

Curricula of B.E Degree

Semester V (Third year) Curriculum

Branch/Course: Applied Electronics and Instrumentation Engineering

Sl. No	Type of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1	Professional Core Course	PCC-EI 501	Power & Industrial Electronics	3	0	0	3	100
		PCC-EI 551	Power & Industrial Electronics Laboratory	0	0	2	1	100
2	Professional Core Course	PCC-EI 502	Control Systems	3	0	0	3	100
		PCC-EI 552	Control Systems Laboratory	0	0	2	1	100
3	Professional Core Course	PCC-EI 503	Microprocessors & Microcontrollers	3	0	0	3	100
		PCC-EI 553	Microprocessors & Microcontrollers Laboratory	0	0	2	1	100
4	Professional Elective Course	PEC-EI 511	Professional Elective I	3	0	0	3	100
5	Open Elective Course	OEC-X* 521	Open Elective I	3	0	0	3	100
6	Humanities & Social Sciences including Management Course	HSM-HU 502	Values and Ethics	2	0	0	2	100
7	Humanities and Social Sciences including Management courses	HSM-HU 581	Grooming & Personality Development	0	0	2	1	100
Total:							21	1000

* X refers to offering codes such as M/EE/HU/ME/EC/EI/CSE

Semester VI (Third Year) Curriculum

Branch/Course: Applied Electronics and Instrumentation Engineering

Sl. No	Type of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1	Professional Core Course	PCC-EI 601	Process Control	3	0	0	3	100
		PCC-EI 651	Process Control Laboratory	0	0	2	1	100
2	Professional Core Course	PCC-EI 602	Analytical Instrumentation	3	0	0	3	100
		PCC-EI 652	Analytical Instrumentation Laboratory	0	0	2	1	100
3	Professional Core Course	PCC-EI 603	Digital Signal Processing	3	0	0	3	100
		PCC-EI 653	Digital Signal Processing Laboratory	0	0	2	1	100
4	Professional Elective Course	PEC-EI 611	Professional Elective II	3	0	0	3	100
5	Open Elective Course	OEC-X* 621	Open Elective II	3	0	0	3	100
6	Humanities and Social Sciences including Management courses	HSM-HU 681	Group Discussion & Personal Interview	0	0	2	1	100
7	Project	PROJ-EI 691	Term Paper for Project Work	0	0	4	2	100
Total:							21	1000

* X refers to offering codes such as M/EE/HU/ME/EC/EI/CSE

Semester VII (Fourth Year) Curriculum

Branch/Course: Applied Electronics and Instrumentation Engineering

Sl. No	Type of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1	Professional Elective Course	PEC-EI 711	Professional Elective III	3	0	0	3	100
2	Professional Elective Course	PEC-EI 712	Professional Elective IV	3	0	0	3	100
3	Professional Elective Course	PEC-EI 713	Professional Elective V	3	0	0	3	100
4	Humanities & Social Sciences including Management Course	HSM-HU 701	Industrial Management & Entrepreneurship	3	0	0	3	100
5	Open Elective Course	OEC-X* 721	Open Elective III	3	0	0	3	100
6	Project	PROJ-EI 791	Project Stage I	0	0	10	5	100
7	Project	PROJ-INT 791	Internship	0	0	-	2	100
Total:							22	700

* X refers to offering codes such as M/EE/HU/ME/EC/EI/CSE

Semester VIII (Fourth year) Curriculum

Branch/Course: Applied Electronics and Instrumentation Engineering

Sl. No	Type of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1	Professional Elective Course	PEC-EI 811	Professional Elective VI	3	0	0	3	100
2	Open Elective Course	OEC-X* 821	Open Elective IV	3	0	0	3	100
3	Open Elective Course	OEC-X* 822	Open Elective V	3	0	0	3	100
4	Project	PROJ-EI 891	Project Stage II	0	0	12	6	100
Total:							15	400

* X refers to offering codes such as M/EE/HU/ME/EC/EI/CSE

Subject Pool for Professional Elective Courses – PEC I ; 5th Semester			
Sl. No.	Code	Subject Name	Credits
1	PEC-EI 511(a)	Data Structure & Algorithms	3
2	PEC-EI 511(b)	Ultrasonic Instrumentation	3
3	PEC-EI 511(c)	Communication Techniques	3
4	PEC-EI 511(d)	Computer Architecture & Organization	3

Subject Pool for Professional Elective Courses – PEC II ; 6th Semester			
Sl. No.	Code	Subject Name	Credits
1	PEC-EI 611(a)	Telemetry & Remote Control	3
2	PEC-EI 611(b)	Industrial Automation	3
3	PEC-EI 611(c)	Computer Networks	3
4	PEC-EI 611(d)	EMI/EMC	3

Subject Pool for Professional Elective Courses – PEC III ; 7th Semester			
Sl. No.	Code	Subject Name	Credits
1	PEC-EI 711(a)	Microcontroller Based Embedded Systems	3
2	PEC-EI 711(b)	VLSI Technology	3
3	PEC-EI 711(c)	Internet of Things & Applications	3
4	PEC-EI 711(d)	Power Plant Instrumentation	3

Subject Pool for Professional Elective Courses – PEC IV; 7th Semester			
Sl. No.	Code	Subject Name	Credits
1	PEC-EI 712(a)	Information Theory & Coding	3
2	PEC-EI 712(b)	Digital Image Processing	3
3	PEC-EI 712(c)	Reliability Engineering.	3
4	PEC-EI 712(d)	Oil & Gas Plant Instrumentation	3

Subject Pool for Professional Elective Courses – PEC V; 7th Semester			
Sl. No.	Code	Subject Name	Credits
1	PEC-EI 713(a)	Soft Computing & Control	3
2	PEC-EI 713(b)	Advanced Control Theory	3
3	PEC-EI 713(c)	Artificial Neural Network	3
4	PEC-EI 713(d)	Environmental Instrumentation	3

Subject Pool for Professional Elective Courses – PEC VI; 8 th Semester			
Sl. No.	Code	Subject Name	Credits
1	PEC-EI 811(a)	Biomedical Instrumentation	3
2	PEC-EI 811(b)	Pattern Recognition	3
3	PEC-EI 811(c)	Agricultural Instrumentation	3

Common Open Elective Courses (OEC)

Sl. No	Paper code	Sem.	Name of the paper
1.	OEC-HU 521(a)	5th	Sanskrit for Technical Knowledge
2.	OEC-PH 521(b)	5th	Material Science
3.	OEC-EC 521(c)	5th	Bio Medical Electronics
4.	OEC-CSE 521(d)	5th	Introduction to Object Oriented Technology & Python
5.	OEC-EI 521(e)	5th	Optical Instrumentation
6.	OEC-HU 621(a)	6th	History of Science & Engineering in India
7.	OEC-HU 621(b)	6th	Infrastructure Finance
8.	OEC-EC 621(c)	6th	Microprocessors & Its Applications
9.	OEC-EI 621(d)	6th	Microprocessors & Its Programming
10.	OEC-M 621(e)	6th	Computational Methods
11.	OEC-HU 721(a)	7th	Introduction to Comparative literature
12.	OEC-HU 721(b)	7th	Economic Policies in India
13.	OEC-M 721(c)	7th	Mathematical Formulation & Approximations
14.	OEC-HU 721(d)	7th	Soft Skills & Interpersonal Communication
15.	OEC-EI 721(e)	7th	MEMS
16.	OEC-EC 721(f)	7th	Nano Electronics
17.	OEC-EE 722(a)	7th	Renewable Energy
18.	OEC-ME 722(b)	7th	Modern Manufacturing Practice
19.	OEC-ME 722(c)	7th	Thermal Engineering & Fluid Machinery
20.	OEC-M 821(a)	8th	Advanced Operations Research
21.	OEC-EE 821(b)	8th	Advanced Topics in Power Systems
22.	OEC-HU 821(c)	8th	Quality Control & Management
23.	OEC-HU 821(d)	8th	Cyber Law and Computer Ethics
24.	OEC-EC 821(e)	8th	Satellite Communication
25.	OEC-EE 821(f)	8th	Energy Audit & Management
26.	OEC-HU 822(a)	8th	Digital Marketing
27.	OEC-HU 822(b)	8th	Human Resource Development & Organizational Behavior

28.	OEC-EC 822(c)	8th	Machine Learning
29.	OEC-EI 822(d)	8th	Sensor Technology
30.	OEC-EE 822(e)	8th	Automotive Control & Robotics
31.	OEC-ME 822(f)	8th	Power Plant Engineering

- Please refer to open elective booklet for the detailed syllabus of above listed open elective papers.

List of MOOCs (Massive Open Online Courses):

The Curriculum for Bachelor of Engineering programme consists of total 160 credits in the entire 4 year programme in Applied Electronics and Instrumentation Engineering. A student will be eligible to get Under Graduate degree with Honours, if he/she completes an additional 20 credits during entire 4 years of time. These could be acquired through any online courses (MOOCs)(not offered in his/her entire 4 year syllabus) as per AICTE in consultation with his/her mentor if needed. List of few massive open online courses (MOOCs) are given below as example:

List of MOOCs for AEIE

No	List of Courses	Duration	Credit	Offered by
1.	Entrepreneurship in Emerging Economies	6 weeks	2	edX
2.	Programming, Data Structures and Algorithms using Python	8 weeks	2	NPTEL
3.	Introduction to Internet of Things	12Weeks	3	NPTEL
4.	IoT Programming and Big Data	5 weeks	2	edX
5.	Robotics: Aerial Robotics	6 weeks	2	Coursera
6.	Deep learning in Computer Vision	5weeks	2	Coursera
7.	Natural Language Processing	12 weeks	3	edX
8.	Introduction to Industry 4.0 and Industrial Internet of Things	12 weeks	3	NPTEL
9.	IoT System Design: Software and Hardware Integration	4 weeks	2	edX
10.	Data Science with Python	10 weeks	3	edX
11.	Convolution Neural Network	4 weeks	1	Coursera
12.	Deep Learning	12 weeks	3	NPTEL
13.	Remote Sensing and Digital Image Processing of Satellite Data	8 weeks	2	NPTEL
14.	Leadership for Engineers	6 weeks	2	edX
15.	Electronic Systems for Cancer Diagnostics	12 weeks	3	NPTEL
16.	Data Analytics with Python	12 weeks	3	NPTEL
17.	Machine Learning	8 weeks	2	NPTEL
18.	Introduction to Machine Learning	12 weeks	3	NPTEL
19.	An Introduction to Artificial Intelligence	12 weeks	3	NPTEL
20.	Artificial Intelligence: Knowledge Representation and Reasoning	12 weeks	3	NPTEL
21.	Privacy and Security in Online Social Media	8 weeks	2	NPTEL
22.	Introduction to Programming with MATLAB	9 weeks	3	Coursera
23.	Data Science for Engineers	8 weeks	2	NPTEL
24.	Embedded Systems Design	12 weeks	3	NPTEL
25.	User-Centric Computing for Human-Computer Interaction	8 weeks	2	NPTEL

26.	VLSI Physical Design	12 weeks	3	NPTEL
27.	Hydraulic Engineering	12 weeks	3	NPTEL
28.	Data Analysis and Presentation Skills: the PwC Approach Specialization	12 weeks	3	NPTEL
29.	Electronics Equipment Integration and Prototype Building	12 weeks	3	NPTEL
30.	Advanced Power Electronics and Control	12 weeks	3	NPTEL
31.	Power Quality Improvement Technique	12 weeks	3	NPTEL
32.	Microwave Integrated Circuits	12 weeks	3	NPTEL
33.	VLSI Signal Processing	12 weeks	3	NPTEL
34.	CMOS Digital VLSI Design	12 weeks	3	NPTEL
35.	Principles of Digital Communication	6 weeks	2	Coursera
36.	Remote Sensing and GIS	6 weeks	2	Coursera
37.	Mathematical Methods and Techniques in Signal Processing	12 weeks	3	NPTEL
38.	Statistical Signal Processing	6 weeks	2	Coursera
39.	Multirate DSP	6 weeks	2	Coursera
40.	High Power Multilevel Converters - Analysis, Design and Operational Issues	12 weeks	3	NPTEL
41.	Power Management Integrated Circuits	12 weeks	3	NPTEL
42.	Nonlinear System Analysis	12 weeks	3	NPTEL
43.	Biomedical Signal Processing	12 weeks	3	NPTEL
44.	Electronic Systems for Cancer Diagnosis	12 weeks	3	NPTEL
45.	Fuzzy Sets, Logic and Systems & Applications	12 weeks	3	NPTEL
46.	Medical Image Analysis	12 weeks	3	NPTEL
47.	Electric Vehicles	12 weeks	3	NPTEL
48.	A brief Introduction to Micro-sensors	12 weeks	3	NPTEL
49.	Design and Simulation of Power Conversion using Open Source Tools	12 weeks	3	NPTEL
50.	Techniques for MEMs- based sensors: clinical Perspective	12 weeks	4	Swayam
51.	Embedded System Design with ARM	12 weeks	3	NPTEL
52.	Real Time Operating System	6 weeks	2	edX
53.	Introduction to scripting in Python	6 weeks	2	edX
54.	Introduction to Soft Computing	12 weeks	3	NPTEL
55.	Programming, Data Structures and Algorithms using Python	12 weeks	3	NPTEL
56.	Ethical Hacking	12 weeks	3	NPTEL
57.	Entrepreneurship in Emerging Economies	8 weeks	2	NPTEL
58.	Energy Efficiency, Acoustics and day lighting in Building	6 weeks	2	edX
59.	Big Data Analytics	12 weeks	3	NPTEL
60.	Introduction to Cyber Security	12 weeks	4	Swayam
61.	Deep learning in Computer Vision	6 weeks	2	edX
62.	Process Automation & PLC	12 weeks	3	NPTEL
63.	Fuzzy Logic and Neural Networks	12 weeks	3	NPTEL
64.	Machine Analysis	12 weeks	3	NPTEL
65.	Switched Mode Power Conversion	12 weeks	3	NPTEL
66.	Neural Networks for Signal Processing - I	12 weeks	4	Swayam
67.	Advanced Power Electronics Applications	12 weeks	3	NPTEL
68.	Mathematical Modeling and Analysis of Electrical Machines	12 weeks	3	NPTEL
69.	Embedded Systems	6 weeks	2	edX
70.	PIC Microcontroller and Applications	12 weeks	3	NPTEL

