Autonomy Curriculum
For
B. TECH DEGREE COURSES
IN
Applied Electronics and Instrumentation Engineering
(NBA Accredited)

(Applicable from the academic session 2024-2025 onwards)

Haldia Institute of Technology
An Autonomous Institute, NAAC Accredited Grade 'A' Institute

Approved by: All India Council for Technical Education (AICTE)
Affiliated to: Maulana Abul Kalam Azad University of Technology, West Bengal
(Formerly Known as - WBUT)

Haldia, Purba Medinipur, West Bengal, India, 721657

Department of Applied Electronics and Instrumentation Engineering

General, Course structure & Theme
&
Semester-wise credit distribution

A. Definition of Credit:

1 Hr. Lecture (L) per week	1 credit
1 Hr. Tutorial (T) per week	1 credit
1 Hr. Practical (P) per week	0.5 credits
2 Hours Practical (Lab) per week	1 credit

B. Range of credits -A range of credits from 150 to 160 for a student to be eligible to get Under Graduate degree in Engineering. A student will be eligible to get Under Graduate degree with Honours or additional Minor Engineering, if he/she completes an additional 20 credits. These could be acquired through MOOCs.

C. Structure of Undergraduate Engineering program :

Sl.	No. Topic	**Breakup of Credits**	
		EIE Curriculum	**As per AICTE**
1	Humanities and Social Sciences including Management	10	12
2	Basic Sciences	25	25
3	Engineering Sciences including workshop, drawing, basics of electrical/mechanical/computeretc.	21	24
4	Professional Core Subjects	50	48
5	Professional Subjects: Subjects relevant to chosenspecialization/branch	19	18
6	Open Subjects: Electives from other technicaland/or emerging subjects	20	18
7	Project work, seminar and internship in industry orelsewhere	15	15
8	Mandatory Courses [Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Traditional Knowledge]	Non-credit	Non-credit
	Total	160	160*

BASIC SCIENCE COURSES

Sr. No.	Course code	Course Title	Hours / Week L:T:P	Credit	Preferred Semester
1	BS-M 101	Mathematics-I	3-1-0	4	**I**
2	BS-PH 101	Physics-I	3-1-3	5.5	**I**
3	BS-BT 101/	Biology for Engineers	2-0-0	2	**I**
4	BS-CH 201	Chemistry-I	3-1-3	5.5	**II**
5	BS-M 201	Mathematics-II	3-1-0	4	**II**
6	BS-M 301	Mathematics-III	2-1-0	3	**III**
7	BS-M 391	Numerical Methods Lab	0-0-2	1.0	**IV**
Total (25 max)				**25**	

ENGINEERING SCIENCE COURSES

Sr. No.	Course code	Course Title	Hours / Week L:T:P	Credit	Preferred Semester
1	ES-CS 201	Computer Programming for Problem solving	3-1-3	5.5	II
2	ES-EE 101	Basic Electrical & Electronics Engg.	3-1-3	5.5	I
3	ES-ME 291	Engineering Drawing	0-0-3	1.5	II
4	ES-ME 191	Workshop Practice	0-0-3	1.5	I
5	ES-EI 401	Electromagnetic Theory	3-0-0	3	**IV**
6	ES-EI 402	Data Structure & Algorithm	3-0-2	4.0	IV
Total (24 max)				**21.0**	

HUMANITIES & SOCIAL SCIENCES INCLUDING MANAGEMENT

Sr. No.	Course code	Course Title	Hours / Week L:T:P	Credit	Preferred Semester
1	HM-HU 201	English Communication	2-0-2	3	II
2	HSMC 201	Values and Ethics in Profession	2-0-0	2	VI
3	HM-HU 481	Advanced Language Lab	0-0-2	1	IV
4	HM-HU 401	Economics For Engineers	3-0-0	2	IV
5	HM-HU 801	Project Management and entrepreneurship	2-0-0	2	VIII
Total (12 max)				**10**	

MANDATORY COURSES

Sr. No.	Course code	Course Title	Hours / Week L:T:P	Credit	Preferred Semester
	MC	Extra-Curricular Activity (NSS, etc.)XC-181	0-0-2	NIL	I

1	MC	Environmental Sciences,	2-0-0	NIL	III
2	MC	Indian constitution and culture	1-0-0	NIL	IV
		Total		**0**	

PROFESSIONAL CORE COURSES

Sr. No.	Course code	Course Title	Hours / Week L:T:P	Credit	Preferred Semester
1	PC-EI 301	Circuit Theory and Network Analysis	3-0-3	4.5	**III**
2	PC-EI 302	Sensors & Transducers	3-0-3	4.5	**III**
3	PC-EI 303	Analog Electronic Circuits	3-1-3	5.5	**III**
4	PC-EI 304	Digital Electronic Circuits	3-1-3	5.5	**III**
5	PC-EI 401	Electrical & Electronic Measurements	3-1-3	5.5	**IV**
6	PC-EI 402	Microprocessors & Microcontroller	3-1-3	5.5	**IV**
7	PC-EI 501	Control Theory	3-1-3	5.5	**V**
8	PC-EI 502	Industrial Instrumentation	3-0-3	4.5	**V**
9	PC-EI 601	Process Control	3-0-3	4.5	**VI**
10	PC-EI 602	Electrical Machine	3-0-0	3	**VI**
11	PC-EI 692	Instrumentation System Design Lab	0-0-3	1.5	**VI**
Total (48 max)				**50**	

PROFESSIONAL ELECTIVE COURSES OFFERED

Sr. No.	Course code	Course Title	Hours / Week L:T:P	Credit	Preferred Semester
1	PE-EI 401/ PE-EI 402	Power Electronics/ Nano Electronics	3-0-0	3	**IV**
2	PE-EI 501/ PE-EI 502	Optical Instrumentation/Advanced Sensors	3-0-0	3	V
3	PE-EI 503/ PE-EI 504	Analog and digital Communication / Telemetry & Wireless Sensor Network	3-0-0	3	**V**
4	PE-EI 603/ PE-EI 604	Plant Instrumentation and Control/Advanced Control System	3-0-0	3	**VI**
5	PE-EI 605/ PE-EI 606	Biomedical and Analytical Instrumentation/ Non Destructive Testing	4-0-0	4	**VI**
6	PE-EI 701/ PE-EI 702	Renewable Energy Sources / Virtual Instrumentation	3-0-0	3	**VII**
Total (18)				**19**	

OPEN ELECTIVE COURSES OFFERED

Sr. No.	Course code	Course Title	Hours / Week L:T:P	Credit	Preferred Semester
1.	OE-EI 501/	Object Oriented Programming /Data Base	3-0-3	4.5	**V**

	OE-EI 502	Management System			
2.	OE-EI 503/ OE-EI 504	Digital Signal Processing/ Signals and Systems	4-0-0	4	V
3.	OE-EI 601/ OE-EI 602	Internet of Things (IoT) and Networking /Artificial Intelligence (AI)	4-0-3	5.5	**VI**
4.	OE-EI 601/ OE-EI 602	Embeded System/ VLSI & Microelectronics	3-0-0	3	**VI**
5.	OE-EI 701/ OE-EI 702	Micro Electro Mechanical Systems (MEMS)/ Mechatronics	3-0-0	3	**VII**
Total (18 max)				**20**	

PROJECT WORK, SEMINAR AND INTERNSHIP IN INDUSTRY OR ELSEWHERE

Sr. No.	**Course code**	**Course Title**	**Hours / Week L:T:P**	**Credit**	**Preferred Semester**
1.	PW-EI 681	Seminar	0-0-4	2.0	VI
2.	PW-EI 781	PROJECT-II	0-0-6	3.0	**VII**
3.	PW-EI 782	INDUSTRIAL TRAINING EVALUATION		2.0	**VII**
4.	PW-EI 881	PROJECT-III	0-0-12	6.0	**VIII**
5.	PW-EI 882	**INTERNSHIP**		2.0	**VIII**
Total (15 max)				**15.0**	

Details course structure

Department of Applied Electronics and Instrumentation Engineering

SEMESTER - I

THEORY

Sr. No.	Categories	Course code	Course Title	Hours / Week L:T:P	Credit
1	Basic Science	BS-M 101	Mathematics-I	3-1-0	4
2		BS-PH 101	Physics-I	3-1-0	4
3	Engineering Science	ES-EE-101	Basic Electrical & Electronics Engineering	3-1-0	4
4	Basic Science	BS-BT 101/	Biology for Engineers	3-0-0	2
Total				**14**	**14**

PRACTICAL

Sr. No.	Categories	Course code	Course Title	Hours / Week L:T:P	Credit
5	Basic Science	BS-PH 191	Physics Lab-I	0-0-3	1.5
6	Engineering Science	ES-EE-191	Basic Electrical & Electronics Engineering. Lab	0-0-3	1.5
7	Engineering Science	ES-ME 191	Workshop Practice	0-0-3	1.5
Total				**9**	**4.5**

