1994..
3. Silberschatz, Galvin, "Operating System Concepts", John Wiley, 2003.
4. Stallings, "Operating system", PHI, New Delhi, 2004.

<table>
<tr><td colspan="2">Department : Electronics and Instrumentation Engineering</td><td colspan="7">Programme : M.Tech. (Instrumentation Engineering)</td></tr>
<tr><td colspan="2">Semester :</td><td colspan="7">Category : TY</td></tr>
<tr><td rowspan="2">Subject Code</td><td rowspan="2">Subject</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>EIE63</td><td>Advanced Process Control</td><td>4</td><td>0</td><td>-</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite</td><td colspan="8">Process control</td></tr>
<tr><td>Objectives</td><td colspan="8">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</td></tr>
<tr><td>Outcomes</td><td colspan="8">On completion students will be able
To design controllers for MIMO processes
Can understand behavior of nonlinear systems</td></tr>
<tr><td>UNIT – I</td><td colspan="4">Multivariable Systems</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="9">Multivariable Systems – Transfer Matrix Representation – State Space Representation – Poles and Zeros of MIMO System - Multivariable frequency response analysis - Directions in multivariable systems - Singular value decomposition</td></tr>
<tr><td>UNIT – II</td><td colspan="4">Multi-Loop Regulatory Control</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="9">Multi-loop Control - Introduction – Process Interaction – Pairing of Inputs and Outputs - The Relative Gain Array (RGA) – Properties and Application of RGA - Multi-loop PID Controller – Biggest Log Modulus Tuning Method - Decoupling Control – LQG Control – RGA for Non-square Plant.</td></tr>
<tr><td>UNIT – III</td><td colspan="4">Multivariable Regulatory Control</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="9">Introduction to Multivariable control –Multivariable PID Controller -Multivariable IMC– Multivariable Dynamic Matrix Controller -Multivariable Model Predictive Control – Generalized Predictive Controller – Multiple Model based Predictive Controller – Constrained Model Predictive Controller - Implementation Issues.</td></tr>
<tr><td>UNIT – IV</td><td colspan="4">Control of Time-Varying and Nonlinear Systems</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="9">Models for Time-varying and Nonlinear systems – Input signal design for Identification – Real-time parameter estimation - Types of Adaptive Control - Gain scheduling – Adaptive Control - Deterministic Self-tuning Controller and Model Reference Adaptive Controller– Nonlinear PID Controller - Control of Hammerstein and Wiener Systems.</td></tr>
<tr><td>UNIT – V</td><td colspan="4">Case –Studies</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="9">Control Schemes for Distillation Column, CSTR, Bioreactor, Three-tank hybrid system, Four-tank system, pH, and polymerization reactor.</td></tr>
<tr><td colspan="2">Total contact Hours: 60</td><td colspan="2">Total Tutorials:</td><td colspan="3">Total Practical Classes: -</td><td colspan="2">Total Hours: 60</td></tr>
<tr><td colspan="9">Reference books:</td></tr>
<tr><td colspan="9">Bequette, B.W., “Process Control Modeling, Design and Simulation”, Prentice Hall of India, 2004.
Stephanopoulos, G., “Chemical Process Control - An Introduction to Theory and Practice”, Prentice Hall of India, 2005.
Seborg, D.E., Edgar, T.F. and Mellichamp, D.A., “Process Dynamics and Control”, Wiley John and Sons, 2nd Edition, 2003.
Coughanowr, D.R., “Process Systems Analysis and Control”, McGraw -Hill nternational Edition, 2004.
E. Ikonen and K. Najim, “ Advanced Process Identification and Control”, Marcel Dekker, Inc. Newyork, 2002
P. Albertos and S. Antonio, “ Multivariable Control Systems An Engineering Approach”, Springer Verlag, 2004 .</td></tr>
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Department : Electronics and Instrumentation Engineering		**Programme :** M.Tech. (Instrumentation Engineering)							
Semester :		**Category** : TY							
Subject Code	**Subject**	**Hours / Week**			**Credit**	**Maximum Marks**			
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**	
EIE64	State Estimation	4	0	-	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**				
Review of Matrix Algebra and Matrix Calculus and Probability Theory – Least Square Estimation – Review of state observers for Deterministic System- Derivation of the Discrete – time Kalman filter – Kalman filter properties- Kalman filter generalization - Correlated Process and Measurement Noise – Case Studies.									
UNIT – II	**Extended Kalman Filter**				**Hours: 12**				
Linearized Kalman filter – Extended Kalman filter – The iterated Extended Kalman filter – The Second order Extended Kalman filter – Constrained Extended Kalman filter- Case Studies									
UNIT – III	**Unscented Kalman Filter**				**Hours: 12**				
Means and Covariance of non-linear transformations – Unscented transformation – Unscented Kalman filtering - General - Unscented transformation - The simplex Unscented transformation – Spherical Unscented transformation - Constrained Unscented Kalman filter – Case Studies.									
UNIT – IV	**The H-Infinity Filter**				**Hours: 12**				
The H- infinity filter-Introduction - Kalman filter Limitations - A game theory Approach to H- infinity filtering – Steady state H- infinity Filtering -Mixed Kalman / H- Infinity filtering - Robust Kalman / H- infinity filtering - Constrained H-infinity filtering – Case Studies.									
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:									
1. Branko Ristic, Sanjeev Arulampalam, Neil Goodon, “Beyond the Kalman Filter: Particle ilters for Tracking Application”, Artech House Publishers, Boston, London, 2004. 2. Dan Simon, “Optimal State Estimation Kalman, H-infinity and Non-linear Approaches”, John Wiley and Sons, 2006.									