71.	Special Electro-mechanical Devices	12 weeks	3	NPTEL
72.	Sliding Mode Control	12 weeks	3	NPTEL
73.	Electromagnetic Fields Applied to Electrical Machines	12 weeks	3	NPTEL
74.	Analysis and Control of Electric Drives	12 weeks	3	NPTEL
75.	Special Electrical Machines	12 weeks	3	NPTEL
76.	Power Electronic Converter-I	8 weeks	2	NPTEL
77.	Power Electronic Converter-II	8 weeks	2	NPTEL
78.	Digital Control Systems	12 weeks	3	NPTEL
79.	AI Applications in Power Electronics	12 weeks	3	NPTEL
80.	Advanced Protection of Power Apparatus and System	12 weeks	3	NPTEL
81.	CAD and Analysis of Electrical Machines	12 weeks	3	NPTEL
82.	Dynamics of Electric Machines	12 weeks	3	NPTEL
83.	Power Semiconductor Controlled Drives	8 weeks	2	NPTEL
84.	Special Operational and Design Features of Electrical Machines	12 weeks	3	NPTEL
85.	English language for Competitive exams	12 weeks	4	NPTEL
86.	Converter Applications	12 weeks	3	NPTEL
87.	Solar and Wind Power Technologies	8 weeks	2	NPTEL
88.	Control Techniques in Power Electronics	12 weeks	3	NPTEL

** List is indicative only. Subject can be selected from the platform other than NPTEL with consultation of mentor.*

Semester V

Course code	PCC-EI 501(For Theory), PCC- EI 551 (For Laboratory)				
Category	Professional Core Course (PCC)				
Course title	Power & Industrial Electronics (Theory & Laboratory)				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	2	4	
Pre-requisites (if any)	Basic Electronics, Analog Electronics & Circuits				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Power semiconductor devices, Rectifier devices, series and parallel operation of rectifiers, power rectification half wave and full wave with high-current diodes from single & three phase a.c. supplies – different circuit arrangements, their analysis, ratings of rectifiers, rectifier transforms, regulation efficiency. SCR, DIAC, TRIAC, UJT, PUT, GTO and other power electronic devices – construction, characteristics and operating principles.	11L
2.	Series and parallel operation of thyristors, Thyristor turn-on & turn-off mechanisms, switching characteristics, triggering modes, different triggering circuits, cosine firing scheme, pulse transformer triggering, UJT triggering, TRIAC firing circuit etc., protection circuits – dv/dt protection, snubber circuits, di/dt protection, over voltage & over current protection, gate protection, heat sink.	11L
3.	A.C. power control – phase control & other techniques-Full-wave, half controlled, bridge circuits, Thyristor converters-controlled rectification, use of free-wheeling diodes, ON-OFF control, natural and forced commutation. a.c. & d.c. choppers.	9L
4	Inverters – configurations – series & parallel, bridge, single and poly phase, self-commutation; inverter control circuits-sequential and d.c. coding; voltage source inverter, current source inverter; cyclo-converters. SMPS, induction and dielectric heating, induction cooking, electric welding. Use of power electronic devices in dc motor control and ac motor.	11L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. Power Electronics by P. C. Sen.
2. Power Electronics by Mohan, Undeland and Robbins.
3. Power Electronics-circuits, devices and applications by Mohammad H. Rashid
4. An Introduction to Thyristors and their Application by M. Ramamoorthy.
5. Power Electronics, Thyristor Controlled Power for Electric Motors b R.S. Ramshaw
6. Power Electronics by K. HariBabu, Scitech Publications Pvt. Ltd.
7. Power Electronics by Harish C Rai, Galgotia publications.
8. Power Electronics and its applications by Alok Jain, Penram publisher

Course outcomes:

After completion of the course, the students will be able to:

CO1: Understand the characteristics of different semiconductor power devices.

CO2: Analyse controlled rectifier circuits.

CO3: Analyse the operation of DC to DC converters.

CO4: Analyse the operation of DC to AC inverters, cyclo-converters.

CO5: Design SMPS.

Laboratory Syllabus:

Detailed Description	Practical Period
List of Experiments: 1. Study of V-I Characteristics of an SCR 2. Study of V-I Characteristics of a DIAC 3. Study of V-I Characteristics of a TRIAC 4. Study of V-I Characteristics of a GTO 5. Study of different Triggering Circuits for Thyristor 6. Study of Uni Junction Transistor (UJT) Triggering Circuit 7. Study of a firing Circuit suitable for single phase half controlled Converter 8. Study UJT relaxation oscillator. 9. Universal motor speed control using thyristor 10. Studies on SMPS 11. Studies on Inverter. 12. PSPICE Simulation of DC to DC step down chopper 13. PSPICE Simulation of single phase controller with R-L Load	
Total:	42P
Total Week Required:	14
No. Of Week Reserved:	02

Course outcomes:

After completing the course the students will be able to:

CO1: Understand practically the characteristics of different semiconductor power devices.

CO2: Develop different triggering circuits

CO3: Design UJT relaxation oscillator

CO4: Understand the operation of motor speed control using controlled rectifier.

Course code	PCC-EI 502(For Theory), PCC- EI 552 (For Laboratory)				
Category	Professional Core Course (PCC)				
Course title	Control Systems (Theory & Laboratory)				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	2	4	
Pre-requisites (if any)	Circuits & Network.				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Elementary control concepts. Open loop and close loop control. Mathematical Model of Physical Systems: Introduction, Differential equation representation of physical systems. Electrical analogy of physical systems. Transfer function concepts, Block diagram algebra, Signal flow graphs. Feedback Characteristics of Control Systems: Introduction, Reduction of parameter variation by use of feedback, Control of system dynamics by use of feedback.	9L
2.	Control System Components: Introduction, DC servomotors, AC servomotors, Tachometer, DC tachogenerators, AC tachogenerators, Stepper motors, Synchro error detectors, Areas of Application.	6L
3.	Time Response Analysis: Introduction, Standard test signals, Performance indices, Time response of first order system, Time response of second order systems.	4L
4.	Stability Analysis in Time Domain: The concept of stability, Assessment of stability from pole positions, Necessary conditions for stability, Routh-Hurwitz stability criterion, Relative stability analysis, Illustrative examples. Root Locus Technique: Introduction, The root locus concept, root locus construction rules..	8L
5.	Frequency Response Analysis: Introduction, Performance indices, Frequency response of second order systems, Polar plots, Bode plots, Series compensation – lag, lead and lead-lag compensation.	8L
6.	Stability Analysis in Frequency Domain: Introduction, A brief review of Principle of Argument, Nyquist stability criterion, Assessment of relative stability – Gain Margin and Phase Margin, Illustrative examples.	3L
7.	Control Actions: P, PD, PI & PID Control.	2L
8.	Introduction to SISO, MIMO systems, state space model.	2L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. Madan Gopal - Control Systems , Principles & Application , TMH
2. Nagrath I. J. and Gopal M. - Control Systems Engineering, New Age International (P) Ltd.
3. Ogata K - Modern Control Systems, Prentice Hall.
4. Benjamin C. Kuo - Automatic Control Systems, PHI
5. Chandna - Control System, CyberTech
6. M. Gopal- Modern Control System, New Age International
7. Mahapatra- Industrial Control & Instrumentation, Universities Press
8. Automatic Control Systems (with MATLAB programs)-Syed Hasan Saeed, S.K.Kataria & Sons.

Laboratory Syllabus:**List of Experiments**

1. Determination of step response for 1st & 2nd order System with unity feedback on Oscilloscope.

2. Familiarization with MATLAB- Control system toolbox, MATLAB-Simulink toolbox / PSPICE.
3. Simulation of step response for First order & Second order System with unity feedback using MATLAB / PSPICE.
4. Determination of performance indices from step response of second order system.
5. Determination of root-locus, Bode-plot, Nyquist plot, using MATLAB-Control system toolbox for a given 2nd/higher order transfer function
6. Determination of different control system specifications Gain Margin, Phase Margin, Gain Crossover frequency & Phase Crossover frequency from 2nd/higher order transfer function
7. Determination of PI, PD, PID controller action on 1st order simulated process.
8. Study the characteristics of ac servomotor and determine its transfer function.
9. Synchro and stepper motor studies.
10. Performance characteristics of a dc motor angular position control system.

Course Outcomes:

After completion of the course, the student will able to:

CO1. Get knowledge about the characteristics of ac servomotor, Synchro, stepper motor and DC motor angular position control system.

CO2. Design of different controllers (P, PI, PID) and study their responses.

CO3. Know step response for 1st & 2nd order System with unity feedback.

CO4. Familiarize with MATLAB- control system toolbox and simulation of step response for 1st & 2nd order system using MATLAB / PSPICE.

CO5. Know root-locus, Bode-plot, Nyquist plot using MATLAB & determination of PI, PD, PID controller action.

Course code	PCC-EI 503 (For Theory), PCC-EI 553 (For Laboratory)				
Category	Professional Core Course (PCC)				
Course title	Microprocessors & Microcontrollers				
Scheme and Credits	L	T	P	Credits	Semester -V
	3	0	2	4	
Pre-requisites (if any)	Analog Electronics & Circuits, Digital Electronics				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Generic-8-bit microprocessor and its architecture, 8085 functional block diagram, Memory mapping, Memory interfacing, timing diagram, different machine cycles. Stack and subroutine, Interrupts and Interrupt service routine, instructions and programming	10L
2.	Architecture of 8086 Microprocessor-functions of general purpose registers-flags and flag register, addressing modes, Memory segmentation and memory organization concepts, Timing diagram.	8L

3.	Data Transfer Schemes & Interfacing: Interfacing with peripherals –memory, timer, serial I/O, parallel I/O, A/D and D/A converters; Programmable peripheral interface (8255A), Direct memory access (DMA), programmable keyboard display interface (8279), serial I/O and data communication-8251; programming for transmit and received data, stepper motor control, dc motor control, sensor interfacing etc.	12L
4.	Introduction to microcontroller, Schematic diagram of intel-8051 microcontroller-memory, timers/counters, special function registers and instructions and programming. Interrupts: interrupts of 8051 microcontroller; programming on interrupts Introduction to RISC processors; ARM microcontrollers.	12L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

List of Experiments:

1.	Familiarization with 8085/8086/8051 register level architecture and trainer kit components and 8085/8086/8051 simulator on PC.
2.	Assembly language programming using 8085/8086 /8051 a) Addition of two numbers or block of numbers b) Subtraction of two numbers/ difference calculation of two numbers c) Storing of data blocks (ascending/descending) d) Searching maximum and minimum number from a block of data
3.	Assembly language programming using 8085/8086 /8051 a) Multiplication and division of 8 bit data b) Shifting a block of memory c) Series calculation d) String Matching e) Code conversion (BCD to binary or reverse) f) Square, square root and factorial calculation of a given number.
4	Writing of a short subroutine and testing.
5	Program using subroutine calls and IN/OUT instructions using 8255 PPI on the trainer kit.
6	Static and scrolling display using 8279 on the trainer kit.
7	Temperature measurement using a microprocessor.
8	Position control of a stepper motor.
9	Measurement and control of speed of a d.c. motor using a microprocessor.
10	Development of a digital clock.
11	Develop a stable oscillator for 100hz and 1khz frequency using microcontroller.
12	Design an interfacing among display devices, microcontroller, and keyboard.
13	Write a program to generate a saw tooth waveform and triangular waveform using 8086/8051 and DAC.
14	Develop a code to interface ADC with 8086/8051 and measure the analog voltage with help of proper interfacing circuit design.

Text/Reference Books:

1. Microprocessor Architecture Programming & Applications with 8085 /8080: Ramesh S Gaonkar.
2. Digital Computer Electronics An Introduction to Microcomputers: Malvino.
3. Assembly Language Programming: Lance A. Lventahl.
4. Microprocessors Theory & Applications: M Rafiquizzaman.
5. Microcomputer Systems The 8086 / 8088 family Architecture, Programming & Design : Liu & Gibson
6. Microprocessor & Interfacing Programming & Hardware: Douglas V. Hall
7. The Intel Microprocessors: Barry B. Brey.
8. Introduction to Microprocessors for Engineers and Scientist: P. K. Ghosh & P.R. Sridhar.
9. Mazidi & Mazidi; The 8051 Microcontrollers And Embedded Systems; Pearson Education
10. Microprocessor Interfacing – Hall D. V. MGH
11. David Calcutt, Frederick Cowan, Hassan Parchizadeh, 8051 Microcontrollers, Hardware, Software and Applications.

Course outcomes:

After completion of the course, the student will able to:

- CO1: Apply assembly language programming.
 CO2: Interface with memory devices.
 CO3: Design interfacing circuit with peripherals like I/O, A/D, D/A, timer etc.
 CO4: Develop systems using different microcontrollers.

Course Code	PEC-EI 511(a)				
Category	Professional Elective Course (PCC)				
Course Title	Data Structure & Algorithms				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	3	
Pre-requisites (if any)	Basic Computing Concepts.				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Data Structure basic: Structure and problem solving, operations, algorithm complexities, time-space tradeoff. Linked Lists: representation of linked lists in memory, traversing a linked list, searching of linked lists, memory allocation and garbage collection, insertion and deletion in and from a linked list. Linked list types. Stack and Queue: Introduction, Array Representation of Stack, Linked List Representation of stack, Application of stack, Queue, Array Representation of Queue, Linked List Representation of Queue.	11 L
2.	Searching and Sorting Techniques, Sorting Techniques: Bubble sort, Merge sort, Selection sort', Heap sort, Insertion Sort. Searching Techniques: Sequential Searching, Binary Searching, Search Trees. Well Known Sorting Algorithms – Insertion sort, Bubble sort, Selection sort, Shell sort, Heap sort.	10 L

	Divide and Conquer Divide and Conquer Strategy; Binary Search; Max. And Min.; Merge sort; Quick sort.	
3.	Trees: Definitions and Concepts, Operations on Binary Trees, Representation of binary tree, Conversion of General Trees to Binary Trees, Sequential and Other Representations of Trees, Tree Traversal. Graphs: Matrix Representation of Graphs, List Structures, Other Representations of Graphs, Breadth First Search, Depth First Search, Spanning Trees. Directed Graphs Types of Directed Graphs; Binary Relation As a Digraph; Euler's Digraphs; Matrix Representation of Digraphs. Applications of Graphs: Topological Sorting, Shortest-Path Algorithms – Weighted Shortest Paths – Dijkstra's Algorithm, Minimum spanning tree- Prim's Algorithm, Introduction to NP-Completeness.	11 L
4	Algorithm: Notation for Expressing Algorithms; Role and Notation for Comments; Example of an Algorithm; Problems and Instances; Characteristics of an Algorithm; Building Blocks of Algorithms; Procedure and Recursion – Procedure, Recursion; Outline of Algorithms; Specification Methods for Algorithms. Dijkstra's algorithm for shortest path. shortest path tree, Shortest and longest paths in directed acyclic graphs. Dynamic Programming Strategy; Multistage Graphs; All Pair Shortest Paths; Travelling Salesman Problems. Backtracking Strategy, 8-Queens Problem, Sum of Subsets, Knapsack Problem.	10 L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. Weiss, Mark A. Data Structures and Algorithm Analysis in C++. 4th Edition. Pearson.
2. Malik, D S. Data Structures in C++, 2nd Edition, Cengage Learning.