SESSIONAL

Sr. No.	Categories	Course code	Course Title	Hours / Week L:T:P	Credit
7	Basic Science	XC-181	Extra-Curricular Activity (NSS, etc.)	0-0-2	0.0

SEMESTER - II

THEORY

Sr. No.	Categories	Course code	Course Title	Hours / Week L:T:P	Credit
1	Basic Science	BS-M 201	Mathematics-II	3-1-0	4
2		BS-CH 201	Chemistry-I	3-1-0	4
3	Engineering Science	ES-CS 201	Computer Programming for Problem solving	3-1-0	4
4	Humanities	HM-HU 201	English Language and Technical Communication	2-0-0	2
5		HS-MC 201	Values Ethics and Indian Knowledge System	2-0-0	2
Total				**16**	**16**

PRACTICAL

Sr. No.	Categories	Course code	Course Title	Hours / Week L:T:P	Credit
6	Basic Science	BS-CH 291	Chemistry Lab-I	0-0-3	1.5
7	Engineering Science	ES-CS 291	Computer Programming Lab	0-0-3	1.5
8		ES-ME 291	Engineering Drawing	0-0-3	1.5
9	Humanities	HM-HU 291	English Language and Technical Communication Lab	0-0-2	1.0
Total				**11**	**5.5**

First Year Total	**50**	**40**

SEMESTER - III

THEORY

Sr. No.	Categories	Course code	Course Title	Hours / Week L:T:P	Credit
1	Basic Science	BS-M 301	Mathematics -III	2-1-0	3
2	Professional Core	PC-EI 301	Circuit Theory and Network Analysis	2-1-0	3
3		PC-EI 302	Sensors & Transducers	3-0-0	3
4		PC-EI 303	Analog Electronic Circuits	3-1-0	4
5		PC-EI 304	Digital Electronic Circuits	3-1-0	4
6	Mandatory Course	MC-ES 301	Environmental Science	2-0-0	0
Total				**19**	**17**

PRACTICAL

Sr. No.	Categories	Course code	Course Title	Hours / Week L:T:P	Credit
7	Professional Core	PC-EI 391	Circuit Theory Lab	0-0-3	1.5
8		PC-EI 392	Sensors &Transducers Lab	0-0-3	1.5
9		PC-EI 393	Analog Electronics Lab	0-0-3	1.5
10		PC-EI 394	Digital Electronics Lab	0-0-3	1.5
11	Basic Science	BS-M 391	Numerical Methods Lab	0-0-2	1.0
Total				**11**	**7.0**

3rd Semester Total	**30**	**24**

SEMESTER -IV

THEORY

Sr. No.	Categories	Course code	Course Title	Hours / Week L:T:P	Credit
1	Professional Core	PC-EI 401	Electrical & Electronic Measurements	3-1-0	4
2		PC-EI 402	Microprocessors & Microcontroller	3-1-0	4
3	Engineering Science	ES-EI 401	Electromagnetic Theory	3-0-0	3
4		ES-EI 402	Data Structure & Algorithm	3-0-0	3
5	Professional Elective Course-**I**	PE-EI 401/ PE-EI 402	Power Electronics/ Nano Electronics	3-0-0	3
6	Humanities	HM-HU 401	Economics For Engineers	2-0-0	2
Total				**19**	**19**

PRACTICAL

Sr. No.	Categories	Course code	Course Title	Hours / Week L:T:P	Credit
7	Professional Core	PC-EI 491	Electrical & Electronic Measurements Lab	0-0-3	1.5
8		PC-EI 492	Microprocessors & Microcontroller Lab	0-0-3	1.5
9	Engineering Science	ES-EI 491	Data Structure & Algorithm Lab	0-0-2	1.0
10	Humanities	HM-HU 481	Advanced Language Lab	0-0-2	1.0
Total				**9**	**5.0**

4th Semester Total	**28**	**24**

2nd Year Total	**58**	**48**

SEMESTER - V

THEORY

Sr. No.	Categories	Course code	Course Title	Hours / Week L:T:P	Credit
1	Professional Core	PC-EI 501	Control System	3-1-0	4
2		PC-EI 502	Industrial Instrumentation	3-0-0	3
3	Professional Elective Course-II	PE-EI 501/ PE-EI 502	Optical Instrumentation/ Advanced Sensors	3-0-0	3
4	Professional Elective Course-III	PE-EI 503/ PE-EI 504	Analog and digital Communication / Telemetry & Wireless Sensor Network	3-0-0	3
5	Open Elective Course-I	OE-EI 501/ OE-EI 502	Object Oriented Programming /Data Base Management System	3-0-0	3
6	Open Elective Course-II	OE-EI 503/ OE-EI 504	Signals and Systems/ Digital Image Processing	3-1-0	4
7	Mandatory Course	MC-ES 501	Indian Constitution And Culture	1-0-0	0
Total				**21**	**20**

PRACTICAL

Sr. No.	Categories	Course code	Course Title	Hours / Week L:T:P	Credit
8	Professional Core	PC-EI 591	Control System Lab	0-0-3	1.5
9		PC-EI 592	Industrial Instrumentation Lab	0-0-3	1.5
10	Open Elective Course-I	OE-EI 591/ OE-EI 592	Object Oriented Programming Lab/Data Base Management System Lab	0-0-3	1.5
Total				**9**	**4.5**

5th Semester Total	**30**	**24.5**

SEMESTER -VI

THEORY

Sr. No.	Categories	Course code	Course Title	Hours / Week L:T:P	Credit
1	Professional Core	PC-EI 601	Process Control	3-0-0	3
2	Professional Core	PC-EI 602	Electrical Machine	3-0-0	3
3	Professional Elective Course-IV	PE-EI 601/ PE-EI 602	Plant Instrumentation and Control/Advanced Control System	3-0-0	3
4	Professional Elective Course-V	PE-EI 603/ PE-EI 604	Biomedical and Analytical Instrumentation/ Non Destructive Testing	4-0-0	4
5	Open Elective Course-III	OE-EI 601/ OE-EI 602	Computer Networking and Internet of Things (IoT)/Artificial Intelligence (AI)	4-0-0	4
6	Open Elective Course-IV	OE-EI 603/ OE-EI 604	Embeded System/ VLSI & Microelectronics	3-0-0	3
Total				**20**	**20**

PRACTICAL& SESSIONAL

Sr. No.	Categories	Course code	Course Title	Hours / Week L:T:P	Credit
7	Professional Core	PC-EI 691	Process Control Lab	0-0-3	1.5
8	Professional Core	PC-EI 692	Instrumentation System Design & AICTE IDEA Lab	0-0-3	1.5
9	Open Elective Course-III	OE-EI 691/ OE-EI 692	Internet of Things (IoT) /Artificial Intelligence (AI)	0-0-3	1.5
10	Seminar	PW-EI 681	Seminar	0-0-4	2.0
Total				**13**	**6.5**

6th Semester Total	**33**	**26.5**

3rd Year Total	**66**	**51**

Seminar may *include presentation on the project topic's introduction, literature survey, research gap finding, problem formulation and objectives.*

Note: *Vocational Training/ Internship conducted up to sixth semester will be evaluated in seventh and eighth semester. Total accumulated hours of Vocational Training/ Internship is 48 hours/week × 24 weeks= 1152 hours*

SEMESTER - VII

THEORY

Sr. No.	Categories	Course code	Course Title	Hours / Week L:T:P	Credit
1	Professional Elective Course-VI	PE-EI 701/ PE-EI 702	Renewable Energy Sources/ Virtual Instrumentation	3-0-0	3
2	Open Elective Course-V	OE-EI 701/ OE-EI 702	Micro Electro Mechanical Systems (MEMS)/ Mechatronics	3-0-0	3
Total				**6**	**6**

PRACTICAL & SESSIONAL

Sr. No.	Categories	Course code	Course Title	Hours / Week L:T:P	Credit
1	Project Work	PW-EI-781	Project-I	0-0-6	**3**
2	Industrial Training	PW-EI-782	Industrial Training Evaluation		2.0
Total				**6**	**5.0**

7th Semester Total	**12**	**11**

*** Project – II includes design of product, experiment, strategy, algorithm, hypothesis, service aid, gadgets and thorough analysis.*

SEMESTER - VIII

THEORY

Sr. No.	Categories	Course code	Course Title	Hours / Week L:T:P	Credit
1	Humanities	HM-HU 801	Project Management and Entrepreneurship	2-0-0	2
Total				**2**	**2**