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<tr><td rowspan="2">Subject Code</td><td rowspan="2">Subject</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>EIE65</td><td>Advanced Digital Signal Processing</td><td>4</td><td>0</td><td>-</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite</td><td colspan="8">Digital Signal Processing</td></tr>
<tr><td>Objective</td><td colspan="8">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</td></tr>
<tr><td>Outcome</td><td colspan="8">Students will have an understanding in analysis of signals and systems using advanced techniques in digital signal processing</td></tr>
<tr><td>UNIT – I</td><td colspan="5">Random Signal Processing and Spectrum Estimation</td><td colspan="3">Hours: 12</td></tr>
<tr><td colspan="9">Discrete Random Processes, Expectations, Variance, Parseval's Theorem, Wiener Khintchine Relation - Power Spectral Density - Periodogram – Sample Autocorrelation - Sum Decomposition Theorem, Spectral Factorization Theorem
Non-Parametric Methods-Correlation Method - Co-Variance Estimator - Consistent Estimators-Periodogram Estimator-Barlett Spectrum Estimation-Welch Estimation-Model based Approach - AR, MA, ARMA signal Modeling-Parameter Estimation using Yule-Walker Method</td></tr>
<tr><td>UNIT – II</td><td colspan="5">Linear Estimation and Prediction</td><td colspan="3">Hours: 12</td></tr>
<tr><td colspan="9">Maximum likelihood criterion-efficiency of estimator-Least mean squared error criterion - Wiener filter-DiscreteWiener Hoff equations-Recursive estimators-Kalman filter-Linear prediction, prediction error-whitening filter, inverse filter-Levinson recursion, Lattice realization, and Levinson recursion algorithm for solving Toeplitz system of equations</td></tr>
<tr><td>UNIT – III</td><td colspan="5">Adaptive Filters</td><td colspan="3">Hours: 12</td></tr>
<tr><td colspan="9">FIR adaptive filters-Newton's steepest descent method - adaptive filter based on steepest descent method-Widrow Hoff LMS adaptive algorithm- Adaptive channel equalization-Adaptive echo chancellor-Adaptive noise cancellation-RLS adaptive filters-Exponentially weighted RLS-sliding window RLS-Simplified IIR LMS adaptive filter.</td></tr>
<tr><td>UNIT – IV</td><td colspan="5">Multirate Digital Signal Processing</td><td colspan="3">Hours: 12</td></tr>
<tr><td colspan="9">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.</td></tr>
<tr><td>UNIT – V</td><td colspan="5">Wavelet Transforms</td><td colspan="3">Hours: 12</td></tr>
<tr><td colspan="9">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</td></tr>
<tr><td colspan="2">Total contact Hours: 60</td><td colspan="2">Total Tutorials: -</td><td colspan="2">Total Practical Classes: -</td><td colspan="3">Total Hours: 60</td></tr>
<tr><td colspan="9">Reference books:</td></tr>
<tr><td colspan="9">Monson H.Hayes, " Statistical Digital Signal Processing and Modeling ", John Wiley and Sons, Inc., New York, 1996.
Sopocles J.Orfanidis, " Optimum Signal Processing ", McGraw Hill, 1990.
John G.Proakis, Dimitris G.Manolakis, " Digital Signal Processing ", Prentice Hall of India, 1995.
Rao, “Wavelet Transforms”, Pearson Education, Asia, 2009</td></tr>
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Semester :		**Category :** TY							
Subject Code	**Subject**	**Hours / Week**			**Credit**	**Maximum Marks**			
		L	**T**	**P**	**C**	**CA**	**SE**	**TM**	
EIE66	Adaptive Control	4	0	-	4	40	60	100	
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**			
Introduction- Adaptive Schemes- The adaptive Control Problem- Applications- Real-time parameter estimation - Least squares and regression methods- Estimating parameters in dynamical systems.									
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**			
Introduction – Design of minimum variance controller - Design of moving average controller - stochastic self-tuning regulators.									
UNIT – V	**Model – Reference Adaptive System**					**Hours: 12**			
Introduction- MIT rule – Determination of adaptation gain - Lyapunov theory –Design of MRAS using Lyapunov theory – Relations between MRAS and STR.									
Total contact Hours: 60		**Total Tutorials: -**		**Total Practical Classes: -**		**Total Hours: 60**			
Reference books:									