Course Objectives:

1. To familiarize the students with the basic data structures.
2. To elucidate the fundamentals of algorithm designs.
3. To tutor the various concepts of data structure related to programming.
4. To illustrate the relationship between algorithm, programming structures and program code segments.

Course Outcomes:

After completion of the course, the student will able to:

- CO1: Formulate and apply procedural and object oriented programming as a modern tool to solve critical problems.
- CO2: Demonstrate the understanding the basic data structures and algorithms.
- CO3: Exhibit the ability to analyze, design, apply, and use data structures to evaluate engineering complications.
- CO4: Formulate and design algorithm and program code segments containing iterative constructs in analyzing asymptotic complexities.

Course Code	PEC-EI 511(b)				
Category	Professional Elective Course (PEC)				
Course Title	Ultrasonic Instrumentation				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	3	
Pre-requisites (if any)	Industrial Instrumentation.				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Ultrasonic waves: Principle of Wave propagation, Modes of Sound Wave Propagation. History & Present Status of US, Future direction. Spread Spectrum: Ultrasonic, Signal Processing Techniques, Flaw Reconstruction Techniques.	10 L
2.	Properties of Acoustic Plane Wave: Wavelength and Defect Detection, Sound Propagation in Elastic Materials, Attenuation of Sound Waves, Acoustic Impedance, Reflection and Transmission Coefficients, Refraction and Snell's Law, Mode Conversion, Signal-to-Noise Ratio, Wave Interaction or Interference, Normal Beam Inspection, Angle Beams, Crack Tip Diffraction, Automated Scanning, Precision Velocity Measurements, Attenuation Measurements.	10 L
3.	Equipment & Transducers: Piezoelectric Transducers, Characteristics of Piezoelectric Transducers, Radiated Fields of US Transducers, Transducer Beam Spread, Transducer Types, Transducer Testing, Transducer Modeling, Couplant. Electromagnetic Acoustic Transducers (EMATs): Lamb Wave Generation, Shear Wave Generation, Velocity Measurements Using EMATs, Texture measurement, US Stress measurement, Composite Materials, Pulser-Receivers, Tone Burst Generators, Arbitrary Function Generators, Electrical Impedance Matching and Termination, Data Presentation, Error Analysis.	11 L
4	Ultrasonic Test methods: Basic Principle of US Testing, Echo, Transit time, Resonance, Direct contact and immersion types. Ultrasonic methods of measuring: thickness, depth, flow, level etc. Various parameters affecting ultrasonic testing and measurements, their remedy. Ultrasonic Wave Applications: US in medical diagnosis, Rail Inspection, Weldments (Welded Joints). Calibration Methods: Distance Amplitude Correction (DAC), Thompson-Gray Measurement Model, Ultrasonic Simulation – UTSIM, Grain Noise Modeling, References & Standards, Transducer Characteristics.	11 L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. Krantkramer - Ultrasonic Testing of materials, Springer 2005
2. Krauthsamer J and Krauthsamer H – Ultrasonic Testing of Materials, Springer Verlag, Berlin, New York.
3. Wells N T – Biomedical Ultrasonics, Academic Press, London 1977.

Course Objective:

1. To introduce the fundamentals of ultrasonic waves.
2. To discuss the various methods for the generation of ultrasonic waves.
3. To provide knowledge on the basics of Ultrasonic Instrumentation.
4. To understand the applications of Ultrasonic Instruments.

Course outcomes:

After completion of the course, the student will able to:

CO1: Choose a suitable measurement technique for different parameters.

CO2: Analyze the different ultrasonic test methods.

CO3: Apply the concepts of ultrasonic instrumentation for practical applications.

CO4: Illustrate the ultrasonic applications in the field of Medicine.

Course Code	PEC-EI 511(c)				
Category	Professional Elective Course (PEC)				
Course Title	Communication Techniques				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	3	
Pre-requisites (if any)	Basic Electronics and Digital Electronics.				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Introduction, Elements of communication systems, Need for modulation. Noise in communication system, Thermal noise (white noise), Shot noise, Partition noise, Flicker noise, Burst noise, Signal to noise ratio, Noise factor, Noise temperature, Narrow band noise. Amplitude modulation: Sinusoidal AM, Modulation index, Average power, Effective voltage and current, Non-sinusoidal modulation. Amplitude modulator circuits, Amplitude demodulator circuits, AM transmitters, Noise in AM Systems.	10 L
2.	Single Sideband modulation, Angle modulation, Frequency modulation, AM & FM receivers. Super heterodyne receivers. Phase modulation, Angle modulation, FM transmitters, angle modulation detectors, slope detectors, Foster-Secley discriminator, PLL demodulator, Automatic Frequency Control (AFC), amplitude limiters, pre-emphasis and de-emphasis.	11 L
3.	Pulse Code Modulation (PCM): Pulse Modulation, Sampling process, Performance comparison of various sampling techniques Aliasing, Reconstruction, PAM, Quantization, Noise in PCM system. Modifications of PCM: Delta modulation, DPCM, ADPCM, ADM, Performance comparison of various pulse modulation schemes, Line codes, PSD of various Line codes. Digital Modulation Schemes: Pass band transmission model, Coherent Modulation Schemes- BPSK, QPSK, BFSK. Non Coherent orthogonal modulation schemes, Differential Phase Shift Keying (DPSK).	11 L

4	Multipath channels: classification, Coherence time, Coherence bandwidth, Statistical characterization of multi path channels, Binary signaling over a Rayleigh fading channel. Multiple Access Techniques: TDMA, FDMA, CDMA and SDMA – RAKE receiver, Introduction to Multicarrier communication-OFDM.	10 L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. Dennis Roody and John Coolen, Electronic Communication, Pearson, 4/e, 2011.
2. George Kennedy, Electronic Communication Systems, McGraw Hill, 4/e, 2008.
3. Tomasi, Electronic Communications System, Pearson, 5/e, 2011.
4. Couch: Analog and Digital Communication. 8e, Pearson Education India, 2013.
5. H.Taub and Schilling Principles of Communication Systems, , TMH, 2007.
6. K.Sam Shanmugham, Digital and Analog Communication Systems, John Wiley & Sons.
7. Pierre Lafrance ,Fundamental Concepts in Communication, Prentice Hall India.
8. Sklar: Digital Communication, 2E, Pearson Education.
9. T L Singal, Digital Communication, McGraw Hill Education (India) Pvt Ltd, 2015.

Course Objectives:

1. To study the concepts and types of modulation schemes.
2. To study different types of radio transmitters and receivers.
3. To study the effects of noise in analog communication systems.
4. To understand the Performance comparison various pulse modulation schemes.
5. To understand the principle of spread spectrum communication and to illustrate the concept of FHSS and DSSS.
6. To understand various Multiple Access Techniques.

Course outcomes:

After completion of the course, the student will able to:

- CO1: Understand the different analog modulation schemes.
CO2: Understand the fundamental ideas of noises and its effect in communication systems.
CO3: Illustrate the Digital representation of analog source
CO4: Compare the performance of various Digital Pulse Modulation Schemes
CO5: Apply the knowledge of ISI problems in Digital communication to derive Nyquist criteria for zero ISI.
CO6: Analyse the need for introducing ISI in Digital Communication in a controlled manner.

Course Code	PEC-EI 511(d)				
Category	Professional Elective Course (PEC)				
Course Title	Computer Architecture & Organization				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	3	
Pre-requisites (if any)	Basic Electronics, Digital Electronics and Microprocessors.				

Module	Detailed Description	Lecture / Tutorial Period
1.	Introduction: Computer Architecture and Organization, Von-Neumann Architecture Computer Arithmetic: Booth's Multiplication Algorithm, Restoring & Non-Restoring Division Algorithms Memory Hierarchy: Main memory Organization, RAM/ROM, Memory Address mapping, Cache Memory	10L
2.	General Processor Organization & Instructions sets: Instruction types and formats, Fixed and Variable Length Instructions; Addressing Modes: Various types of Addressing modes, Displacement Addressing- Indexing; Instruction interpretation: Micro Operations and their RTL level specifications, Instruction Phases, Instruction cycle	10L
3.	Control Unit Design: Hardwired Control Unit, Micro Programmed Control Unit I/O Transfer: Program controlled, Interrupt controlled and Direct Memory Access Uni-programming and Multi-programming Architectural support. RISC versus CISC Architectures: Concepts of Register Windows used in RISC Measure of computer performance: Benchmarking, MIPS, FLOPS	10L
4.	Pipelined processors: Pipeline Stalls, Hazards, Techniques for eliminating /reducing hazards, Instruction Flow Charts Flynn's Classification: SIMD: Array Processors, Loosely Coupled, Tightly Coupled machines, ICNs; MIMD: Multiprocessors, Shared Memory, Cache Coherence	12L
	TOTAL:	42L
	Total Week Required:	14
	No. Of Week Reserved:	02

Text and/or Reference Books:

1. J.P.Hayes, Computer Architecture and Organization, Mc Graw Hill.
2. William Stallings, Computer Organization and Architecture, Pearson
3. K.Hwang, F.Briggs, Parallel processing and Computers Architecture, Tata McGraw Hill
4. Hennessey, Patterson, Computer Architecture, Elsevier.
5. Kai Hwang Advanced Computer Architecture, Mc Graw Hill International.
6. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Naraig Manjikian, Computer Organization and Embedded Systems, Mc Graw Hill International.

After completion of the course, the student will able to:

- CO1: Get fundamental knowledge of different computer architecture
- CO2: Understand the structure, function and characteristics of computer systems.
- CO3: Understand the design of the various functional units and components of computers.
- CO4: Identify the elements of modern instructions sets and their impact on processor design.

Course Code	HSM-HU 502 (For Theory)				
Category	Humanities and Social Sciences including Management courses				
Course Title	Values and Ethics				
Scheme and Credits	L	T	P	Credits	Semester – V
	2	0	0	2	
Pre-requisites (if any)	Students are expected to have some basic understanding of moral values and some sense of right or wrong activities with some practical examples which they learn from their childhood and from the family, friends, school, society etc.				

Theory Syllabus:

Module	Detailed Description	Lecture / Tutorial Period
1.	Nature of professional ethics: -Introduction, definition, morals ðics sources of ethics, sources of ethics, relationship between ethics and management. Nature of professional ethics, importance of ethics in profession, nature and objectives of ethics, need for ethics.	03L
2.	Engineering Ethics: Senses of 'Engineering Ethics' - variety of moral issued - types of inquiry - moral dilemmas - moral autonomy - Kohlberg's theory - Gilligan's theory - consensus and controversy – Models of Professional Roles - theories about right action - Self-interest - customs and religion - uses of ethical theories. Valuing Time – Co-operation – Commitment – Nature of Engineering Ethics, Profession and Professionalism, Professional Ethics, Code of Ethics, Sample Codes – IEEE, ASCE, ASME and CSI.	06L
3.	Effects of technological growth:- Energy Crisis, Rapid technological growth, environmental degradation and pollution, human operator in Engineering projects and industries, problems of man, machine, interaction. Impact of assembly line and automation.	04L
4.	Ethics in profession:- Engineering profession, ethical issues in engineering practice, conflicts between business demands and professional ideals, social and ethical responsibilities of technologists, code of professional Ethics, Whistleblowing and beyond, effects of globalization in modern organization, case study.	05L
5.	Ethical decision making:- Values, morals, standards,corporate social responsibility, attitude and beliefs, ethical values and dimensions dilemmas- decision making,organization and power politics.	05L
6.	Managing ethics:- Building a value system, role of law enforcement, training in ethics, ethics in commercial and operational profession, ethics in finance, ethics in HRM, ethics in Global Business, ethics and IT.	05L
	Total	28L
	Total week required	14
	No. of week reserved	02

Books: Text and/or Reference:

1. Blending the best of the East & West, Dr. Subir Chowdhury, EXCEL
2. Ethics & Mgmt. & Indian Ethos, Ghosh, VIKAS
3. Business Ethics, Pherwani, EPH
4. Ethics, Indian Ethos & Mgmt., Balachandran, Raja, Nair, Shroff Publishers
5. Business Ethics: concept and cases, Velasquez, Pearson
6. Engineering Ethics: Charles D. Fleddermann, Pearson / PHI, New Jersey 2004 (Indian Reprint)
7. Engineering Ethics – Concepts and Cases: Charles E Harris, Michael S. Protchard and Michael J Rabins, Wadsworth Thompson Learning, United States, 2000 (Indian Reprint now available)
8. Ethics and the Conduct of Business: John R Boatright, Pearson Education, New Delhi, 2003.
9. Fundamentals of Ethics for Scientists and Engineers: Edmund G Seebauer and Robert L Barry, Oxford University Press, Oxford, 2001.

Course Outcomes:

At the end of this course, students will be able to

- Apply the concept of values and ethics and its application in engineering field.
- Make themselves aware about various factors influencing ethical decisions.
- Develop some practical views and skills, and instil in their mind certain basic points of ethical decision making with the help of case studies.
- Convince and resolve a moral dilemma and to take an ethical decision in case of conflicting interests.
- Develop about the social and ethical responsibilities of an engineer and his role in nation building and inclusive growth.
- Develop the basics on when and how to play a whistleblowers role if it is essential as a social responsibility to save the public and the nation.

Course Code	HSM-HU 581 (For Laboratory)				
Category	Humanities and Social Sciences including Management Courses				
Course Title	Grooming & Personality Development				
Scheme and credits	L	T	P	Credits	Semester—V
	0	0	2	1	
Pre-requisites (if any)	Basic knowledge of speaking and writing in English				

Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Self-Development Skills: Introduction to personality; Self-Esteem and Self-Confidence; problem solving; Stress Management; Goal-Setting.	5P

2.	Public Speaking: Importance; Types, Mechanics; Pillars of Public Speaking; Overcoming fear of Public Speaking.	5P
3.	Oral presentation and professional speaking: Basics of English pronunciation public preparing for a speech.; Elements of effective presentations, Body language and use of voice during presentation; connecting with the audience during presentation; projecting a positive image while speaking; planning and preparing a model presentation; Organizing the presentation to suit the audience and content.	6P
4.	Career Oriental Communication: Design and Style applying for a job: Language and format of job application; Resume& bio-data.	5P
5.	Job Interview: Purpose and process, language and style to be used, types of interview question and how to answer them.	7P
	Total	28P
	Total week required	14
	No. of week reserved	02

Text Books:

1. Development and Soft Skills. Barun K. Mitra, Oxford University Press, New Delhi: 2016.
2. Personality Development: Rajiv K. Mishra, Transform Yourself. Rupa Publications, 2012.
3. Personality Development, Elizabeth B. Hurlock, McGraw Hill Education, 2017.

Reference Books:

1. Personality Development and Career Management. M. Onkar S. Chand Publication.
2. Managing Soft Skills for Personality Development. Ed. by B. N. Ghosh. McGraw Hill, India: 2012.