PRACTICAL & SESSIONAL

Sr. No.	Categories	Course code	Course Title	Hours / Week L:T:P	Credit
2	Project Phase-II	PW-EI881	Project-II	0-0-12	6.0
3	Internship	PW-EI 882	Internship Evaluation	-	2.0
Total				**12**	**8.0**

8th Semester Total	**14**	**10**

4th Year Total	**26**	**21**

Grand Total	**200**	**160**

**** Project – II entails upshot of the project (keeping in view of utility, technical feasibility, economic viability, eco friendliness) and also to divulge conclusion and future scope.*

Note: A multidisciplinary laboratory using AICTE IDEA lab, IoT Lab, Computing lab etc. to be conducted for a duration of 7.5 hours/week × 84 weeks (14 week/ sem× 6 sem) = 630 hours

The credits of the different courses are ascertained through the guide lines laid down by NBA are shown here:

Course code	Course Title	Teaching & Learning Scheme					
		Classroom Instructions (CI) (in hours/sem)		Lab instructions (LI) (In hours/sem)	Team Work (TW) and Self Learning (SL) (TW+SL) (In hours per/sem)	Total no. of hours/sem	Total credits (C) (Total Hours/30)
		L	T	P	SL		
BS-M 101	Mathematics-I	42	14	0	64	120	4
BS-PH 101	Physics-I	42	14	0	64	120	4
ES-EE-101	Basic Elec. & Electro. Engineering	42	14	0	64	120	4
BS-BT 101/	Biology for Engineers	28		0	32	60	2
BS-PH 191	Physics Lab-I			42	3	45	1.5
ES-EE-191	Basic Elec. & Electro. Engineering. Lab			42	3	45	1.5
ES-ME 191	Workshop Practice			42	3	45	1.5
XC-181	NSS, etc.			50	0	50	0
BS-M 201	Mathematics-II	42	14		64	120	4
BS-CH 201	Chemistry-I	42	14		64	120	4
ES-CS 201	Computer Programming for Problem solving	42	14		64	120	4
HM-HU 201	English Language and Technical	28	0		32	60	2
HS-MC 201	Values Ethics and Indian Knowledge System	28	0		32	60	2
BS-CH 291	Chemistry Lab-I		0	42	3	45	1.5
ES-CS 291	Computer Programming Lab		0	42	3	45	1.5
ES-ME 291	Engineering Drawing		0	42	3	45	1.5
HM-HU 291	English Language and Technical Communication Lab		0	28	2	30	1

BS-M 301	Mathematics -III	28	14		48	90	3
PC-EI 301	Circuit Theory and Network Analysis	28	14		48	90	3
PC-EI 302	Sensors & Transducers	42	0		48	90	3
PC-EI 303	Analog Electronic Circuits	42	14		64	120	4
PC-EI 304	Digital Electronic Circuits	42	14		64	120	4
MC-ES 301	Environmental Science	28	0		22	50	0
PC-EI 391	Circuit Theory Lab		0	42	3	45	1.5
PC-EI 392	Sensors &Transducers Lab		0	42	3	45	1.5
PC-EI 393	Analog Electronics Lab		0	42	3	45	1.5
PC-EI 394	Digital Electronics Lab		0	42	3	45	1.5
BS-M 391	Numerical Methods Lab		0	28	2	30	1
PC-EI 401	Electrical & Electronic Measurements	42	14		64	120	4
PC-EI 402	Microprocessors & Microcontroller	42	14		64	120	4
ES-EI 401	Electromagnetic Theory	42	0		48	90	3
ES-EI 402	Data Structure & Algorithm	42	0		48	90	3
PE-EI 401/ PE-EI 402	Power Electronics/ Nano Electronics	42	0		48	90	3
HM-HU 401	Economics For Engineers	28	0		32	60	2
PC-EI 491	Electrical & Electronic Measurements Lab		0	42	3	45	1.5
PC-EI 492	Microprocessors & Microcontroller Lab		0	42	3	45	1.5
ES-EI 491	Data Structure & Algorithm Lab		0	28	2	30	1
HM-HU 481	Advanced Language Lab		0	28	2	30	1
PC-EI 501	Control System	42	14		64	120	4
PC-EI 502	Industrial Instrumentation	42	0		64	106	3
PE-EI 501/ PE-EI 502	Optical Instrumentation/ Advanced Sensors	42	0		48	90	3
PE-EI 503/ PE-EI 504	Analog and digital Communication / Telemetry & Wireless Sensor Network	42	0		48	90	3
OE-EI 501/ OE-EI 502	Object Oriented Programming /Data Base Management System	42	0		48	90	3
OE-EI 503/ OE-EI 504	Digital Signal Processing/ Signals and Systems	42	14		64	120	4
MC-ES 501	Indian Constitution And Culture	14	0		11	25	0
PC-EI 591	Control System Lab		0	42	3	45	1.5
PC-EI 592	Industrial Instrumentation Lab			42	3	45	1.5
OE-EI 591/	Object Oriented Programming		0	42	3	45	1.5

OE-EI 592	Lab/Data Base Management System Lab						
PC-EI 601	Process Control	42	0		48	90	3
PC-EI 602	Electrical Machine	42	0		48	90	3
PE-EI 603/ PE-EI 604	Plant Instrumentation and Control/Advanced Control System	42	0		48	90	3
PE-EI 605/ PE-EI 606	Biomedical and Analytical Instrumentation/ Non Destructive Testing	56	0		64	120	4
OE-EI 601/ OE-EI 602	Computer Networking and Internet of Things (IoT)/Artificial Intelligence (AI)	56	0		64	120	4
OE-EI 603/ OE-EI 604	Embeded System/ VLSI & Microelectronics	42	0		48	90	3
PC-EI 691	Process Control Lab	0	0	42	3	45	1.5
PC-EI 692	Instrumentation System Design & AICTE IDEA Lab	0	0	42	3	45	1.5
OE-EI 691/ OE-EI 692	Internet of Things (IoT) /Artificial Intelligence (AI)		0	42	3	45	1.5
PW-EI 681	Project-I		0	35	25	60	2
PE-EI 701/ PE-EI 702	Non Conventional Energy Sources/ Ultrasonic Instrumentation	42	0		48	90	3
OE-EI 701/ OE-EI 702	Micro Electro Mechanical Systems (MEMS)/ Mechatronics	42	0		48	90	3
PW-EI-781	Project-II		0	50	40	90	**3**
PW-EI-782	Industrial Training Evaluation		0	0	30	30	2
HM-HU 801	Project Management and Entrepreneurship	28	0			28	2
PW-EI881	Project-III		0	80	70	150	6
PW-EI 882	Internship Evaluation		0	0	30	30	2
						4819	

Mathematics-III

Course Name: Mathematics-III	**Category: Basic Science**
Course Code: BS-M 301	**Semester: 3rd**
L-T-P: 3-0-0	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Continuous Assessment: 30 Marks
Tutorial: 0 hr/week	End Semester Exam.: 70 Marks
Total Lectures: 36	
Pre-Requisites: Mathematics-I, Mathematics-II	

Objectives:

The objective of this course is to introduce the student to familiarize and develop skills in the design and analysis of Analog Electronic Circuit, which form the building blocks of almost any electronic system.

Course Outcomes:

CO1: Demonstrate a thorough understanding of probability concepts, including discrete and continuous random variables, conditional probability, independence, Bayes' theorem, and the application of probability distributions to real-world problems.
CO2: Analyze statistical data using measures of central tendency, dispersion, moments, skewness, and kurtosis, and apply curve-fitting techniques and regression analysis for data interpretation in practical scenarios.
CO3: Apply Fourier series and Fourier transforms to analyze periodic functions, signal processing, and other engineering applications, demonstrating an understanding of properties, convergence, and applications in real-life domains like sound and biomedical signal processing.
CO4: Employ numerical methods such as interpolation, numerical integration, and differential equation solvers to compute approximate solutions to mathematical problems and evaluate errors in numerical computations.