1. K.J. Astrom and B. J. Wittenmark, “Adaptive Control”, Addison-Wesley Publishing House, 1995.
2. T. Soderstorm and Peter Stoica, “System Identification”, Prentice Hall International, 1989.
3. Ljung L, “System Identification: Theory for the user”, Prentice Hall, Englewood Cliffs, 1987.

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<tr><td rowspan="2">Subject Code</td><td rowspan="2">Subject</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>EIE67</td><td>Process Optimization</td><td>4</td><td>0</td><td>-</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite</td><td colspan="8"></td></tr>
<tr><td>Objectives</td><td colspan="8">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</td></tr>
<tr><td>Outcome</td><td colspan="8">Able to find an optimal solution to any process
Apply optimization theory and methods in control theory</td></tr>
<tr><td>UNIT – I</td><td colspan="5">Mathematical Preliminaries</td><td colspan="3">Hours: 12</td></tr>
<tr><td colspan="9">Vector Spaces, Vector Space Operations, Data Fitting, Eigenvalues and Eigenvectors Convergence in R^n, Calculus on R and R^n,Calculus for a Function of One Variable Calculus for a Function of Several Variables, Convex Analysis, Convex sets, Convex Functions</td></tr>
<tr><td>UNIT – II</td><td colspan="5">One-Dimensional Optimization</td><td colspan="3">Hours: 12</td></tr>
<tr><td colspan="9">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></tr>
<tr><td>UNIT – III</td><td colspan="5">Unconstrained Gradient Based Optimization Methods</td><td colspan="3">Hours: 12</td></tr>
<tr><td colspan="9">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></tr>
<tr><td>UNIT – IV</td><td colspan="5">Linear Programming</td><td colspan="3">Hours: 12</td></tr>
<tr><td colspan="9">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></tr>
<tr><td>UNIT – V</td><td colspan="5">Constrained Optimization Methods and Evolutionary Algorithms</td><td colspan="3">Hours: 12</td></tr>
<tr><td colspan="9">Lagrange Multipliers, Kuhn-Tucker Conditions, Convex optimization, Transformation Methods, Penalty Function Techniques, Method of Multipliers Linearization Methods, Linearly Constrained Problems, Cutting Plane Method, Direction Generation Methods, The Method of Feasible Directions, The Generalized Reduced Gradient Method, case studies.
EVOLUTIONARY ALGORITHMS: Box Complex Method, Box Complex Method, Genetic Algorithm, Case studies.</td></tr>
<tr><td colspan="2">Total contact Hours: 45</td><td colspan="2">Total Tutorials: 15</td><td colspan="3">Total Practical Classes: -</td><td colspan="2">Total Hours: 60</td></tr>
<tr><td colspan="9">Reference books:</td></tr>
<tr><td colspan="9">Mohan C Joshi, Kannan M Moudgalya "Optimization: Theory and practice" Narosa publishing House.
S.S.Rao, "Engineering optimization: Theory and practice", New Age International (P) Limited, 3rd edition, 1998.</td></tr>