Course outcomes:

On completion of the course students will be able to:

- Groom themselves through the knowledge of personality development attributes –self confidence, problem solving and stress management skills etc.
- Deliver confidently an organized, refined, professional and credible speech for better suit the audience.
- Acquire the basic concepts of English pronunciation and elements of effective presentations, body language and use of voice during presentation.
- Connect with the audience during presentation and exhibit the art of projecting a positive image while speaking and preparing a model presentation.
- Learn the effective language for writing job application, resume and bio-data.
- Familiar with common interview questions and the techniques to answer them.

Semester VI

Course code	PCC-EI 601(For Theory), PCC- EI 651 (For Laboratory)				
Category	Professional Core Course (PCC)				
Course title	Process Control (Theory & Laboratory)				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	2	4	
Pre-requisites (if any)	Linear Control Theory				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	The basic process control loop- different blocks in the loop. Open loop vs. closed loop systems. Generation of Control Action in pneumatic, electric/ electronic, hydraulic. Construction of different controllers. Digital controller, components and working of direct digital control (DDC), benefits of DDC, digital controller realization. Tuning of Controller – open loop & closed loop methods.	11L
2.	Schemes and analysis of Feedback control, Cascade control – Definitions, primary & secondary loop, instability analysis and cascade loop saturation, Feedforward control – Load balancing, steady state model, dynamic model, feedforward-feedback control configuration, Ratio control – Flow ratio control, ratio stations, remote sensing of ratio, Selective control: Override control, Auctioneering control, Valve-position control, Split-range control; batch and continuous process control, multi variable control schemes, adaptive control.	10L
3.	Final control elements – Actuators pneumatic spring & springless piston motor, pneumatic, hydraulic, and electrical actuators. Control valves – types, valve sizing, characteristics, body materials, trim of control action, single & double seated valve, special type of control valves – Flow, Pressure, Directional control valve. Selection criteria for control valve. Valve positioners – Performance, application & advantages. P-I and I-P converters.	10L
4	Control schemes in industrial processes- distillation columns, heat exchanger, furnaces, reactors, boiler, evaporator, combustion. Programmable Logic Controller: Architecture, basic symbols used in PLC realization, relay logic and ladder logic, PLC ladder diagram realization, Application case study. Distributed Control System and SCADA system : DCS structure, DCS hardware and software, networks, gateways and connectivity, case study: SCADA hardware and software.	11L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text and/or Reference Books:

1. Harriot – Process control, MGH
2. Conghanowr D.R. – Process System Analysis & Control. MGH, 2nd Ed
3. Curtis D Johnson – Process Control Instrumentation Technology, - Pearson Education/PHI
4. Luyben W. L – Simulation & Control for Chemical Engg.
5. George Stephanopoulos – Chemical Process Control – An Introduction to theory & Practice, PHI
6. Considine Douglas M – Process /Industrial Instruments and Control Handbook, MH
7. Bequette – Process Control – Modeling, Design and Simulation, PHI
8. D Patranabis – Principles of Process Control, TMH
9. K Krishnaswamy – Process Control, New Age International
10. S K Singh - Industrial Instrumentation and Control, TMH
11. Surekha Bhanot – Process Control, OXFORD

Course outcomes:

After completion of the course, the students will be able to:

- CO1: Get Fundamental knowledge of process control loop, Tuning of Controller and Control action in pneumatic, electric/ electronic, hydraulic.
- CO2: Know the Construction, Schemes and analysis of feedback, Split-Range, batch and continuous process control, multi variable control, adaptive control.
- CO3: Learn about feedforward control, Ratio control, Cascade control, over ride-control and Final control elements.
- CO4: Study P-I and I-P converters, Safety valves and Control schemes in different applications. PLC and DCS.

Laboratory Syllabus:

Detailed Description	Practical Period
List of Experiments: <ol style="list-style-type: none">1. Study of level, flow, temperature, pressure control loop.2. Study of the performance of the level control loop using local PID controller.3. Study of the performance of the flow control loop using local PID controller.4. Study of the performance of the temperature control loop using local PID controller.5. Study of the performance of the pressure control loop using local PID controller.6. Study of the performance of the level control loop using PLC.7. Study of the performance of the flow control loop using PLC.8. Study of the performance of the temperature control loop using PLC.9. Study of the performance of the pressure control loop using PLC.10. Study of the performance of the level control loop using DCS.11. Study of the performance of the flow control loop using DCS.12. Study of the performance of the temperature control loop using DCS.13. Study of the performance of the pressure control loop using DCS.14. Study and Characteristics of control valves (with and without positioners).15. Study of zener barrier / isolating interface and their use for the construction of an	

intrinsically safe measurement system.	
16. Study of the performance of the wireless temperature transmitter.	
17. Study of profibus/fieldbus system.	
Total:	42P
Total Week Required:	14
No. Of Week Reserved:	02

Course outcomes:

After completing the course the students will be able to:

CO1: Integrate the measurement systems with the process for process monitoring and control

CO2: Study the performance of level, flow, temperature and pressure control loop using local PID controller.

CO3: Study the performance of level, flow, temperature and pressure control loop using PLC and DCS.

CO4: Study the Characteristics of control valves.

CO5: Study the profibus/fieldbus system.

Course Code	PCC-EI 602 (For Theory), PCC- EI 652 (For Laboratory)				
Category	Professional Core Course (PCC)				
Course Title	Analytical Instrumentation (Theory & Laboratory)				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	2	4	
Pre-requisites (if any)	Basic Chemistry, Industrial Instrumentation.				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Introduction of analytical instrumentation: Difference between analytical and monitoring instruments, block diagrams; Classification of Analytical instruments; Spectrophotometer, Flame Photometry/Colorimeter: Beer law, Lambert law, Beer Lambert law, Single beam photometer, Double beam photometer, UV – Vis. Spectrometry: Absorption, Emission, Scattering, UV – Vis range, IR Spectroscopy, FT- IR spectroscopy; Nuclear Magnetic Resonance Spectroscopy; Atomic Fluorescence Spectroscopy; Raman Spectroscopy.	12 L
2.	Chromatography: Classification, Working principle, Gas Chromatography Instrumentation, Carrier gases, Modes of separation, Injectors, Columns, Detectors e.g. TCD, FID, ECD, AID etc. Applications. Liquid Chromatography; High Pressure LC; Gas Analyser: IR Gas Analyser, Thermal Conductivity Analyser; NO _x , SO _x , CO _x monitor, H ₂ S analyser, Oxygen Analysers: Working Principle, Application, Zirconia, Pauling cell, Mackerth type galvanic analyser.	10 L
3.	Mass Spectrometry: Basic components, Working principle, Ionization methods, Ion detectors, Inductively Coupled Plasma, Mass Analysers, Applications Types - Magnetic Deflection MS; ToF MS; Radiofrequency MS; Quadrupole MS; Fourier Transform Ion Cyclotron Resonance MS.	10 L

	Radiation Detector: Ionization Chamber, Proportional Counter, Geiger Muller Counter, Scintillation Counter.	
4	pH Meter: Nernst equation, construction of electrodes, metal electrode, hydrogen electrode, membrane electrode, Ion selective electrode, working principle, glass electrode, reference electrode, calomel electrode, Ag/AgCl electrode, combination electrode, working principle, calibration of pH meter applications of pH meter. Conductivity Meter: Working principle; specification, construction; applications, advantages and drawbacks, different types of conductivity meters; Polarography.	10 L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. R S Khandpur - Handbook Of Analytical Instruments, Tmh
2. Liptak B G (Ed) – Instrument Engineer's Handbook, Chilton Book Co, Philadelphia
3. Jones E B – Instrument Technology, Vol-II, Analysis Instruments Butterworths Scientific Publication, London.
4. O' Higgins P J – Basic Instrumentation in Industrial Measurements, Mc Graw Hill Book Co.

Course Objectives:

1. To provide a solid background in the fundamental concepts and methods of spectroscopy, chromatography & environmental pollution and an appreciation of issues in each of these fields in current research
2. To introduce the basic concept of qualitative and quantitative analysis of a given sample.
3. To study various spectroscopic techniques and its instrumentation.
4. To study the concept of separation science and its applications.
5. To study the concept of radiochemical analysis along with industrial analyzers.
6. To introduce the techniques of troubleshooting instruments in the chemical laboratory.
7. To emphasize on the safe use of chemical instrumentation.
8. To prepare the student to solve problems related to the use of chemical instruments.

Course Outcomes:

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

- CO1: Describe the functions, strengths, and limitations of various analytical instruments.
- CO2: Describe the calibration method for various analytical instruments.
- CO3: Operate numerous types of analytical instruments and analyzers.
- CO4: Explain the function and importance of analyzer sample systems.
- CO5: Understand the applications and usage of chromatography in real time industrial environments.
- CO6: Choose specific techniques employed for monitoring different pollutants in air and water.
- CO7: Select Instrument for a particular analysis with rudimentary idea of its merits, demerits and limitations.

Laboratory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Study of pH meter with different buffer solutions and Measurements of pH values of the different Normality Solution of Sodium Chloride.	1 P
2.	Study of conductivity-meter with different buffer solutions and Measurements of the values of conductivity of any electrolytic solution with computer interfaced. a) with different temperature. b) with different concentration.	1 P
3.	Study of the Gas Chromatography and analysis of any one hydrocarbon gas sample like Ethylene, Acetylene with proper detector.	1 P
4	Study of Thermal Conductivity or Flame Ionization or Electron Capture detector and its experimentation for the detection of the corresponding parameters.	1 P
5.	Study and analysis of concentration of a. Oxygen, b. Nitrogen Oxides and c. Sulfur Di Oxide Using proper Analyzer with proper simulator.	1 P
6.	Study of Electrode and experimentation with one of them and proper simulation s/w to measure ion concentration of any standard solution	1 P
7.	Measurements of arsenic, TDS of water collected from different places using proper detector.	1 P
8.	Study and Experimentation with IR spectrophotometer and proper simulator for compositions analysis of sample.	1 P
	Total	8 P
	Total Weeks Required	08
	No. of Weeks Reserved	02

Text/Reference Books:

1. R S Khandpur - Handbook Of Analytical Instruments, TMH
2. Liptak B G (Ed) – Instrument Engineer’s Handbook, Chilton Book Co, Philadelphia
3. Jones E B – Instrument Technology, Vol-II, Analysis Instruments Butterworths Scientific Publication, London.
4. O’ Higgins P J – Basic Instrumentation in Industrial Measurements, Mc Graw Hill Book Co.

Course Objectives:

1. To provide hands-on experience with some basic instrumental techniques for chemical analysis.
2. To develop an understanding of computerized data acquisition.
3. To understand the procedure of statistical data analysis of chemical samples.
4. To acquire premise of using the types of sensors for measuring fluid, solid and dynamical quantities.

Course Outcomes:

After completion of the course, the student will be able to:

CO1: Select appropriate techniques involved in different analytical measurements.

CO2: Perform the measurements of different chemical compositions based on their concentration, opulence et cetera.

CO3: Analyze the measurement data obtained from sample and draw inferences.

CO4: Present and interpret results in the form of a concise scientific report.

Course code	PCC-EI 603(For Theory), PCC- EI 653 (For Laboratory)				
Category	Professional Core Course (PCC)				
Course title	Digital Signal Processing (Theory & Laboratory)				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	2	4	
Pre-requisites (if any)	Circuits & Network.				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Introduction: Difference between analog , discrete time and digital signals, overview of digital signal processing, application areas. Discrete-time signals: Representation of discrete-time signal, basic idea of sampling and reconstruction of signal, sampling theorem, sequences – periodic, energy, power, unit-sample, unit-step, unit-ramp, real & complex exponentials, arithmetic operations on sequences. Discrete time system: Definition, representation of linear time invariant systems(LTI), impulse response, derivation for the output sequence, concept of convolution, graphical, analytical methods to compute convolution , stability and causality conditions, recursive and non-recursive systems.	11L
2.	Z-Transform: Definition, mapping between s-plane and z-plane, unit circle, convergence and ROC, properties of Z-transform, Z-transform on sequences. Inverse Z-transform by contour integration, power series & partial-fraction expansions.	10L
3.	DTFT, DFT and FFT: Definition, Characteristics of DTFT sequence, DTFT of different sequences, Derivation of DFT/IDFT from DTFT sequence, basic properties of DFT, Twiddle factor, circular convolution, multiplication of DFT. Fast Fourier transform (FFT), FFT algorithms, Radix 2 algorithm- Decimation-in-time and decimation-in- frequency algorithm, signal flow graph, butterfly diagram.	11L
4	Digital filter: Introduction of digital filters, FIR, IIR filters, their representation advantages and disadvantages. Design of FIR filter- Linear phase filter, Window technique, Gibbs phenomenon. Design of IIR filter from analog filter, Bilinear Transformation method, Impulse invariant method, Butterworth, Chebyshev IIR filters. Realization of IIR and FIR filters-structures, Direct form-I and II structures, cascade and parallel structures. DSP Processors, Texas instruments family of DSP processors. Introduction to FPGA.	10L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. J.G. Proakis & D.G. Manolakis, Digital Signal Processing, Principles, Algorithms and Applications, *Pearson/PHI*
2. R. Babu, Digital Signal Processing, *Scitech*
3. S.K.Mitra, Digital Signal Processing - A Computer based approach, *TMH*.
4. S. Salivahanan et al, Digital Signal Processing, *TMH*
5. E.C. Ifeachor et.al., Digital Signal Processing : A Practical approach, *Pearson Education*.
6. Hammimg R.W, Digital Filters, *Pearson/ PHI*
7. A. Oppenheim, R.Schafer , Digital Signal Processing, *Pearson/PHI*.
8. Roman Kuc, Introduction to DSP, *BS Publication*.
9. L.R. Rabiner & B.Gold, Theory and Application of Digital Signal Processing, *Pearson/PHI*
10. K.Padmanabhan, S.Ananthi & R.Vijayarajeswaran, A Practical Approach to Digital Signal Processing- *New Age*.

Laboratory Syllabus:

List of Experiments

Using Matlab:

1. Generation of Signals
2. Linear and circular convolution of two sequences
3. Plot of DTFT of sequence
4. DFT and FFT on sequences
5. Design of FIR filters
6. Design of IIR filters

Using Hardware Kits

7. Study of various addressing modes of DSP hardware using simple programming examples
8. Sampling of input signal and display
9. Implementation of FIR filters
10. Calculation of FFT

Course outcomes:

After completion of the course, the student will able to:

- CO1: Develop the knowledge on signals used in digital signal processing.
- CO2: Get knowledge about signals, systems, time and frequency domain concepts and the associated mathematical tools those are fundamental to all DSP techniques.
- CO3: Get a thorough understanding and working knowledge of design, implementation, analysis and comparison of digital filters for processing of discrete time signals.
- CO4: Understand various sampling techniques and different types of filters.