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Fundamentals of Probability:** Probability' spaces, conditional probability, independence: Bayes theorem. Discrete random variables, Independent random variables, the multinomial distribution. Poisson approximation to the binomial distribution infinite sequences of Bernoulli trials , sums of independent random variables; Expectation of Discrete Random Variables, Chebyshev's lnequality. Continuous random variables and their properties, distribution and density functions, normal, exponential and gamma densities.	8	**1-4**
Module: 2	**Data Statistics:** Basic Statistics, Measures of Central tendency, measures of dispersions: Moments, skewness and Kurtosis, Correlation and regression — Rank correlation. Curve fitting by the method of least squares- fitting of	6	**1-4**

	straight lines, second degree parabolas and more general curves. **Mini Project:** Analysis of Traffic Patterns, Analysis of Health Data.		
Module: 3	**Fourier Series:** Periodic functions: Properties, Even & Odd functions: Properties, Special wave forms: Square wave. Half wave Rectifier, Full wave Rectifier, Saw-toothed wave, Triangular wave. Euler's Formulae for Fourier Series, Fourier Series for functions of period 21, Dirichlet's conditions. Sum of Fourier series. Theorem for the convergence of Fourier Series (Without Proof. Fourier Series of a function with its periodic extension. Half Range Fourier Series: Constriction of Half range Sine and Cosine Series. Parseval's identity (Without Proof). **Mini Project:** Application in the domain of sound signal processing and biomedical signal processing, pattern recognition of basic signal, denoising of signals.	**6**	**1-4**
Module: 4	**Fourier Transform:** Fourier Integral Theorem (statement only), Fourier Transform of a function, Fourier Cosine & Sine Transforms. Fourier, Cosine & Sine Transforms of elementary functions. Properties of Fourier Transform: Linearity. Shifting, Change of scale, Modulation and applications. Fourier Transform of Derivatives. Convoliition Theorem (statement only), Inverse of Fourier Transform.	**4**	**1-4**
Module: 5	**Numerical Methods-I** Approximation in numerical computation, Tnincation and rounding errors, Fixed and floating- point arithmetic. Calculus of finite diffeiences, Newton forward/backward interpolation, Lagrange's and Newton's divided difference Interpolation.	**6**	**1- 4**
Module: 6	**Numerical Methods-II:** Trapezoidal rule. Simpson's 1/3 rule, Expression for corresponding error terms. Bisection method, Regula-Falsi method, Newton-Raphson method. Euler's . Modified Euler's and Runge-Kutta methods for solving ODE. **Mini Project:** Approximate solutions to the initial value problem using Euler's Method, the Improved Euler's Method, and the Runge-Kutta Method. Initial Value Problem.	**6**	**1-4**

Text Books:

Suggested Text/Reference Books :

1. ReenaGarg, Chandrika Prasad, Advanced Engineering Mathematics, Khanna Publishers.
2. Erwin Kreyszig, Ads anced Engineering Mathematics, John Wiley & Sons.
3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.
4. Michael Greenberg, Advanced Engineering Mathematics, Pearson.
5. Veerarajan T.. Engineering Mathematics for first year Tata McGraw-Hill, New Delhi.
6. A. Gupta, Groundwork of mathematical probability and statistics. Academic publishers.
7. Murray R Spiegel, Larry J. Stephens, Narinder Kumar. Statistics (Schaum's Outline Series). MCGraw Hill Education.
8. N.G. Das. Statistical Methods (Combined Volume), Tata-McGraw Hill.
9. Gupta & Kapoor. Fundamentals of Mathematical Statistics,Gupta (Sultan Cliand &SOns).
10. Jain, lyengar ,& Jain: Numerical Methods (Problems and Solution).
11. S.A.Mollah, Numerical Analysis and Computational Procedures. Books & Allied Ltd

CO-PO-PSO Mapping:

BS-M 301												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
1	3	3	2	2	1	1	-	-	-	-	-	2
2	3	3	2	2	1	1	-	-	-	-	-	2
3	3	3	3	3	2	1	-	-	-	-	-	2
4	3	3	3	3	2	1	-	-	-	-	-	2

BS-M 301			
CO	**PSO1**	**PSO2**	**PSO3**
1.	3	3	2
2.	3	3	2
3.	3	3	3
4.	3	3	3

Name of the Subject

Course Name: Environmental Science	**Category:** Mandatory Course
Course Code: MC-ES 301	**Semester: 3rd**
L-T-P: 2-0-0	**Credit: 0**
Teaching Scheme	**Examination Scheme**
Theory: 2hrs./week	Continuous Assessment: NIL
Tutorial: NIL	End Semester Exam.: NIL
Total Lectures: 24	
Pre-Requisites: Electrical and Electronics Engineering	

Objectives:

The objective of environmental science is to understand and address the complex interactions between humans and the natural environment. It involves studying the physical, chemical, biological, and social processes that influence the environment, as well as the impact of human activities on natural systems.

The subject aims to encourage the students with the followings:-

1. **Understanding Global Issues**: Equip students with knowledge about pressing environmental challenges such as climate change, deforestation, pollution, biodiversity loss, and resource depletion.
2. **Ethical and Responsible Action**: Foster a sense of environmental ethics, encouraging students to act as responsible stewards of the planet and make decisions that benefit both people and the environment.
3. **Environmental Conferences and Workshops**: Students are often encouraged to attend environmental conferences, workshops, and forums where they can present research, network with professionals, and stay updated on global trends and innovations in environmental science.

Course Outcomes (COs):

On completion of this course, the student will be able to

CO.1. Recall the components of natural environment, its relationships with human activities and also analyze human impacts on the environment.

CO.2. Understand key current environmental problems as well as be conversant with basic environmental legislation.

CO.3. Identify and apply the effect of the pollutants on the environment: atmosphere (air and noise), water and soil.

CO.4. Analyze the mathematical principles for successful solution of practical environmental engineering problems which in turn helps to solve any environmental issue arise during core industrial process or final uncontrolled as well as unplanned discharge.

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Module Name: Introduction to Environment and Degradation** o Basic ideas of environment, basic concepts, man, society & environment, their interrelationship. Mathematics of population growth and associated problems, Importance of population study in environmental engineering, definition of resource, types of resource, renewable, non-renewable, potentially renewable, effectof excessive use vis-à-vis population growth, Sustainable Development. Materials balance: Steady state conservation system, steady state system with non conservative pollutants, step function. o Environmental degradation: Natural environmental Hazards like Flood, earthquake, Landslide-causes, effects and control/management; Anthropogenic degradation like Acid rain-cause, effects and control. Nature and scope of Environmental Science and Engineering.	**4**	**1,2**
Module: 2	**Module Name: Ecology and Biodiversity** o Elements of ecology: System, open system, closed system, definition of ecology, species, population, community, definition of ecosystem components types and function. Structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems, Mangrove ecosystem (special reference to Sundar ban); Food chain [definition and one example of each food chain], Food web. Biogeochemical Cycle- definition, significance, flow chart of different cycles with only elementary reaction [Oxygen, carbon, Nitrogen, Phosphate, Sulphur]. o Biodiversity- types, importance, Endemic species, Biodiversity Hotspot, Threats to biodiversity, Conservation of biodiversity.	**4**	**1,2**
Module: 3	**Module Name: Atmospheric Composition and Dispersion** o **Atmospheric Composition:** Troposphere, Stratosphere, Mesosphere,Thermosphere, Tropopause and Mesopause. o **Energy balance:** Conductive and Convective heat transfer, radiation heat transfer, simple global temperature model [Earth as a black body, earthasalbedo], Problems.global climate and consequently on sea water level, agriculture and warming. Earth's heat budget.Lapse rate: Ambient lapse rate Adiabatic lapse rate, atmospheric stability, temperature inversion (radiation inversion). o **Atmospheric dispersion:** Maximum mixing depth, ventilation coefficient, effective stack height, smokestack plumes and Gaussian plume model. Definition of pollutants and contaminants, Primary and secondary pollutants: emission standard, criteria pollutant. Sources and effect of different air pollutants- Suspended particulate matter,oxides of carbon, oxides of nitrogen, oxides of sulphur, particulate, PAN. Smog, Photochemical smog and London smog. o **Depletion Ozone layer:** CFC, destruction of ozone layer by CFC, impact of other green house gases, effect of ozone modification.Standards and control measures: Industrial,	**7**	**1,2,3**

	commercial and residential air quality standard, control measure (ESP. cyclone separator, bag house, catalytic converter, scrubber (ventury).		
Module: 4	**Module Name: Hydrosphere** o Pollutants of water, their origin and effects: Oxygen demanding wastes, pathogens, nutrients, Salts, thermal application, heavy metals, pesticides, volatile organic compounds.River/Lake/ground water pollution: River: DO, 5 day BOD test, Seeded BOD test, BOD reaction rate constants, Effect of oxygen demanding wastes on river[deoxygenation, reaeration], COD, Oil, Greases, pH. Lake: Eutrophication [Definition, source and effect]. Ground water: Aquifers, hydraulic gradient, ground water flow (Definition only). o Standard and control: Waste water standard [BOD, COD, Oil, Grease], Water Treatment system [coagulation and flocculation, sedimentation and filtration, disinfection, hardness and alkalinity, softening] o Waste water treatment system, primary and secondary treatments [Trickling filters, rotating biological contractor, Activated sludge, sludge treatment, oxidation ponds] tertiary treatment definition. Water pollution due to the toxic elements and their biochemical effects: Lead, Mercury, Cadmium, and Arsenic.	**4**	**3**
Module: 5	**Module Name: Lithosphere** o Internal structure of earth, rock and soil Solid Waste: Municipal, industrial, commercial, agricultural,domestic, pathological and hazardous solid wastes; Recovery and disposal method- Open dumping, Land filling, incineration, composting, recycling. Solid waste management and control (hazardous and biomedical waste).	**2**	**2,3**
Module: 6	**Module Name: Noise pollution** o Definition of noise, effect of noise pollution, noise classification [Transport noise, occupational noise, neighborhood noise] Definition of noise frequency, noise pressure, noise intensity, noise threshold limit value. o Environmental impact assessment o Environmental Audit o Environmental laws and protection act of India, Different international environmental treaty/ agreement/ protocol.	**3**	**3**