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<tr><td colspan="2">Department : Electronics and Instrumentation Engineering</td><td colspan="8">Programme : M.Tech.</td></tr>
<tr><td colspan="2">Elective</td><td colspan="8">Category : TA</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>EIE68</td><td>Micro-Electro Mechanical Systems</td><td>4</td><td>0</td><td>-</td><td>4</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8">-Should know the basics of VLSI fabrication.</td></tr>
<tr><td>Objectives:</td><td colspan="8">• 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.</td></tr>
<tr><td>Outcome:</td><td colspan="8">• 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</td></tr>
<tr><td>UNIT – I</td><td colspan="4">Introduction to MEMS</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="9">Microsystems vs. MEMS - Markets for Microsystems and MEMS, Scaling Principles. MEMS and Microsystems, Miniaturization, Typical products- Micro Sensors, MEMS with micro actuators, Micro-accelerometers and Micro fluidics-micro fabrication.</td></tr>
<tr><td>UNIT – II</td><td colspan="4">MEMS materials Fabrication Methods</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="9">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- Dry etching: Vapour – Plasma / RIE – DRIE- Other processing techniques and materials: LIGA– Lift-off– Chemical Mechanical Polishing (CMP)– Soft Lithography and polymers – Wafer Bonding - Process integration:– Process flows– Commercial surface micromachining– Design rules and Mask making- Sample Process Flows- A Bulk Micro machined Diaphragm Pressure Sensor-A Surface-Micro machined Suspended Filament.</td></tr>
<tr><td>UNIT – III</td><td colspan="4">MEMS mechanics, Modelling, Dynamics, Structures and Electrostatics</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="9">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.</td></tr>
<tr><td>UNIT – IV</td><td colspan="4">Advanced MEMS for Sensing and Actuation</td><td colspan="4">Hours: 12</td></tr>
<tr><td colspan="9">Electromechanical effects: Piezoresistance - Piezoelectricity - Shape memory alloy Thermal effects: Temperature coefficient of resistance - Thermo-electricity – Thermocouples – Micro fluidics: Low Reynolds number fluid flow - Pressure-driven flows - Squeeze film damping - Surface tension and bubbles -Devices: pumps, valves, mixers - Integrated fluidic systems: BioMEMS.</td></tr>
</table>

UNIT – V	Design of Pressure Sensors and Accelerometers	Hours: 12

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.

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

Text Books:

1. Stephen D. Senturia, Microsystems Design , Springer International Edition, 2001.
2. Tai Ran Hsu, MEMS & Micro systems Design and Manufacture, Tata McGraw Hill, New Delhi,

Reference Books:

1. M. Madou, "Fundamentals of Micro Fabrication", 2nd Edition, CRC Press, 2002.
2. Nadim Maluf, An introduction to Micro electro mechanical system design, Artech House, 2000