Course code	PEC-EI 611(a)				
Category	Program Elective Course (PEC)				
Course title	Telemetry & Remote Control				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)	Analog Electronics & Circuits				

Theory Syllabus:

Module	Detailed Description	Lecture / Tutorial Period
1	Basic Concept: Telemetry- its purpose and applications. Basic schemes-voltage, current, frequency and pneumatic telemetry systems and limitations. Wired and wireless telemetry systems and their applications, PLCC Multiplexing (Time Division Multiplexing & Frequency Division Multiplexing systems): Basic concept and block schematic for TDM & FDM system, de-multiplexing schemes, comparisons, applications and limitations. IRIG standards in multiplexing systems.	10L
2	Modem: Introduction, QAM, modem protocols, synchronous protocols. Satellite Communication and Telemetry: Introduction, TT&C services and subsystems, the earth station. Kepler's laws.	9L
3	Fibre-Optic Telemetry: Optical fibre as a transmission medium, interconnections, repeater, Sources and Detectors; Receivers, wave-length division multiplexing (WDM) Industrial Communication System: Introduction, OSI network model and details architecture, Token Buses and Rings, HART and HART Protocol, Fieldbus and Device Networks; Foundation Fieldbus, Profibus Networks, Industrial Ethernet and TCP/IP based systems	11L
4	Data Acquisition System: Fundamental concept, analog and digital signal transmission in processes; Protocols and standards, Data Acquisition: Buses, Networks, Software and Data Handling, Data Reconciliation and Software method for bias detection P&ID diagram and single line diagram-introduction, interpretation of it, applications; Annunciator-basic concept, working principle and applications in industries, hooter, buzzer and bell systems Remote Control: Concept, schemes and industrial applications with examples.	12L
Total:		42L
Total Weeks Required:		14
No. Of Week Reserved:		02

Text and/or Reference Books:

1. Patranabis D., Telemetry Principles; TMH
2. Anand MMS, Electronic Instruments and Instrumentation Technology, PHI
3. Béla G. Lipták, Process Software and Digital Networks, CRC Press
4. Dr. Frank Carden, Dr. Robert Henry, Dr. Russ Jedlicka; Telemetry Systems Engineering Artech House USA

5. Pandiyan Jagadeesh, Introduction to SmartPlant P&ID: The Piping & Instrumentation Diagrams (P&ID) Handbook, APJBooks

Course outcomes:

After completion of the course, the student will able to:

CO1: Explain telemetry, remote control system and competent to analyze utility of multiplexing system in it.

CO2: Explaining MODEM and its functionalities and satellite telemetry system

CO3: After the end of the course pupil will be adroit of deciphering optical telemetering and functional explanation of industrial communication system.

CO4: After finishing the course students will be able to explain and analyze industrial DAS and remote control system.

Course code	PEC-EI 611(b)				
Category	Professional Elective Course (PEC)				
Course title	Industrial Automation				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)	Process Control				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Introduction, Architecture of Industrial Automation Systems Measurement Systems Characteristics, Data Acquisition Systems	10L
2.	Introduction to Automatic Control, P - I - D Control, PID Control Tuning, Feed Forward control, Ratio Control, Time Delay Systems and Inverse Response Systems, Special Control Structures. Flow control valves.	10L
3.	Introduction to Sequence Control, PLC, RLL, Sequence Control, Scan Cycle, Simple RLL programs, RLL Elements, RLL Syntax, Structured design approach to sequence control, PLC Hardware environment.	11L
4	Hydraulic control systems, industrial hydraulic circuits, pneumatic control systems, energy savings with variable speed drives, Introduction to CNC machines. Field Bus networks, Higher Level Automation systems.	11L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. Industrial Instrumentation, Control and Automation, S. Mukhopadhyay, S. Sen and A.K. Deb, Jaico Publishing House, 2013
2. Chemical Process Control, An Introduction to Theory and Practice, George Stephanopoulos, Prentice Hall India, 2012
3. Electric Motor Drives, Modelling, Analysis and Control, R. Krishnan, Prentice Hall India, 2002
4. Hydraulic Control Systems, Herbert E. Merritt, Wiley, 1991

Course outcomes:

After completion of the course, the students will be able to:

CO1: Have a good idea of the use of different controllers for automation

CO2: Understand the different techniques for controlling devices automatically.

CO3: Get a comprehensive picture of computer based automation of manufacturing operations.

CO4: Have an idea of field bus network.

Course Code	PEC-EI 611(c)				
Category	Professional Elective Course (PEC)				
Course Title	Computer Networks				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)	Basic Electronics and Digital Electronics				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Introduction to Networks, Internet, Protocols and Standards. OSI model, Layers in OSI model, TCP/IP suite, Addressing, Analog and digital signals. Network classification, MAN, WAN, LAN, Protocol hierarchy, Networks software. Physical Layer, digital transmission, multiplexing, transmission media, circuit switched network, Datagram network, virtual circuit networks, Switch and Telephone Network.	11 L
2.	Data Link layer: Introduction, Block coding, cyclic coding, checksum, framing, flow and error control, noise-less channels, noisy channels, HDLC, point to point protocols. Medium access sub-layer, random access sub-layer, controlled access, channelization, IEEE standards, Ethernet, Fast Ethernet, Giga-Bit Ethernet, wireless LANS.	10 L
3.	Connecting LANs, backbone network, virtual LANs, Wireless LANs, SONET, frame relay and ATM. Network layer, logical addressing, internetworking, tunneling, address mapping, ICMP, IGMP, forwarding, uni-casting routing protocols, multicast routing protocols.	11 L
4	Transport layer: Process to process delivery, UDP and TCP protocols, SCTP, data traffic, congestion, congestion control, QoS, Integrated services, differential services, QoS in switched networks. Application layer – Domain name space, DNS in internet, electronic mail, FTP, WWW, HTTP, SNMP, multi-media, network security. Network Devices: Repeaters, Hubs, Switches, Routers, Gateways, WAP, Modem, Bridges, Proxy server,	10 L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. An Engineering Approach to Computer Networks, S. Keshav, 2nd Edition, Pearson Education.
2. Understanding communications and Networks, W. A. Shay, 3rd Edition, Cengage Learning.
3. Computer and Communication Networks, Nadar F. Mir, Pearson Education.
4. Computer Networking: A Top-Down Approach Featuring the Internet, James F. Kurose, K. W. Ross, 3rd Edition, Pearson Education.

Course Objectives:

1. To acquaint the students with the layered communication architectures (OSI and TCP/IP).
2. To learn socket programming and how to implement client/server programs.
3. To familiarize the students with current topics such as security, network management, sensor networks.
4. To learn the principles of routing and semantics and syntax of IP.

Course Outcomes:

After completion of the course, the student will able to:

CO1: Understand the client/server model and key application layer protocols.

CO2: Know the principles of congestion control and trade-offs in fairness and efficiency.

CO3: Identify the errors in network communication and correct them using checksums and CRC.

CO4: Recognize the key protocols for multimedia networking including IntServ and DiffServ for IP.

Course code	PEC-EI 611(d)				
Category	Professional Elective Course (PEC)				
Course title	EMI/EMC				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)	Basic Electronics.				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Introduction to EMI and EMC, Intra and inter system EMI, Elements of Interference, Sources and Victims of EMI, Conducted and Radiated EMI emission and susceptibility, Case Histories, Radiation hazards to humans, Various issues of EMC, EMC Testing categories, EMC Engineering Application.	10 L
2.	Electromagnetic field sources and Coupling paths, Coupling via the supply network, Common mode coupling, Differential mode coupling, Impedance coupling, Inductive and Capacitive coupling, Radiative coupling, Ground loop coupling, Cable related emissions and coupling, Transient sources, Automotive transients.	10 L
3.	Working principle of Shielding and Murphy's Law, LF Magnetic shielding, Apertures and shielding effectiveness, Choice of Materials for H, E, and free space fields, Gasketing and sealing, PCB Level shielding, Principle of Grounding, Isolated grounds, Grounding strategies for Large systems, Grounding for mixed signal systems, Filter types and operation, Surge protection devices, Transient	12 L

	protection. Fundamental considerations, EMI Shielding effectiveness tests, Open field test, TEM cell for immunity test, Shielded chamber, Shielded anechoic chamber, EMI test receivers, Spectrum analyzer, EMI test wave simulators, EMI coupling networks, Line impedance stabilization networks, Feed through capacitors, Antennas, Current probes, MIL -STD test methods, Civilian STD test methods.	
4	Need for Standards, Generic/General Standards for Residential and Industrial environment, Basic Standards, Product Standards, National and International EMI Standardizing Organizations; IEC, ANSI, FCC, AS/NZS, CISPR, BSI, CENELEC, AEC. Electro Magnetic Emission and susceptibility standards and specifications, MIL461E Standards.	10 L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. Clayton Paul, "Introduction to Electromagnetic Compatibility", Wiley Interscience, 2006
2. Dr. V.P. Kodali, IEEE Publication, "Engineering Electromagnetic Compatibility", Printed in India by S. Chand & Co. Ltd., New Delhi, 2000.
3. C.R. Pal., "Introduction to Electromagnetic Compatibility", Ny John Wiley, 1992.
4. V Prasad Kodali, "Engineering Electromagnetic Compatibility", IEEE Press, Newyork, 2001.
5. Henry W. Ott, "Electromagnetic Compatibility Engineering", John Wiley & Sons Inc, Newyork, 2009
6. Daryl Gerke and William Kimmel, "EDN's Designer's Guide to Electromagnetic Compatibility", Elsevier Science & Technology Books, 2002
7. W Scott Bennett, "Control and Measurement of Unintentional Electromagnetic Radiation", John Wiley & Sons Inc., (Wiley Interscience Series) 1997.
8. Dr Kenneth L Kaiser, "The Electromagnetic Compatibility Handbook", CRC Press 2005,

Course Objectives:

1. To tutor the basics of EMI and EMC.
2. To instill knowledge on the EMI coupling mechanism and its mitigation techniques.
3. To impart comprehensive insight about the current EMC standards and about various measurement techniques.
4. To familiarize with the importance of error correction methods in communication and storage.

Course outcomes:

After completion of the course, the student will able to:

- CO1: Find solution to EMI Sources, EMI problems in PCB level / Subsystem and system level design.
- CO2: Measure emission immunity level from different systems to couple with the prescribed EMC standards.
- CO3: Develop the ability to compare and contrast the strength and weaknesses of various errors.
- CO4: Demonstrate competence in analyzing and evaluating the practice of different electronic and electrical errors.

Course Code	HSM-HU 681 (For Laboratory)				
Category	Humanities and Social Sciences including Management Courses				
Course Title	Group Discussion & Personal Interview				
Scheme and credits	L	T	P	Credits	Semester—VI
	0	0	2	1	
Pre-requisites (if any)	Basic knowledge of oral & technical communication				

Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Advanced Techniques in Technical Communication: using e-mail for business communication; standard e-mail practices; language in e-mail, using internet for collecting information; referencing while using internet materials for project reports; writing for media.	5P
2.	Presentation: Techniques of effective presentations by using various audiovisual aids	5P
3.	Interview: methods and Etiquettes; practice of mock interview; interview through telephone/ video-conferencing	8P
4	Group Discussion: Model group discussion through the choice of appropriate programmers.	7P
5.	Interaction with experts.	3P
	Total	28P
	Total week required	14
	No. of week reserved	02

Text Books:

1. How to Prepare for Group Discussion & Interview, Hari Mohan Prasad, Rajnish Mohan Tata McGraw Hill Education, New Delhi: 2012.
2. Mastering Interviews and Group Discussions, Dinesh Mathur CBS Publication, 2017.
3. Technical Interviews, Anil Kumar Maini.,Excel with Ease. Pearson, 2011.

Reference Books:

1. Group Discussions and Interviews, Anand Ganguly RPH, 2014.
2. The Interview Book: Your Definite Guide to the Perfect Interview Technique, James Innes. Prentice Hall Business, 2009.

Course outcomes:

On completion of the course students will be to:

- Learn structure and format for effective communications, using e-mail for business communication; standard e-mail practices; language in e-mail, using internet for collecting information; referencing while using internet materials for project reports; writing for media.
- Deliver effective power-point presentation.

- Take part in Interview through telephone/video-conferencing.
- Become proficient to face interviews and model group discussions through the choice of appropriate programmers.

Course code	PROJ-EI 691				
Category	Project				
Course title	Term Paper Leading to Project Work				
Scheme and Credits	L	T	P	Credits	Semester – VI
	0	0	0	2	
Pre-requisites (if any)					

The object of **Term Paper Leading to Project Work** is to enable the student to take up investigative study in the broad field of Electronics and Instrumentation Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on five/six students in a group, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work.

The assignment to normally include:

1. Survey and study of published literature on the assigned topic.
2. Preparing a Written Report (term paper) on the study proposed for the project work to be conducted from 7th semester onwards.
3. Presentation of the term paper before a departmental committee.

Semester VII

Course code	PEC-EI 711(a)				
Category	Professional Elective Courses (PEC)				
Course title	Microcontroller Based Embedded Systems				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	Microprocessors & Microcontrollers				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1	Introduction: Microcontroller based systems, Historical perspective, von Neumann versus Harvard Architecture and CISC versus RISC Processors.	4L
2	Overview of Embedded System: Basics of Embedded System, Embedded Processor, Components of Embedded System, Brief introduction to Embedded software in system, Design Process in Embedded System.	6L
3	Embedded Hardware: Processor & Memory: Brief overview of 8051 Architecture and real world interfacing, Introduction to advanced Processor Architectures-ARM, Processor and Memory organization, Parallelism in instruction level, Processor and memory selection	8L
4	I/O Types: Serial and Parallel communication Ports, Timer and Counting devices, Watchdog timers, real time clock, Serial bus Communication Protocols- I2C, CAN, and Parallel Communication Protocol-ISA.	4L
5	Interrupt Service Mechanism: Concept of ISR, different interrupt sources, Interrupt handling Mechanism, Multiple Interrupts, Interrupt Latency and deadline.	2L
6	Embedded Software Development: Programming concept in assembly language and High level language-C, Processor directives, functions and macros and other programming elements, Embedded C++ concept only.	3L
7	RTOS (Real time operating System)- OS overview, Process, Interrupt and memory management, RTOS overview, Basic Design rule using RTOS, Task scheduling using Priority based scheduling, cyclic scheduling and round robin scheduling.	5L
8	Embedded system Design using PIC microcontroller: Introduction to Microchip PIC16 family, PIC16F873 processor architecture- features, memory organization, on chip peripherals, Watchdog timer, Data EEPROM, Asynchronous serial port, SPI mode, I2C mode, Interfacing with ADC, DAC LCD, sensors, stepper motor, and key board.	8L
9	Case study: A Home Protection System.	2L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text and/or Reference Books:

1. J.W. Valvano, "Embedded Microcomputer System: Real Time Interfacing", Brooks/Cole, 2000.
2. Jack Ganssle, "The Art of Designing Embedded Systems", Newness, 1999.
3. V.K. Madiseti, "VLSI Digital Signal Processing", IEEE Press (NY, USA), 1995.
4. David Simon, "An Embedded Software Primer", Addison Wesley, 2000.
5. K.J. Ayala, "The 8051 Microcontroller: Architecture, Programming, and Applications", Penram Intl, 1996.