Text Books:

1. Masters, G. M., “Introduction to Environmental Engineering and Science”, Prentice-Hall ofIndia Pvt. Ltd., 1991.

Reference Books:

1. De, A. K., “Environmental Chemistry”, New Age International.

Circuit Theory and Network Analysis

Course Name: Circuit Theory and Network Analysis	**Category:** Professional Core
Course Code: PC-EI 301	**Semester:** 3rd
L-T-P: 2-1-0	**Credit:** 3
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	**Continuous Assessment:** 30 Marks
Tutorial: 1	**End Semester Exam.:** 70 Marks
Total Lectures: 36	
Pre-Requisites: Knowledge of matrix, KCL, KVL, Laplace Transformation (basic level) and concept of Resistance, Inductor, Capacitor.	

Objectives:

This course aims to introduce with the time domain and frequency domain analysis of various electrical circuits for real time uses and also helps to solve complex networks in simpler way.

The subject aims to encourage the students with the followings:-

1. **Comprehensive Understanding of Circuit Analysis:** Students will develop a deep understanding of analyzing both DC and AC circuits, using fundamental laws and advanced techniques.
2. **Understanding Signals and Systems:**The course will deepen students' understanding of various types of signals and systems, focusing on their behavior under different conditions in continuous forms.
3. **Proficiency in Transform Techniques:** Through the study of Laplace and Fourier Transforms, students will learn to analyze circuits in both time and frequency domains, enabling them to solve complex transient and steady-state problems.
4. **Application of Network Theorems:** Students will gain expertise in applying network theorems like Thevenin's, Norton's, and Superposition to simplify and solve electrical circuits.
5. **Design and Analysis of Filters:** Students will learn to design and analyze various filters, including passive and active, preparing them for practical applications in signal processing.

Course Outcomes (COs):

On completion of this course, the student will be able to

CO.1. **Recall** and **explain** the fundamental concepts and principles such as Kirchhoff's laws, types of signals (e.g., step, ramp, sinusoidal), and network theorems of electrical circuits and systems.

CO.2. **Apply** network theorems for AC, DC sources and **analyse** electrical circuits using systematic techniques like node variable analysis, loop variable analysis, and source transformation.

CO.3. **Synthesize** different filters circuits using operational amplifiers and **evaluate** their performance for specific applications using Laplace and Fourier transforms to assess time and frequency domain characteristics.

CO.4. **Develop** comprehensive problem solving skill by **integrating** the knowledge of coupled circuits, transient analysis, two-port networks and graph theory to develop solutions for complex engineering problems.

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Module Name:** ***Introduction to Signal & System*** Network, Circuit, System, Signal, Continuous & Discrete, Fixed & Time varying, Linear and Nonlinear, Causal and Non-causal, Stable and Unstable, Lumped and Distributed, Passive and Active networks and systems. Independent & Dependent sources, Step, Gate, Ramp, Impulse, Sinusoidal, Damped Sinusoidal, Square, and Saw tooth signals. Express any signals in terms of the standard signals.	**5**	**CO 1**
Module: 2	**Module Name:*****Electrical Circuit Analysis*** **Analysis of DC & AC Circuits:** Kirchoff's Voltage Law & Current Law, Formulation of network equations, Source transformation, Loop variable analysis, Node variable analysis, Concept of Super-mesh and Super-node. **Network Theorem:** Superposition, Thevenin's, Norton's, Maximum power transfer theorem, Millman's theorem, Tellegen's theorem and its application in circuit analysis and energy distribution system. Solution of Problems with DC & AC sources along with Dependent sources. **Coupled Circuits:** Coupling, Types of coupling, Magnetic coupling, Polarity of coils, Polarity of induced voltage, Concept of Self and Mutual inductance, Coefficient of coupling, Modeling of coupled circuits, and Solution of problems.	**8**	**CO 1, 2, 4**
Module: 3	**Module Name:** ***Time and Frequency Domain Analysis*** **Circuit Transients:** DC Transient in R-L & R-C circuits with and without initial charge, R-L-C circuits, Transient analysis of different electrical circuits with and without initial conditions, solution of problems. **Laplace Transforms:** Concept of complex frequency, transformation of step, exponential, over-damped surge, critically damped surge, damped sine, un-damped sine functions of Laplace Transform, linearity, real-differentiation, real-integration, Initial Value Theorem and Final Value Theorem, Inverse Laplace Transform, applications in circuit analysis, Partial Fractions expansion, Heaviside's Expansion Theorem, Impulse, Step &	**12**	**CO 1, 2, 3, 4**

	Sinusoidal response of RL, RC, and RLC circuits. Order of the electrical circuit, Concept of Convolution theorem and its application. Solution of Problems with DC & AC sources. **Fourier Transform:** Fourier series and Fourier Transform, Application, Difference between Laplace Transform and Fourier Transform.		
Module: 4	**Module Name: *Graph Theory*** Formation of graph and its orientation, Concept of Tree, Branch, Connected and Unconnected graph, planer and non-planer graph sub-graph, rank, Tree link, junctions, Incidence matrix (A_a), Reduced Incidence Matrix (A), Fundamental Tie-sets (B_f) and Cut-sets (Q_f), Relation between A_a, A, B_f and Q_f, solution of problems.	**3**	**CO 1, 4**
Module: 5	**Module Name: *Two Port Networks Analysis*** Open circuit Impedance & Short circuit Admittance parameter, Transmission parameters and Inverse Transmission parameters, Hybrid parameters and their inter relations and interconnection. Solution of Problems with DC & AC sources.	**4**	**CO 1, 2, 4**
Module: 6	**Module Name: *Filter Circuits*** Concept of Filter, Passive filter and Active filter, Analog filter and Digital filter, Radio frequency filter and Audio frequency filter. Analysis of Low pass, High pass, Band pass, Band reject, All pass filters (first and second order only) using operational amplifier. Solution of Problems.	**4**	**CO 1, 2, 3, 4**

Text Books:

1. Network and Systems, D. Roychowdhury, (New Age International)
2. Network Analysis and Synthesis, S.P Ghosh, A.K. Chakraborty (McGraw Hill)

Reference Books:

1. Network Analysis, M. E. VanValkenburg (Prentice Hall)
2. Network and Systems, Ashfaq Husain, (Khanna Book Publisher)
3. Circuit Theory, A. Chakrabarty (Dhanpat Rai & Co.)
4. Network, Lines and Fields - John D. Ryder.

Sensors and Transducers

Course Name: Sensors and Transducers	**Category: Professional Core**
Course Code: PC-EI 302	**Semester: 3rd**
L-T-P: 3-0-0	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Continuous Assessment: 30Marks
Tutorial: Nil	End Semester Exam.: 70 Marks
Total Lectures: 36	
Pre-Requisites: Basics of Physics, Electronics and Engineering Mathematics	

Objectives:

This course aims to familiarize the students with different types of sensor and transducers, their working principle, applicability in measurement and instrumentation systems. The general concept and characteristics of measurement system are also discussed so that learner can appreciate the pertinence of sensors and transducers in instrumentation systems.

Course Outcomes (COs):

On completion of this course, the student will be able to

CO.1. **Recognize** the function of sensors and transducers in measurement systems and **define** various performance characteristics of measuring instruments.
CO.2. **Explain** the working principle of various types of sensors and transducers i.e. Mechanical, Electromechanical, Resistive, Inductive, Capacitive, Piezoelectric, Thermal and Magnetic etc.
CO.3. **Categorize** various sensors/transducers based on their properties like transduction principal, output signal nature etc.
CO.4. **Evaluate** performance of a particular sensor in a complex technical problem and **select** a suitable sensor/transducer for a particular industrial application.