Course outcomes:

After completion of the course, the student will able to:

CO1: Gain fundamental knowledge of different embedded systems.
 CO2: Develop the design approach using advanced controllers to real-life situations.
 CO3: Interfacing of the systems with other data handling / processing systems.
 CO4: Get knowledge of engineering constraints like energy dissipation, data exchange speeds etc

Course code	PEC-EI 711(b)				
Category	Professional Elective Course (PEC)				
Course title	VLSI Technology				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	Basic Electronics				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Introduction to VLSI: Design Flow & Methodologies, Concepts of Regularity, Modularity and Locality, Testability, Reliability, Yield & other process Parameters. MOS inverters and Transmission Gates: Static Load MOS inverters with Resistive load, n-MOS(Enhanced & Depletion type) load, Pseudo –nMOS, Saturated Load, More Saturated Load. Calculation of Noise Margin.	9L
2.	Analog VLSI: CMOS Current Sources and sinks, CMOS Voltage and Current references CMOS Differential Amplifier, Operational Amplifier, Comparator CMOS inverters and Transmission Gates: Static Load MOS inverters with Resistive load, n-MOS(Enhanced & Depletion type) load, Pseudo –nMOS, Saturated Load, More Saturated Load. Calculation of Noise Margin. Dynamic Load MOS inverter: CMOS inverter, VTC, Switching Characteristics (Rise Fall & Delay time), Calculations of V_{IL} , V_{IH} , V_{OH} , V_{th} , Noise Margin, Power Dissipation (Static, Dynamic & Short circuit), Effect of aspect ratio change in CMOS circuit. Transmission gates: nMOS, pMOS& CMOS transmission gates and logic transfer characteristics.	10L
3.	Digital VLSI: Combinational MOS Logic Circuits: nMOS & Pseudo nMOS logic and CMOS logic gates: Realization of NAND, NOR, XOR, half and full adders & other Boolean Logic functions. AND-OR-INVERT (AOI) & OR - AND –INVERT (OAI) gates. Sequential Logic Circuits: The SR latch circuit, clocked latch and flip-flop, CMOS D-latch and edge-triggered circuits, Schmitt trigger circuit Dynamic Logic Circuits: Basic concept, capacitive feed through, charge sharing & other source of charge loss. Pass transistor logic, synchronous dynamic circuit techniques, Dynamic CMOS Logic, Clocked CMOS Logic (C^2 MOS), CMOS Domino Logic, NP Domino Logic (Zipper/ NORA CMOS). Ratioed logic & Ratio less Logic	12L

4	VLSI Physical Design: Partitioning, Floor planning, Placement& Routing Algorithms. Low-Power VLSI Design Issues: Overview of power consumption, Various ways for power reduction, delay and power optimization, Activity Capacitances and power supply adjustment for power reduction, sleeping mode, Introduction of double threshold voltage. Introduction to FPGA, CPLD, ASIC and FPGA based combinational and sequential circuit design.	11L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Reference/Text Book:

1. Ken Martin, Digital Integrated Circuit Design, OUP
2. CMOS Digital Integrated Circuits - S.M. Kang and Y. Leblebici, TMH
3. Digital Integrated Circuits - J.M. Rabaey, PHI.
4. Neil H.E Weste, Kim Haase, David Harris, A.Banerjee, “CMOS VLSI Design : A circuits & Systems Perspective”, Pearson Education
5. Wayne Wolf,” Modern VLSI Design – System-on-chip Design”, Prentice Hall India/Pearson Education
6. Philips E. Allen & Douglas R. Holberg, “ CMOS Analog Circuit Design” , Oxford University Press
7. David Hodges, Horace G Jackson, &Resve A Saleh, “ Analysis & Design of Digital Integrated Circuits”, Tata McGraw-Hill
8. R. L. Geiger, P. E. Allen, Noel R. Strader, “ VLSI Design techniques for Analog and Digital Circuits”, McGraw-Hill International.

Course outcomes:

After completion of the course, the students will be able to:

- CO1: Bring both Circuits and System views on design together.
 CO2: Understand the design of complex digital VLSI circuits, simulation and synthesis tool for hardware design.
 CO3: Design digital systems using MOS circuits.
 CO4: Synthesis of digital VLSI systems from register -transfer or higher level descriptions in hardware design languages.

Course Code	PEC-EI 711(c)				
Category	Professional Elective Course (PEC)				
Course Title	Internet of Things & Applications				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	Basic Communication, Computation.				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Internet of Things Introduction, Brief history and evolution, IoT architecture, Trends in the adaptation of IoT, Societal benefits, Risks, privacy and security issues. Open source platform set-up. Implementation of two platforms, Logic to program translation, library creation, Dry-run.	11 L
2.	Embedded systems overview, micro-controller architecture, setting up arduino development environment, Arduino sketches, classes, sketch structure, Arduino shields, micro-controller peripheral usage. Communication protocols – UART, SPI, I2C, CAN. IoT sensors and actuators interfacing. Debugging applications using Arduino IDE. Wired and wireless communication. Ethernet client server, WiFi application, Bluetooth application, ZigBee.	11 L
3.	Introduction to Python, Native datatypes and operators, dunctions, strings, error and exception handling, file handling, regular expressions, modules and packages. Raspberry Pi hardware familiarization, Raspbian OS. IoT gateway. Raspberry pi as device, interfacing sensors and actuators using GPIO. Camera interfacing with Rpi.	10 L
4	IoT Communication Models and Protocols. Request-Response, Publish-Subscribe, Push-Pull, Exclusive Pair. Injection engines. Application Protocols: HTTP, CoAP, MQTT, AMQP Communication APIs: REST-based, WebSocket-based Network Layer: IPv4, IPv6, 6LoWPAN Network linking and loading, Cloud computing services, Cloud and IoT integration, Cloud evolution. Firmware updat3es, cryptography basics, privacy considerations and design guidelines,	10 L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2014.
2. Peter Waher, “Learning Internet of Things”, PACKT publishing, BIRMINGHAM – MUMBAI.
3. Bernd Scholz-Reiter, Florian Michahelles, “Architecting the Internet of Things”, ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer.
4. Daniel Minoli, “Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications”, ISBN: 978-1-118-47347-4, Willy Publications.
5. Vijay Madiseti and Arshdeep Bahga, “Internet of Things (A Hands-on Approach)”, 1st Edition, VPT, 2014.

Course Objectives:

1. To describe Internet of Things and how it works.
2. To define the infrastructure for supporting the IoT deployments.
3. To understand the elements of an IoT device.
4. To recognize the factors contributing to the emergence of IoT.

Course outcomes:

After completion of the course, the student will able to:

CO1: Design and program IoT devices.

CO2: Use real-time IoT protocols for communications.

CO3: Build an IoT device to work with a Cloud Computing infrastructure.

CO4: Transfer IoT data to the cloud and in between cloud providers.

Course Code	PEC-EI 711(d)				
Category	Professional Elective Course (PEC)				
Course Title	Power Plant Instrumentation				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	Basic Mechanics, Industrial Instrumentation				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	General Concepts Power generation; Different types of Power plants; Setups, energy conversions and measurement requirements; examples of Thermal, Hydel, and Nuclear plants; Basic building block for all types of power generation plants. Instrumentation for: 1) Turbines; 2) Condensers; 3) Generators; 4) Coal handling; 5) Water treatment 6) Feed water, combustion air and flue gases.	10 L
2.	Boiler Control - Steam pressure control, combustion control, Furnace Draft control, Steam (Main & Reheat) temperature control, Feed water control, Attenuator; Deaerator control; Combustion Control-air/fuel ratio control; Drum level control; Super heater control; . Control loops in boiler- Data logger and computer control; supervisory control and monitoring system; P&I diagram of boiler; Cogeneration distributed control system in power plants; Interlocks in boiler operation. Data handling: Processing, logging, acquisition, accounting, display and storage. Instrumentation for Generator and Bus bar coupling. Introduction to power plant modeling/simulation	12 L
3.	Parameters of power plant and its measurement: Electrical and non-electrical parameter measurement - correction factor for steam temperature and steam pressure; drum level measurement; radiations detector; smoke density measurement; speed vibration; shell temperature monitoring & control - steam pressure control lubricant temp control of turbines. Instrumentation for safety interlocks - protective gears, emergency measures, Alarm systems and Analysis; Pollution measurement, monitoring and control; Dust monitor.	10 L
4	Analyzers in power plants: Flue gas oxygen analyzer - analysis of impurities in feed water and steam - Dissolved oxygen analyzer - chromatography - PH Meter -	10 L

	Fuel analyzer. Nuclear Power Plant: Nuclear power plant instrumentation - P&I diagram of different types of nuclear power plant - radiations detection instruments - process sensors for nuclear power plants – Spectrum.	
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. Sam Dukelow. G “The control of Boilers”, instrument society of America, 1991.
2. Modern power station practice, Vol.6, "Instrumentation Controls and Testing", Pergamon Press, Oxford, 1971. A 153.
3. P.K. Nag, ‘Power Plant Engineering’, Tata McGraw Hill, 2001.
4. Elonka. S.M, and Kohan. A.L, “Standard Boilers Operations”, McGraw Hill, New Delhi, 1994.
5. Electric Power Engineering Handbook – Edited by L. L. Grigsby.
6. E.Al. Wakil, ‘Power Plant Engineering’, Tata McGraw Hill, 1984.

Course Objective:

1. To create awareness of energy resources and its scenario in India.
2. To study the concept of power generation using various resources and methods.
3. To study the role of Instrumentation in power plants.
4. To study and compare various power plants for optimal performance.

Course outcomes:

After completion of the course, the student will be able to:

- CO1: Secure knowledge about the overall operation of a power plant, its characteristics, and performance.
- CO2: Analyze the various measurements involved in power plants.
- CO3: Apply of linearization techniques in case of nonlinear measurements.
- CO4: Develop knowledge of designing aspect in power plant commissioning.
- CO5: Understand the methods of monitoring different power plant parameters. .

Course Code	PEC-EI 712(a)				
Category	Professional Elective Course (PEC)				
Course Title	Information Theory & Coding				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	Digital Electronics and Communication Techniques.				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Introduction Information; Information sources; Information content of a Symbol; information rate; Mathematical representation; Discrete memoryless channel (DMC), types of Channels; Information measure for continuous random variables, Entropy: Conditional & Joint Entropies; Channel capacity; Mutual information; entropy relations for a continuous channel; Capacity of Additive White Gaussian Noise (AWGN); Shannon Hartley Law; Exchange of Bandwidth for SNR;	10 L
2.	Source Coding: Source Coding Theorem, Classification of Codes; Kraft Inequality; Entropy Coding-Huffman and Shanon-Fano. Lempel-Ziv Encoding and Run-Length Encoding, Rate Distortion Function and Optimum Quantizer.	10 L
3.	Error Control Coding: Classification of Codes; Detection and Correction errors; Error classification; Error detection and correction techniques; Generation and detection of coded signals; Drawbacks of Coding techniques; Classification of Error correcting codes; Types of error control. Linear Block Codes: Error detection method; Error detection using VRC and LRC; Burst Error and its Correction; Hamming code; Error detection and correcting capabilities of hamming code; Hamming code encoder; Syndrome decoder; Decoding of LBC;	10 L
4	Cyclic Codes: Cyclic Property, Polynomials, Division Algorithm for Polynomials, Method of Generating Cyclic Code, Cyclic Redundancy Check; Generator and Parity check matrices of Cyclic code; Systematic form of Generator matrix; Encoder for Cyclic code; Difference between Source coding, Lin coding and error detection; Syndrome calculator for Cyclic codes; Decoder for Cyclic code; Bose Chaudhuri Hocquenghem Code: Minimal Polynomials, Generator Polynomials, Reed-Solomon Code. Turbo code. Golay code; Convolutional Codes: Time Domain approach; Transfer domain approach; graphical representation; Code tree; Code Trellis; State diagram; Decoding methods; Viterbi Algorithm; Metric Diversion effect; Free distance and Coding gain; Transfer function of Convolutional codes;	12 L
	Total	42 L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. Ranjan Bose, Information Theory, Coding and Cryptography, TMH.
2. Jones, Information & Coding Theory, Springer.
3. Senn J., Analysis and Design of Information Systems, McGraw Hill.
4. M. Mansurpur, Introduction to Information Theory, McGraw Hill.
5. Shu Lin and D. I. Costello Jr., Error Control Coding, Prentice Hall.
6. Dr. Sanjay Sharma, Communications System, Katson Books.

Course Objectives:

1. To introduce the principles and applications of Information Theory
2. To acquaint with the techniques of error detection and correction techniques.
3. To study the measurement methods of information, entropy and relationships between conditional and joint entropies.
4. To learn the coding schemes with various method viz. VRC, LRC, LBC, CRC et cetera.
5. To introduce the principles of ciphering methods and cryptography.

Course Outcome:

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

CO1: Apply information theory and linear algebra in source coding and channel coding techniques.

CO2: Understand various error control encoding and decoding methods.

CO3: Point out the errors sent during transmission and rectify the same.

CO4: Analyze the performance and efficiency of error control codes.

CO5: Understand the basic concepts of cryptography.

Course code	PEC-EI 712(b)				
Category	Professional Elective Courses (PEC)				
Course title	Digital Image Processing				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	Digital Electronics				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Digital Image Fundamentals-Elements of visual perception, image sensing and acquisition, image sampling and quantization, basic relationships between pixels - neighborhood, adjacency, connectivity, distance measures. Image Enhancements and Filtering-Gray level transformations, histogram equalization and specifications, pixel-domain smoothing filters – linear and order-statistics, pixel-domain sharpening filters – first and second derivative, two-dimensional DFT and its inverse, frequency domain filters – low-pass and high-pass.	10L
2.	Color Image Processing-Color models–RGB, YUV, HSI; Color transformations– formulation, color complements, color slicing, tone and color corrections; Color image smoothing and sharpening; Color Segmentation. Image Segmentation- Detection of discontinuities, edge linking and boundary detection, thresholding – global and adaptive, region-based segmentation.	10L

3.	Wavelets and Multi-resolution image processing- Uncertainty principles of Fourier Transform, Time-frequency localization, continuous wavelet transforms, wavelet bases and multi-resolution analysis, wavelets and Sub band filter banks, wavelet packets. Image Compression-Redundancy–inter-pixel and psycho-visual; Loss less compression – predictive, entropy; Lossy compression- predictive and transform coding; Discrete Cosine Transform; Still image compression standards – JPEG and JPEG-2000.	12L
4	Fundamentals of Video Coding- Inter-frame redundancy, motion estimation techniques – full search, fast search strategies, forward and backward motion prediction, frame classification – I, P and B; Video sequence hierarchy – Group of pictures, frames, slices, macro-blocks and blocks; Elements of a video encoder and decoder; Video coding standards – MPEG and H.26X. Video Segmentation- Temporal segmentation–shot boundary detection, hard-cuts and soft-cuts; spatial segmentation – motion-based; Video object detection and tracking.	10L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text and/or Reference Books:

1. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Second Edition, Pearson Education 3rd edition 2008
2. Anil Kumar Jain, Fundamentals of Digital Image Processing, Prentice Hall of India.2nd edition 2004
3. Murat Tekalp, Digital Video Processing" Prentice Hall, 2nd edition 2015

Course outcomes:

After completion of the course, the student will able to:

CO1: Represent mathematically the various types of images.

CO2: Process the images for the enhancement of certain properties or for optimized use of the resources.

CO3: Analyze the different types of images.

CO4: Develop algorithms for image compression and coding.

Course code	PEC-EI 712(c) (For Theory)				
Category	Professional Elective Course (PEC)				
Course title	Reliability Engineering (Theory)				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	Mathematics				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1	Introduction, Elements of Probability and definition of Reliability. Failure data analysis: Failure Data, Mean Failure Rate, Mean Time to Failure, Mean Time between Failure, Graphical Plots, MTTF in Terms of Failure Density, Reliability in terms of Hazard Rate and Failure Density.	9L
2	Hazard Models: Constant Hazard, Linearly-increasing Hazard, The Weibull Model, Density Function and Distribution Function, Distribution Function and Reliability Analysis. System Reliability: Reliability in Series, Parallel and Mixed Configuration, Application to Specific Hazard Models, Methods of Solving Complex Systems, Markov Models, Markov Graphs, Systems subjected to Probability Laws.	12L
3	Reliability Improvement, Improvement of Components' Reliability, Redundancy, Unit Redundancy, Standby Redundancy, Optimization, Reliability Cost Trade-off. Fault-Tree Analysis, Construction, Calculation of Reliability from Fault Tree, Event Tree Analysis, Use of Boolean Algebra to Reliability Analysis	11L
4	Maintainability, Availability, System Downtime, Reliability and Maintainability Trade-Off. Repairable systems, Instantaneous Repair Rate, Mean Time to Repair(MTTR), Reliability Allocation for Series System. Application of Reliability.	10L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. Reliability Engineering and Risk Analysis, A Practical Guide: Mohammad Modarres, Mark P. Kaminskiy, Vasily Krivtsov, Third Edition, CRC Press.
2. Reliability Engineering: L.S. Srinath, East-West Press Private Limited.
3. Reliability Engineering, 2nd Edition, Elsayed A. Elsayed, Wiley Publication

Course outcomes:

After completion of the course, the student will be able to :

- CO1: Get fundamental knowledge of reliability of different system and calculation of reliability.
CO2: Know about improvement of reliability of systems.
CO3: Familiar with failure data analysis and different hazard models.
CO4: Learn reliability allocation for different system.

Course code	PEC-EI 712(d) (For Theory)				
Category	Professional Elective Course (PEC)				
Course title	Oil & Gas Plant Instrumentation				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	Basic Electronics				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Introduction: Structure of Oil & Gas Industry; World oil supply and demand; Oil desalting: Operation, variables, heater treater design, crude and condensation stabilization, LTX Stabilization.	9L
2.	Oil & Gas Treatment: Emulsion treatment, emulsifier, demulsifier, gravity separation, coalescence, coalescing media, electrostatic coalescers. Treating Equipment: Pressure vessels - Vertical, horizontal, Electrostatic. Process heat duty, Sensible heat of natural gas, Water, Heat transfer from fire-tube. Heat exchangers- types, fluid placement, sizing, number of tubes.	10L
3.	Natural Gas Dehydration: (a) Glycol Process: operation, effect of variables, dew point depression, stage calculation. NTU - graphical and analytical methods, Absorber sizing. Lean oil absorption. (b) Solid-bed process: design & operation, effect of process variables, Regeneration and cooling calculations. Hydrocarbon recovery. (c) Hydrate formation & inhibition. Natural Gas Sweetening: Acid gases, Toxicity, Pipeline specification. Solid-bed Process: Design, operation & effect of variables. Adsorbent selection. Multistage Separation, Hengstebach's Flash calculation, stabilizer design. Amine and other absorptive process details.	12L
4	Reservoir Management: Data acquisition, analysis and management: Classification of data, acquisition, analysis and application, validation, storing and retrieval Reservoir model: Role of reservoir model in reservoir management, Reservoir performance analysis and prediction: Naturally producing mechanism, reserves and role of various forecasting tools- volumetric method, MBE, Decline curve and mathematical simulation Health & Safety Practices: Oil pollution, stack emission, flaring and fugitive release, drilling waste, rock cutting, oily sludge, HSE regulations for Oil & Gas industry.	11L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. A.L. Waddams, 'Chemicals from Petroleum', Butter and Janner Ltd., 1968.
2. J.G. Balchan. and K.I. Mumme, 'Process Control Structures and Applications', Van Nostrand Reinhold Company, New York, 1988.
3. Austin G.T. Shreeves, 'Chemical Process Industries', McGraw Hill International Student edition, Singapore, 1985.
4. B.G Liptak, 'Instrumentation in Process Industries', Chilton Book Company, 1994

Course outcomes:

After completion of the course, the students will be able to:

- CO1: Understand the principles of operation for different oil and gas industry.
 CO2: Understand the operation of different treatment technique and equipment.
 CO3: Learn about the dehydration process.
 CO4: Learn to make reservoir modeling in reservoir management.

Course code	PEC-EI 713(a) (For Theory)				
Category	Professional Elective Course (PEC)				
Course title	Soft Computing & Control				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	Control Systems				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Introduction to soft Computing and its constituents. Fuzzy Logic: Introduction, definition of fuzzy set, difference between fuzzy set and crisp set, Operations on fuzzy sets, Basic operators, T-norm, S-norm, other aggregation operators. Fuzzy Relations, implications, cylindrical extensions, projection and composition.	11L
2	Approximate reasoning, compositional rule of inference, rule based system, term set, Fuzzification, reasoning, defuzzification, Different fuzzy models, Fuzzy logic based control systems.	11L
3	Neural Networks: Introduction to artificial neural networks, basic models, multilayer perception, Hopfield networks, and learning vector quantization network. Learning of neural networks, Back propagation training algorithm. Self-organizing features maps , Neural network based control.	11L
4	Basics of genetic algorithm (GA), Different GA Operators, Applications of GA. Some Hybrid Neuro-fuzzy control systems.	9L

	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. Dirankov&Hellemdron – Fuzzy Logic Control, Narosa
2. Timothy J. Ross Fuzzy Logic with Engineering Applications
3. S Haykians – Neural Networks, Pearson
4. Anderson – An Introduction to Neural Network, PHI
5. Goldberg – Genetic Algorithm, Pearson
6. Rajsekaran&Pai – Neural Networks, Fuzzy Logic & Genetic Algorithm: Synthesis and Applications, Pearson
7. Bose – Neural Network Fundamentals and Graphs – Algorithms and Applications, TMH

Course outcomes:

After completion of the course, the student will be able to:

- CO1: Get knowledge of Soft Computing and its constituents, Fuzzy Logic, crisp set; fuzzy logic, its importance in real life
- CO2: Get knowledge about different fuzzy models (MA/TS) – applications.
- CO3: Learn artificial neural networks, multilayer perception. Learning of neural networks, Back propagation training algorithm.
- CO4: Get fundamental knowledge of Self organizing features maps, genetic algorithm (GA) and its applications. Some Hybrid (Neuro-fuzzy, fuzzy-neural and fuzzy-GA) systems.

Course code	PEC-EI 713(b) (For Theory)				
Category	Professional Elective Course (PEC)				
Course title	Advanced Control Theory				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	Control Systems				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Introduction, State variable analysis of dynamical systems: canonical forms, stability, controllability and observability – continuous and discrete systems. Linear system design by state variable feedback.	10L

2.	Analysis of SISO process control loop by z-transform technique, z-and s-domain relationship, stability analysis of discrete systems in z-plane, stability analysis by using Bilinear transformation, Jury's stability test,. Digital control algorithms.	12L
3.	Nonlinear elements and systems – phase plane and describing function methods. Stability analysis and Liapunov's method. Introduction to optimal control-quadratic performance index and regulator problems.	12L
4.	Adaptive and Self-tuning control: Need for adaptive control, adaptive control by preset compensation, adaptive control by pattern recognition, adaptive control by discrete parameter estimation.	8L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text and/or Reference Books:

1. MadanGopal- Modern Control theory, PHI
2. NagrathI. J. and Gopal M.- Control Systems Engineering, New Age International (P) Ltd.
3. Ogata K - Modern Control Systems, Prentice Hall,
4. Benjamin C. Kuo - Automatic Control Systems., PHI
5. M. Gopal: Modern Control System, New Age International
6. Mahapatra- Industrial Control & Instrumentation, Universities Press.
7. Automatic Control Systems (with MATLAB programs)- Syed Hasan Saeed, S.K.Kataria & Sons.

Course outcomes:

After completion of the course, the student will be able to:

- CO1: Get fundamental knowledge of modern control system: State variable analysis, stability, controllability and observability for continuous and discrete systems. Linear system design by state variable feedback.
- CO2: Know about the analysis of SISO process control loop by z-transform technique, Jury's stability test, Digital control algorithms.
- CO3: Get introduce with optimal control – quadratic performance index and regulator problems. Nonlinear elements and systems–phase plane and describing function methods. Stability analysis and Liapunov's method.
- CO4: Learn Adaptive and Self-tuning control.

Course code	PEC-EI 713(c)				
Category	Professional Elective Course (PEC)				
Course title	Artificial Neural Network				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	Mathematics				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1	Overview of Biological Neuron: Structure of biological neuron relevant to Artificial Neural Network (ANN). Fundamental concepts of ANN, Basic model, Single layer and multilayer feedforward network, feedback networks, characteristics of ANN. Learning of ANNs: Supervised, Unsupervised, Reinforced, Competitive learning etc.	12L
2.	Linear, Multi-linear, Nonlinear ANN, adaptability and Stability of ANN models. Neural Network Paradigms: McCulloch-Pitts Model, concept of Perceptron; Perceptron learning procedure, single layer Perceptron, Multilayer Perceptron, Delta learning Algorithm, ADALINE and MADALINE, Mathematical analysis. Winner-Takes-All algorithm, back propagation Learning- mathematical analysis and application.	13L
3	Hopfield model and Competitive learning Model: Mathematical Analysis, Memory type Paradigm (RAM, CAM, BAM, TAM, LAM), Real time models. Self Organizing Map, Probabilistic NN, Radial Basis Function.	9L
4	Application: Image Data Processing, Traffic control, Switching control in Communication field, Intelligent Control.	8L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. S. Haykin, Neural Networks: A Comprehensive Foundation 2nd edition, (Prentice Hall, 1999)
2. Anderson – An Introduction to Neural Network, PHI
3. Bose – Neural Network Fundamentals and Graphs – Algorithms and Applications, TMH
4. K. Mehrotra, C. Mohan, and S. Ranka, Elements of Artificial Neural Networks, MIT Press, 1997.
5. C. Looney, Pattern Recognition Using Neural Networks, Oxford University Press, 1997.
6. C. Bishop, Neural Networks for Pattern Recognition, Oxford University Press, 1995.
7. J. Hertz, A. Krogh, R.G. Palmer, Introduction to the Theory of Neural Computation (Addison-Wesley, 1991)

Course outcomes:

After completion of the course, the student will able to:

CO1: Understand mathematical foundations of neural network model.

CO2: Get knowledge about different learning of artificial neural networks: supervised, unsupervised, reinforced, competitive, Hebbian. ANN learning Algorithm. Perceptron, delta learning algorithm, ADALINE and MADALINE.

CO3: Familiarize different learning models: Hopfield and competitive learning model, Mathematical analysis, RAM, CAM, BAM, TAM, LAM, Real time models. SOM, Probabilistic NN, Radial basis Function. Neuro-fuzzy networks and control.

CO4: Design and implement neural network systems to solve real world problems.

Course Code	PEC-EI 713(d)				
Category	Professional Elective Course (PEC)				
Course Title	Environmental Instrumentation.				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	Industrial Instrumentation.				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Introduction: Necessity of instrumentation & control for environment, sensor requirement for environment. Instrumentation methodologies: Ultraviolet analyzers, total hydrocarbon analyzers using flame ionization detector, Gas chromatography in environmental analysis, photo ionization, portable & stationary analytical instruments.	8L
2.	Quality of water: Standards of raw & treated water, sources of water & their natural quality, effects of water quality. Water quality parameters: Thermal conductivity, detectors, Opacity monitors, pH analyzers & their application, conductivity analyzers & their application. Water treatment: Requirement of water treatment facilities, process design. Waste Water and Flow Monitoring System Automatic waste water sampling, optimum waste water sampling locations, and waste water measurement techniques. Instrumentation set up for waste water treatment plant. Latest methods of waste water treatment plants. Flow monitoring: Non- open channel flow measurement, open channel waste water flow measurement. Rain water harvesting: necessity, methods, role of NGOs & municipal corporation.	10L
3.	Sedimentation & flotation: General equation for settling or rising of discrete particles, hindered settling, effect of temperature, viscosity, efficiency of an ideal settling basin , reduction in efficiency due to various causes, sludge, storage & removal, design criteria of settling tank, effect of temperature on coagulation. Ground water monitoring: Level measurement in ground water monitoring wells, laboratory analysis of ground water samples, instrumentation in ground water monitoring, instrumentation in assessment of soil & ground water pollution.	12L
4	Air Pollution and Sound Monitoring Systems Definitions, energy environment relationship, importance of air pollution, Air sampling methods & equipment, analytical methods for air pollution studies. Control of air pollution. Sound pollution: basics of sound pollution, its effect to environment. Acoustic noise measurement & monitoring. Instruments in Weather station	7L

	Instruments in Weather station like Barometer, Rain gauge, Ceilometer etc. Global environmental analysis, Virtual Instruments in Environmental Engineering Laboratory, Rover Environmental Monitoring station (REMS).	
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. Water treatment technology - Walter J. Weber.
2. Air pollution engineering – M. N. Rao & H. V. N. Rao.
3. Air pollution control technology – Wark & Warner.
4. Environmental Instrumentation & Analysis Handbook, Randy D. Down & Jay H. Lehr, Wiley.
5. Environmental Engineering- Peany Howard S, Donal R Rowe and George Tacho Banoylous Teddy.
6. Environmental Engineering and Science, Gilber M Masters, Pearson Education (1997)

Course Objectives:

1. Analysis sources and effects of air and water pollutants.
2. Evaluation air pollution sampling and measurement techniques.
3. Application of water sampling and analysis techniques.
4. Assessment of solid waste management and noise level measurement techniques.