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Introduction:** o General concepts and terminology of measurement systems, transducer classification, static and dynamic characteristics of a measurement system, Definition, principles of sensing and transduction, classification	**5**	**1**
Module: 2	**Resistive Transducers** o Potentiometric type: Forms, materials, resolution, accuracy, sensitivity o Strain Gauges: theory, types, materials, design consideration, sensitivity, gauge factor, variation with temperature, adhesives, rosettes, applications-force, velocity and torque measurements	**8**	**2,3,4**
Module: 3	**Inductive sensors**: o common types- reluctance change type, mutual inductance change type, transformer action type, - brief discussion with respect to materials, construction and input output variables, Ferromagnetic plunger type-short analysis; proximity measurement o LVDT: Construction, materials, output-input relationship, I/O curve,	**5**	**2,3,4**

	discussion		
Module: 4	**Capacitive sensors:** o Variable distance- parallel plate type, Variable area- parallel plate, serrated plate/teeth type and cylindrical type, variable dielectric constant type: calculation of sensitivities; proximity measurement o Stretched Diaphragm type: microphones, response characteristics	**5**	**2,3,4**
Module: 5	**Piezoelectric elements:** o Piezoelectric effects, charge and voltage coefficients, crystal model, materials, natural and synthetic types – their comparison, *Modes of mechanical deformation:TEM,LEM,FSM,TSM,VEM ;* force and stress sensing, *Bimorphs and Multimorphs*; piezoelectric accelerometer	**5**	**2,3,4**
Module: 6	o **Magnetic sensors:** Sensors based on Villari effect for assessment of force, torque, rpm meters o **Tachometers** – Stroboscopes, Encoders, o **Seismic accelerometer:** Measurement of vibration. o **Optical sensors:** LDR, Solar Cell, Photo diode, Photo Transistor, Photo Darlington Pair o **Hall effect:** Hall drive, performance characteristics	**8**	**2,3,4**

Text Books:

1. D Patranabis, Sensors and Transducers, PHI, 2nd ed.
2. E. A. Doebelin, Measurement Systems: Application and Design, McGraw Hill, New York
3. H. K. P. Neubert, Instrument Transducers, Oxford University Press, London and Calcutta

Reference Books:

1. D.V.S. Murty, Transducers and Instrumentation, PHI, 2nd ed.
2. K. Krishnaswamy and S. Vijayachitra, Industrial Instrumentation, New Age International Publishers, 2nd ed.
3. B. G. Liptak, Instrument Engineers' Handbook - Process Measurement and Analysis, Vol. 1, 4th Edition, CRC Press.

Analog Integrated Circuits

Course Name: Analog Integrated Circuits	**Category: Professional Core Course**
Course Code: PC-EI 303	**Semester: 3rd**
L-T-P: 3-1-0	**Credit: 4**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Continuous Assessment: 25Marks
Tutorial: 1 hr/week	Attendance: 5 Marks
Total Lectures: 48	End Semester Exam.: 70 Marks
Pre-Requisites: Atomic Structure , Semiconductor Physics	

Objectives:

The objective of this course is to introduce the student to familiarize and develop skills in the design and analysis of Analog Electronic Circuit, which form the building blocks of almost any electronic system.

Course Outcomes:

PC-EI 303.1: Illustrate working principle of different electronic circuit and their applications.
PC-EI 303.2: Define semiconductor device and different operating condition and their performance parameter
PC-EI 303.3: Use standard equivalent circuit models to predict the expected performance of various general-purpose electronic circuits
PC-EI 303.4: Recognize different signal circuits and the use in industrial, real life, modern control system application.

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Semiconductor devices** Brief overview of semiconductor and junction diode. Major applications of diode : Rectifier , Filter , Clipper , Clamper , Voltage Multiplier , Overview to linear power supply	**6**	**1-4**
Module: 2	**Biasing of BJT** Transistor Biasing Circuits: Different types of biasing circuits for BJT, stability factors, bias compensation, dc & ac load line analysis and thermal runaway. stability factors	**8**	**1-4**
Module: 3	**Transistor Amplifier** Small Signal Analysis of BJT: Transistor hybrid model, derivation of voltage gain, current gain, input impedance and output impedance, trans-conductance, low frequency small signal analysis of CE, RC coupled amplifier using hybrid-π model and determination of voltage gain, current gain, input impedance and output impedance, Frequency	**10**	**1-4**

	response of a RC , Transistor Power Amplifiers : Class A ,Class B ,Class AB , Class C		
Module: 4	**Feedback and Oscillator Circuits:** Feedback concept, Feedback topologies, classification of amplifiers, Bark-Hausen criteria. Oscillators- Wien bridge oscillator, Phase shift oscillator	**5**	**1-4**
Module: 5	**Operational Amplifier** Operational Amplifier (OPAMP): Ideal OPAMP, Block diagram of the internal circuit of OP amp, Equivalent circuit, characteristics, Inverting and non-inverting configuration (ideal & Practical), Different parameters like CMRR, slew rate, offset voltage & current, offset minimizing techniques etc. **Applications of OP AMP** **Linear applications OPAMP**: Inverting & Non inverting amplifier, differential amplifier, Instrumentation amplifier and its application, Summing amplifier, adder, scaling amplifier, subtractor , V-I and I- V converter, log and antilog amplifier, precision rectifier (half & full wave), Analog multiplier, integrator and differentiator (ideal & Practical), AC amplifier, Wave generation using opamp, Analog Computation techniques :solution of differential equation & simultaneous equations , Practical problems using OP AMP **Nonlinear applications OPAMP**: Comparator, Zero crossing detector , Schmitt Trigger	**13**	**1- 4**
Module: 6	**Multi-vibrator, Regulators** Introduction to multi-vibrator, IC555, Linear Voltage Regulator: Series and Shunt, IC based, power supply design.	**6**	**1-4**

Text Books:

1. Electronic circuits: Discrete and Integrated .by Donald Schilling, Charles Belove, TuviaApelewicz, Raymond Saccardi
2. Adel S. Sedra& Kenneth C. Smith, Microelectronic Circuits, Oxford University Press, New Delhi.
3. Jacob Millman& Christos C. Halkias, Integrated Electronics, McGraw Hill.
4. Ramakant A. Gayakwad, Op-Amps and Linear Integrated Circuits, PHI Learning,New Delhi.

Reference Books:

Sergio Franco, Design with Operational Amplifiers and Analog Integrated Circuits, 3rd Edition, McGraw Hill.

1. Robert L. Boylestad& Louis Nashelsky, Electronic Devices and Circuit Theory, Pearson/PHI, New Delhi.
2. Operational Amplifiers & Linear Integrated Circuits - R. F. Coughlin and F. F. Driscoll

CO-PO-PSO Mapping:

PC-EI 303												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
1	3	3	2	2	1	1	-	-	-	-	-	2
2	3	3	2	2	1	1	-	-	-	-	-	2
3	3	3	3	3	2	1	-	-	-	-	-	2
4	3	3	3	3	2	1	-	-	-	-	-	2

PC-EI 303			
CO	**PSO1**	**PSO2**	**PSO3**
1.	3	3	2
2.	3	3	2
3.	3	3	3
4.	3	3	3

Digital Electronic Circuits

Course Name: Digital Electronic Circuits	**Category:** Professional Core
Course Code: PC-EI 304	**Semester: 3rd**
L-T-P: 3-1-0	**Credit: 4**
Teaching Scheme	**Examination Scheme**
Theory: 3hrs	Continuous Assessment: 30Marks
Tutorial: 1 hrs	End Semester Exam.: 70 Marks
Total Lectures: 48	
Pre-Requisites:	

Prerequisites for a Digital Electronics subject typically include the following:

1. **Basic Electrical Engineering**: Understanding of fundamental electrical concepts such as voltage, current, resistance, and Ohm's law, as well as basic circuit theory.
2. **Introduction to Electronics**: Familiarity with basic electronic components such as resistors, capacitors, diodes, and transistors, as well as simple analog circuits.
3. **Mathematics**: Knowledge of algebra, binary numbers, and basic mathematical logic, including set theory and Boolean algebra.

Objectives:

The subject aims to encourage the students with the following:

1. **Develop Fundamental Knowledge:** To build a strong foundation in digital logic, including number systems, coding techniques, and the design of basic combinational and sequential circuits.
2. **Enhance Problem-Solving Skills:** To apply Boolean algebra, Karnaugh maps, and other simplification techniques in solving complex digital design problems.
3. **Hands-on Experience:** To provide practical experience in constructing, testing, and analyzing digital circuits through laboratory exercises and simulations.
4. **Foster Analytical Thinking:** To encourage students to analyze and interpret circuit behavior, performance metrics, and troubleshooting issues in digital systems.
5. **Design Capabilities:** To enable students to design and implement digital systems, integrating multiple components to achieve desired functionalities.
6. **Prepare for Advanced Learning:** To prepare students for advanced courses in electronics, embedded systems, and computer architecture by solidifying their understanding of digital electronics principles.

Course Outcomes (COs):

On completion of this course, the student will be able to

CO.1. **Recall** the postulates, theorems of Boolean algebra, coding, number systems, and the logic of combinational and sequential circuits.

CO.2. **Understand** the formation and conversion techniques of digital number systems and coding, as well as the working principles of combinational and sequential circuits.

CO.3. **Apply** Boolean theorems, Karnaugh map (K-map) method, and Quine-McCluskey (Q-M) method to simplify Boolean functions, and design combinational and sequential circuits.

CO.4. **Analyze** the output of combinational and sequential like ADDER, ENCODER, DECODER, MULTIPLEXER, COUNTER, REGISTER, ADC, DAC etc.

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Module Name: Introduction to Digital Electronics & Number systems** ➢ Introduction to Digital system, Data and number systems, Analog vs. Digital Systems, Applications of Digital Electronics ➢ Decimal, binary, octal and hexadecimal number systems and their arithmetic operations; conversion of one number system to another. ➢ Binary codes, natural BCD codes, weighted, non-weighted, sequential, self-complementing, cyclic, Excess-3, Alphanumeric, Gray codes, Code conversion- from one code to another, Binary Multiplication, Binary Division. ➢ Signed binary number representation with 1's and 2's complement methods, Binary arithmetic	**6**	**1-2**
Module: 2	**Module Name: Boolean algebra** ➢ Logic Operation-NOT, AND, OR, NAND, NOR, XOR and XNOR – operations, truth tables, Electrical analogy of gates, Venn diagram. ➢ All Postulates and laws of Boolean algebra with proof, De Morgan's theorem. Minimization of Logic Expressions using Algebraic method. ➢ Canonical forms of expressions, minterms and maxterms, SOP and POS forms. ➢ Simplification and minimization of Logic Expressions using K- map method (up to 4 variables). Concept of don't care and use of don't care terms in K-map method, POS based minimization. ➢ Limitation of K-map and Quine-McClausky (Q-M) method of minimization of logic functions and concept of PI, EPI	**8**	**1-4**
Module: 3	**Module Name: Combinational Logic Design** ➢ **Adders:** Half Adder, Full Adder, Binary parallel adder, Composite adder, Carry look ahead adder, BCD adder. ➢ **Multiplexers and Demultiplexer:** basic 2:1, 4:1, 8:1 multiplexer equation and circuit diagram. Implementation of higher order MUX using lower order MUX, function implementation using MUX, basic 1:2 and 1:4 DEMUX equation and circuit diagram. function implementation usingDEMUX, application of MUX and DEMUX ➢ **Encoder & Decoders**: basic 2:4, 3:8, 4:16 decoder equation and circuit diagram. Implementation of higher order decoder using lower order decoder, function implementation using decoder. ➢ 4:2 Encoders and Priority Encoders equation with circuit diagram. Application of DECODER and ENCODER ➢ 3 bit and 4 bit EVEN and ODD Parity Generator and checkers, 1 bit, 2 bits,4 bits Magnitude Comparators with equation and circuit diagram ➢ **Code converter:** Binary to Gray and Gray to Binary, BCD to XS-3 and XS-3 to BCD, BCD to Binary and Binary to BCD	**12**	**1-4**

Module: 4	**Module Name: Sequential Logic Design** ➢ Concept of Sequential circuit, difference between combinational and sequential circuit, Introduction to latches (S-R Latch, both NOR and NAND) with characteristic table, truth table, equation and circuit diagram. ➢ Introduction to different types of Flip-Flop (S-R, D, J-K, T) with characteristic table, Excitation table, equation and circuit diagram. ➢ Triggering of flip-flops, Asynchronous inputs in FF, race around condition, Master-slave configuration; Conversion of Flip-flop and application of FF, mealy and moore machine. ➢ **Asynchronous & Synchronous counters** - Full-sequence length counter, Binary up and down counter, Bidirectional counter, Modulo-N counter (both Synchronous and asynchronous) Arbitrary sequence counter. ➢ **Registers:** SISO, SIPO, PIPO, PISO, Bi-directional and universal shift registers, Ring and Johnson (twisted ring) counters, application of register.	**10**	**1-4**
Module: 5	**Module Name: Analog-to-Digital and Digital-to-Analog Converters** ➢ Introduction to analog- digital data conversion, specification of D/A converter. ➢ D/A conversion- R-2R ladder type, weighted resistor type. ➢ Specification of A/D converter; A/D conversion- Flash type, successive approximation type and dual-slope type, **sigma delta converters (introduction)**	**4**	**1-4**
Module: 6	**Module Name: Introduction to Digital Logic Families & Memory and Programmable Logic Devices & Families** Classification of Digital Logic Families; characteristics of Digital ICs. ➢ TTL: characteristics, Totem-Pole output, Open Collector output, Tri-state output, ➢ ECL: characteristics, OR/NOR gate. ➢ MOS: characteristics, PMOS, NMOS. CMOS: characteristics NAND, NOR, logic circuit realization ➢ Introduction to Memory Devices ➢ RAM, ROM, PROM, EPROM, EEPROM: Static vs. Dynamic RAM ➢ Logic Devices (PLDs): Introduction to PLDs (PAL, PLA, CPLD, FPGA) ➢ Basic Architecture and Applications of PLDs, Design and Implementation Using PLDs, Design Examples Using PAL and PLA ➢	**8**	**1-4**
	Total	**48**	

1. Digital Fundamentals by T.L. Floyd &R.P.Jain (Pearson).
2. Fundamental of digital circuits by A. Anand Kumar (PHI).
3. Digital Electronics, RishabhAnand (Khanna Publishing House)
4. Digital Integrated Electronics by H. Taub& D. Shilling (TMH).
5. Digital Design, M. Morris Mano, Michael D. Ciletti, (Pearson)

Reference Books:

1. Digital Circuit & Design by S. Aligahanan&S.Aribazhagan (Bikas Publishing)
2. Digital Electronics by A.K. Maini (Wiley-India)
3. Digital Circuits-Vol-I & II by D. RayChaudhuri (Platinum Publishers)
4. Modern Digital Electronics by R.P. Jain (McGraw Hill)
5.

Digital Electronics Lab

Course Name: Digital Electronics Lab	**Category:** Professional Core
Course Code: PC-EI 394	**Semester:** 3rd
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination scheme: Maximum marks:**
Tutorial: Nil	External Assessment:60
Practical: 3 hrs./week	Internal Assessment:40
Credit Points: 1.5	

Course Outcomes:	
CO. 1	**Recall** and **identify** basic digital electronic components, including logic gates, flip-flops, and integrated circuits (ICs).
CO. 2	**Demonstrate** the ability to construct and test basic combinational and sequential circuits using breadboards and simulation software.
CO. 3	**Apply** Boolean algebra and simplification techniques to design and implement optimized digital circuits in the lab.
CO. 4	**Experiment** with and **configure** digital circuits, such as multiplexers, decoders, and counters, to achieve desired logical outputs.
CO. 5	**Analyze** the performance of digital circuits by measuring and interpreting output waveforms, timing diagrams, and other parameters.
CO. 6	**Create** and **assemble** complex digital systems by integrating multiple combinational and sequential circuits, and **evaluate** their overall functionality and efficiency.
Pre-Requisite:	
1	Mathematics Fundamentals

Experiment No.	**Laboratory Experiments**	COs
1.	Realization of basic gates using Universal logic gates.	CO1,2
2.	Code conversion circuits- BCD to Excess-3 & vice-versa.	CO1-6
3.	Construction of simple arithmetic circuits-Adder, Subtractor.	CO1-6
4.	4-bit parity generator & comparator circuits.	CO1-6
5.	Construction of simple Decoder & Multiplexer circuits using logic gates.	CO1-6
6.	Design of combinational circuit for BCD to decimal conversion to drive 7-segment display using multiplexer.	CO1-6
7.	Realization of RS-JK & D flip-flops using Universal logic gates.	CO1-6
8.	Realization of Asynchronous Up/Down counter.	CO1-6
9.	Realization of Synchronous Up/Down counter.	CO1-6
10.	Realization of Universal Register using JK flip-flops & logic gates.	CO1-6
11.	Realization of Universal Register using multiplexer & flip-flops.	CO1-6
12.	Construction of Adder circuit using Shift Register & full Adder.	CO1-6
13.	Realization of Ring counter & Johnson's counter.	CO1-6
14.	Construction of adder circuit using Shift Register & full Adder.	CO1-6
15.	Mandatory Design and Implementation of Mini Project.	CO1-6

Numerical Methods Lab

Name of the Course: Numerical Methods Lab	**Category: Basic science Courses**
Course Code: BS-M 391	**Semester:3rd**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination scheme: Maximum marks:**
Tutorial: Nil	External Assessment:60
Practical: 2 hrs./week	Internal Assessment:40
Credit Points: 1	