Course outcomes:

After completion of the course, the student will able to:

- CO1: Summarize and classify capabilities and limitations of analytical instruments.
CO2: Justify use of an analytical instrument in solving real world problem.
CO3: Familiarize with current literature, research in analytical instrumentation.
CO4: Develop analytical instrument with emphasize on safe use of analytical instruments.

Course Code	HSM-HU701 (For Theory)				
Category	Humanities and Social Sciences including Management Courses				
Course Title	Industrial Management & Entrepreneurship				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)					

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
01.	Introduction: Management: Its Nature, Purpose and Importance in Modern Organizations-Functions of Management- Types of Managerial Decisions-Information Processing -Importance of Ethics in Workplace-Basic idea about the Social Responsibility.	04L
02.	Strategic management: Business Mission, Vision, Formulation of objectives, Assessment of the external environment, Assessment of external competences, Strategic alternatives, portfolio analysis, methods, strategic choice.	06L
03.	Leading-Human Factors and Motivation in Enterprises: Maslow's Hierarchl' of Needs theory, Herzberg's Two factor theory, Mc Gregor's X Theory and Y Theory-Leadership: Trait approaches-Leadership Behavior and Styles(overview),Group behavior, Stages in Group Development	05L
04.	Human Resource Management: Meaning of human Resource and Human Resource management, Understanding Human Behavior in Modern Organizations- Overall idea about the Operative Functions of Human Resource Management-Recruitment and Selection-Performance Appraisal-Training and Development-Compensation management-Employee Relations: Brief Overview of each of these, Industrial grievance Management.	05L
05.	Marketing Management: Marketing as a Concept and Process-Role of Marketing in Modern Organizations- Concept of Marketing Mix-Product, Product Mix and Product line-Pricing: Meaning and Objectives-Basic idea about Promotion and Promotion Mix	05L
06.	Financial Management: Importance and Scope of Financial Management- Management of Working Capital- Dividend Policy- Capital Budgeting- Cost of capital & Capital Structure: functional ratios. Brief Overview of each of these	05L
07.	Productivity, Operations Management and Total Quality Management: Production and Operations Management: - -Productivity Problems and Measurement- Tools and Techniques for Improving Productivity- Basic Idea about Total Quality Management: Material handling, inventory control, JIT manufacturing, waste management.	07L
08.	Entrepreneurship and Small Business: Forms of Ownership The Nature of Entrepreneurship -Entrepreneurial Scopes and Opportunities- - New Venture Creation: Developing Business Plan, Forms of ownership, Different forms of entrepreneurship, partnership ventures, creativity in entrepreneurship, need for financing of new ventures.	05L
	Total	42L
	Total week required	14
	No. of week reserved	02

Books: Text and/or Reference:

1. Essentials of Management: H. Koontz and H. Weihridr, TatzMcGraw-Hill
2. S. P. Robbins and M. Coulter, Irlanagement; Prentice Hall India

3. J. R. Sdrermerhorn, Jr., Management, Wiley-India
4. J. A. F. Stoner, R. E. Freeman and D. R. Gilbert, Jr., Management, Prentice Hall
5. Management Theory and Practice By C B Gupta
6. Strategic Management and Business Policy By Azhar Kazmi
7. Principles of Management by Richard L. Daft,
8. Human Resource Management by Dr. S. S. Khanka
9. Production and Operations Management by S. Anil Kumar and N. Suresh,
10. Fundamentals of Entrepreneurship Development & Business Communication by Pranam Dhar
11. Discourses of Strategic Management by Dilip Roy

Course Outcomes:

At the end of this course, students will be able to

- Understand the concept of management and its different functions and how management concepts can be applied to practices as a member and leader in a team in a multidisciplinary environment to make management effective.
- Develop an understanding of professional, ethical, legal, and social issues and responsibilities of an industrial engineer to accomplish a common goal.
- Acquire certain knowledge about how to motivate people to work efficiently in industry.
- Make them possess the skill set required to make an appropriate staffing decision and to design, implement and evaluate training programmes for the successful completion of a project.
- Know the dynamics of marketing in business and to apply theoretical marketing concepts to the practical situations like marketing research, marketing mixes and selling propositions etc.
- Know the concepts of financial management and how top management exercises financial control relating to capital structure, investment, dividend decisions etc.
- Make them understand management of manufacturing and production system and to use different techniques and tools to improve productivity.
- Instill some leadership and entrepreneurial and risk bearing attributes to enable them to start up their own ventures.

Course code	PROJ-EI 791				
Category	Project				
Course title	Project Stage I				
Scheme and Credits	L	T	P	Credits	Semester – VII
	0	0	10	5	
Pre-requisites (if any)					

The object of Project Stage I is to enable the student to take up investigative study in the broad field of Electronics & Instrumentation Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include:

1. Survey and study of published literature on the assigned topic;
2. Working out a preliminary Approach to the Problem relating to the assigned topic;
3. Conducting preliminary Analysis/Modelling/Simulation/Experiment/Design/Feasibility;
4. Preparing a Written Report on the Study conducted for presentation to the Department;
5. Final Seminar, as oral Presentation before a departmental committee.

Course code	PROJ-INT 791				
Category	Project				
Course title	Internship				
Scheme and Credits	L	T	P	Credits	Semester – VII
	0	0	-	2	
Pre-requisites (if any)					

Minimum of six weeks in an Industry in the area of Electronics and Instrumentation Engineering. The summer internship should give exposure to the practical aspects of the discipline. In addition, the student may also work on a specified task or project which may be assigned to him/her. The outcome of the internship should be presented in the form of a report.

Semester VIII

Course code	PEC-EI 811(a) (For Theory)				
Category	Professional Elective Course (PEC)				
Course title	Biomedical Instrumentation				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	3	0	0	3	
Pre-requisites (if any)	Basic Electronics				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Introduction to Biomedical Instrumentation: Components of Man – Instrument system. Challenges in bio medical instrumentation; Artifacts of Biomedical instrumentation; Biomedical transducers; In vivo and In vitro processes, Introduction to Human Physiology: Physiological Systems in Human body; Cardio vascular system, Respiratory system, Muscular system, Nervous system. Bio electrodes, Bio potential – resting and action; Propagation of action potential, Electrode – tissue interface; Selection criteria of electrodes.	12L

2.	ECG, EMG, EEG, ERG – Principle, procedure, interpretation, electronic circuits, lead system, recording methods, typical waveforms, Blood, Heart & Lungs: Blood pressure, Blood flow rate, heart sound and cardiac output measurement, respiratory system measurement, lung volume, Plethysmography, Spirometry, Pace maker, Defibrillator, Blood gas analyzers, Oximeters. Blood cell counter.	11L
3.	Imaging Techniques: X – ray, Ultrasound, Computer Tomography, Magnetic Resonance Imaging, Positron Emission Tomography, and Radionuclide Imaging. Their working principle, block diagram, image artifacts, image intensifiers, Drawbacks. Application areas.	9L
4	Assisting and therapeutic device: Ventilator, Anesthesia machine, Nerve and muscle simulator, Audiometers, Diathermy, Endoscopes, Kidney machine – Dialysis. Lithotripsy. Laser application in Medicine: Thermal and Non – thermal, Ophthalmology, Retinopathy, Glaucoma, Dermatology, Biotelemetry: Transmission & Reception aspects of biological signals, Safety and precautions of biomedical equipment: Care and Feeding of battery-operated medical equipment. Bioinformatics: basics of molecular biology, computational bioinformatics, matching algorithms, BLAST.	10L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text Books/ References:

- 1 L. Cromwell, “Biomedical Instrumentation and Measurements”, Pearson Education.
2. J. J. Carr, “Introduction to Biomedical Equipment Technology”, Pearson Education.
3. R. S. Khandpur, “Handbook of Biomedical Instrumentation”, TMH, New Delhi.
4. N. Pandey, “Bio-Medical Electronics and Instrumentation”, Katson books, New Delhi.
5. Cremer- Bioinformatics

Course outcomes:

After completion of the course, the students will be able to:

- CO1: Understand the application of the electronic systems in biological and medical applications.
CO2: Acquire knowledge and functionality of different biomedical instruments.
CO3: Understand the practical limitations on the electronic components while handling biosubstances.
CO4: Understand and analyze the biotelemetry system of different physiological parameters.

Course code	PEC-EI 811(b)				
Category	Professional Elective Courses (PEC)				
Course title	Pattern Recognition				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	3	0	0	3	
Pre-requisites (if any)	Mathematics				

Theory Syllabus:

Module	Detailed Description	Lecture / Tutorial Period
1.	Introduction: Mathematical preliminaries, What is Pattern recognition; Applications and Examples, Clustering vs. Classification; Supervised vs. unsupervised, Relevant basics of Linear Algebra, vector spaces, Probability Theory basics, Basics of Estimation theory, Decision Boundaries, Decision region / Metric spaces/ distances, Mathematical Assignments	10L
2.	Classification: Bayes decision rule, Error probability, Normal Distribution, Linear Discriminant Function (equal covariance matrices), Non-linear Decision Boundaries (unequal covariance matrices), Mahalanobis Distance, K-NN Classifier, Fisher's LDA, Layer Perceptron, Multi-layer Perceptron, Training set, test set; standardization and normalization, List of Assignments	12L
3.	Clustering: Basics of Clustering; similarity / dissimilarity measures; clustering criteria. Different distance functions and similarity measures, Minimum within cluster distance criterion, K-means algorithm; Single linkage and complete linkage algorithms, MST, K-medoids, DBSCAN, Data sets - Visualization; Unique Clustering; No existence of clusters	9L
4.	Feature selection: Problem statement and Uses; Algorithms - Branch and bound algorithm, sequential forward / backward selection algorithms, (l,r) algorithm; Probabilistic separability based criterion functions, interclass distance based criterion functions. Feature Extraction: PCA + Kernel PCA Recent advances in Pattern Recognition: Structural PR, SVMs, FCM, Soft-computing and Neuro-fuzzy techniques, and real-life examples	11L
	TOTAL:	42L
	Total Week Required:	14
	No. Of Week Reserved:	02

Text/Reference Books:

1. Required: Duda, Hart and Stork, Pattern Classification, Second Edition, Wiley, 2001.
2. T.M. Mitchell, Machine learning, McGraw-Hill, New York, 1997.
3. S. Theodoridis, K. Koutroumbas, Pattern recognition, Academic Press, 1999.

Course outcomes:

After completion of the course, the student will able to:

- CO1: Get knowledge about clustering and classification
CO2: Analysis of different types of dataset statistically.
CO3: Apply different classification algorithm techniques.
CO4: Develop knowledge of different types of feature extraction and selection techniques.
CO5: Know detailed of different computational techniques and their applications.

Course Code	PEC-EI 811(c)				
Category	Professional Elective Course (PEC)				
Course Title	Agricultural Instrumentation				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	3	0	0	3	
Pre-requisites (if any)	Industrial Instrumentation.				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	<p>Introduction: Necessity of instrumentation & control for agriculture, engineering properties of soil; Fundamental definitions & relationships, index properties of soil, permeability & seepage analysis, shear strength, Mohrs circle of stress, active & passive earth pressures, stability & slopes.</p> <p>Instrumentation in Process industry Flow diagram of sugar plant & instrumentation set up for it, flow diagram of fermenter & control (batch process), flow diagram of dairy industry & instrumentation set up for it, juice extraction - control process & instrumentation set.</p>	10 L
2.	<p>Weather Monitoring Instruments: Hygrometer, Pyroheliometer, Pan Evaporator, ETgage; Meteorological Display Unit, Pyranometer, Luxmeter, Salinity Refractometer, Psychrometer, soil pH meter, soil moisture/water content meter, tensiometer, hydrometer, soil salinity conductivity meter, sunshine duration meter, Agro meteorological Digital Weather station. Time Domain Reflectometer (TDR).</p> <p>Instrumentation in Irrigation and Green house System Irrigation systems: necessity, irrigation methods: overhead, centre pivot, lateral move, micro irrigation systems, soil moisture measurement methods: resistance based method, voltage based method, thermal based method, details of gypsum block, irrigation scheduling, irrigation efficiencies, Application of SCADA for DAM parameters & control.</p>	11 L
3.	<p>Green houses & instrumentation: ventilation, cooling & heating, Anemometer for wind speed, temperature & humidity, rain gauge carbon dioxide enrichment measurement & control.</p> <p>Instruments in Farming Automation in earth moving equipment & farm equipment, implementation of hydraulic, pneumatic & electronics control circuits in harvesters cotton pickers, tractor etc. classification of pumps: pump characteristics, pump selection & installation.</p>	11 L
4	<p>Food Processing Definition, Food quality measurement, food safety and standards bill 2005, central committee for food standards, Agmark, Bureau of Indian Standards, Codex Standards, recommended international code of hygiene for various products, Design consideration: cold storage, atmospheric controller and preservatives; biosensors.</p>	10 L

	Automation in Food Industry Application of SCADA & PLC in food packing industry, Trends in modern food processing, Equipment for creating and maintaining controlled atmosphere.	
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. Handbook of Instrumentation Process control –B.G.Liptak, Chilton.
2. Irrigation: Theory and Practice, Michael. A.M, Vikas Publishing House Pvt Ltd, 2008.
3. Process control and instrumentation technology, “C.D. Johnson”, PHI.
4. Mineral Processing Technology, Wills B.A., 4th Ed.,Pergamon Press.
5. Automatic Control for food processing system, R.G.Moreira, T.P.Coulate, 2001.

Course Objectives:

1. To recognize and identify the physical mechanisms of basic sensors and how they interact with the measurand for agricultural applications.
2. To understand the heat and water flow through soil - sensing and visualization.
3. To facilitate mechanisms for crop monitoring.
4. To diagnose crop conditions using color detection and machine vision techniques.

Course outcomes:

After completion of the course, the student will able to:

- CO1. Characterize problems and possible technological solution of agro industries.
CO2. Familiarize with current literature, research in agricultural instrumentation
CO3. Analyze and design of automation system by evaluating agricultural parameter measurement constraint.
CO4. Monitor and test fertigation in Greenhouse.

Course code	PROJ-EI 891				
Category	Project				
Course title	Project Stage II				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	0	0	12	6	
Pre-requisites (if any)					

The object of Project Stage II & Dissertation is to enable the student to extend further the investigative study taken up under Project Stage I, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership. The assignment to normally include:

1. In depth study of the topic assigned in the light of the Report prepared under Project Stage I;
2. Review and finalization of the Approach to the Problem relating to the assigned topic;
3. Preparing an Action Plan for conducting the investigation, including team work;
4. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed;
5. Final development of product/process, testing, results, conclusions and future directions;
6. Preparing a paper for Conference presentation/Publication in Journals, if possible;
7. Preparing a Dissertation in the standard format for being evaluated by the Department.
8. Final Seminar Presentation before a Departmental Committee.