Course Outcomes:	
CO. 1	**Understand and explain** the principles behind interpolation methods such as Newton forward/backward and Lagrange's interpolation. *(Understanding).*
CO. 2	**Apply** numerical integration techniques like Trapezoidal rule, Simpson's 1/3 rule, and Weddle's rule to solve real-world engineering problems. *(Applying)*
CO. 3	**Solve** systems of linear equations using numerical methods like Gauss elimination and Gauss-Seidel iterations, demonstrating proficiency in problem-solving. *(Applying)*
CO. 4	**Analyze** and **compare** the efficiency of different methods for solving algebraic equations, such as the Regular Falsi and Newton-Raphson methods. *(Analyzing)*
CO. 5	**Develop** numerical solutions for ordinary differential equations using Euler's and Runge-Kutta methods and evaluate their accuracy in various applications. *(Creating and Evaluating)*
CO. 6	**Utilize** software tools such as MATLAB, Python, or LabVIEW for implementing numerical algorithms and interpreting results in complex engineering contexts. *(Applying)*
Pre-Requisite:	
1	BS-M101, BS-M202

Exp. No.	**Laboratory Experiments**	COs
1	Assignments on Newton forward /backward, Lagrange's interpolation.	CO.1
2	Assignments on numerical integration using Trapezoidal rule, Simpson's 1/3 rule, Weddle's rule.	CO.2
3	Assignments on numerical solution of a system of linear equations using Gauss elimination and Gauss-Seidel iterations	CO.3
4	Assignments on numerical solution of Algebraic Equation by Regular-falsi and Newton Raphson methods.	CO.4
5	Assignments on ordinary differential equation: Euler's and Runga-Kutta methods.	CO.5
6	Introduction to Software Packages: Matlab / Python/ Labview / Mathematica	CO.6

Text and reference books:

1. C.Xavier: C Language and Numerical Methods.
2. E. Balagurusamy: Numerical Methods, Scitech.
3. R.S. Salaria: Numerical Methods, Khanna Publishing House
4. Rudra Pratap, Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers,Oxford University Press.
5. Mark Lutz and David Ascher, Learning Python, Published by O'Reilly & Associates.

Circuit Theory Lab

Name of the Course:Circuit Theory Lab	**Category:Professional Core**
Course Code: PC-EI 391	**Semester:3rd**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination scheme:**
Tutorial: Nil	External Assessment:60
Practical: 3 hrs./week	Internal Assessment:40
Credit Points:1.5	

Course Outcomes: *At the endofthecourse,astudent willbe ableto:*	
CO. 1	***Understand*** the basic concepts of DC and AC circuit behavior, transient response, two-port network, filtering circuit and the generation of various signals using MATLAB.
CO. 2	***Acquire*** the ability to use various transformation tools and design electrical circuit-based simulations, enhancing software proficiency for analysis and design.
CO. 3	***Understand*** the requirement of time and frequency response of any practical circuit.
CO. 4	Skillfully ***measure and record*** experimental data, analyze results, and prepare comprehensive technical laboratory reports, with a focus on interpreting the transient response of R-L, R-C, and R-L-C circuits, as well as the frequency response of LP, HP, and BP filters.
CO. 5	***Create and execute*** small-scale projects that entail developing simulations or hardware configurations for electrical networks.
CO. 6	***Assess and ensure*** adherence to safety standards in both simulations and hardware configurations, demonstrating a discerning approach to evaluating safety precautions in electrical network design and implementation.
Pre-Requisite:	
1	Knowledge of various passive and active components are required.
2	Concepts of basic electrical parameters and their measuring techniqueare needed.
3	Theories of different circuit laws are essential.

Experiment No.	**Laboratory Experiments**	**COs**
1	Transient response in R-L and R-C Network: Simulation/hardware	CO 1-4
2	Transient response in R-L-C Series circuits Network: Simulation/hardware	CO 1-4
3	Determination of Impedance (Z) and Admittance(Y) parameters of two port network	CO 1-4
4	Frequency response of LP and HP filters	CO 1-5

5	Frequency response of BP and BR filters	CO 1-5
6	Generation of Periodic, Exponential, Sinusoidal, Damped sinusoidal, Step, Impulse, and Ramp signals using MATLAB in both discrete and analog form.	CO 1, 2, 4
7	Determination of Laplace transform and inverse Laplace transformation using MATLAB	CO 1, 2, 4, 5
8	Design and Implementation of Mini Project.	CO 1-6

Text and reference books:

- Network and Systems, D.Roychowdhury,(New Age International)
- Network Analysis, M.E.VanValkenburg (Prentice Hall)

Special Remarks (If any):

- Student can learn PSPICE simulation also to buildup software knowledge.
- Student can practice hardware circuit using online MULTISIM simulator.

Sensors and Transducers Lab

Course Name: Sensors and Transducers Lab	**Category:** Professional Core
Course Code: PC-EI 392	**Semester:** 3rd
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination scheme: Maximum marks:**
Tutorial: Nil	External Assessment:60
Practical: 3 hrs./week	Internal Assessment:40
Credit Points: 1.5	

Course Outcomes:	
CO. 1	**List** the sensors & transducers used in speed, torque, displacement, light intensity measurement systems in industry as well as home appliances.
CO. 2	**Demonstrate** the operations of different sensors and transducers based measurement systems.
CO. 3	**Apply** necessary safety rules related to different sensor based laboratory instruments.
CO. 4	**Examine** functionalities and input output **relationships** of different sensors and transducers.
CO. 5	**Characterize** different types of sensors and **deduct** conclusion by **evaluating** sensor outputs.
CO. 6	Function effectively as an individual and as a member in teams for **development** of small sensor based projects.
Pre-Requisite:	
1	Basis knowledge of physics, mathematics and sensors.

Experiment No.	**Laboratory Experiments**	COs
1.	Displacement measurement by using a capacitive transducer.	1 – 4
2.	Displacement measurement by using LVDT.	1 – 4
3.	Study of a load cell with tensile and compressive load.	1 – 4
4.	Torque measurement using Strain gauge transducer.	1 – 4
5.	Displacement measurement using Hall proximity sensor.	1 – 4
6.	Study of the characteristics of a LDR.	1 – 4
7.	Speed measurement using a Stroboscope.	1 – 4
8.	Mandatory Design and Implementation of Mini Project.	1 – 6

Analog Circuits Design Lab

Course Name: Analog Circuits Design Lab	**Category:** Professional Core Course
Course Code: PC-EI 393	**Semester:** 3rd
Duration: 6 months	**Maximum Marks:**
Teaching Scheme	**Examination scheme:**
Tutorial: Nil	External Assessment: 60
Practical: 3 hrs./week	Internal Assessment: 40
Credit Points: 1.5	

Course Outcomes:	
CO. 1	Set up standard experimental methods and select proper instruments to evaluate performance characteristics of different electronic circuits
CO. 2	Determine experimental procedures for different types of electronic circuits.
CO. 3	Evaluate possible reasons of inconsistency between experimental observations and theoretical values and interpret the experimental data.
CO. 4	Investigate different types of instruments connections keeping in mind technical, economical, safety issues.
CO. 5	Analyze graphical presentations of experimental data and solve different complex technical problems.
CO. 6	Design mini electronic based systems.
Pre-Requisite:	
1	Basic Electronics

Exp. No.	**Laboratory Experiments**	COs
1.	Introduction: Study of characteristics curves of B.J.T &F.E.T	CO 1
2.	Construction of a two-stage R-C coupled amplifier & study of its gain & Bandwidth.	CO 2
3.	Study of timer circuit using NE555 & configuration for monostable & astable multivibrator.	CO 3
4.	Study of class A & class B power amplifiers.	CO 3
5.	Study of Switched Mode Power Supply & construction of a linear voltage regulator using regulator IC chip.	CO 5
6.	Construction of a simple function generator using IC.	CO 4
7.	Study of DAC & ADC.	CO 4
8.	Mandatory Design and Implementation of Mini Project.	CO 6
Beyond Syllabus		
1.	Realization of current mirror & level shifter circuit using Operational Amplifiers.	CO 3
2.	Realization of a Phase Locked Loop using Voltage Controlled Oscillator (VCO).	CO 3
3.	Construction & study of Bistable multivibrator using NE555.	CO 3
5.	Study of class C & Push-Pull amplifiers.	CO 4

Text and reference books:

Special Remarks (If any):

Economics for Engineers

Course Name: Economics for Engineers	**Category:** Humanities & Social Sciences
Course Code: HM HU 401	**Semester: 4th**
L-T-P: 3-0-0	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Continuous Assessment: 30Marks
Tutorial: Nil	End Semester Exam.: 70 Marks
Total Lectures: 36	
Pre-Requisites: Mathematics	

Course Objectives:

1. Understand basic economic concepts and their relevance to engineering decision-making and apply economic principles to analyse engineering projects and assess their feasibility.
2. Develop skills in cost estimation, project evaluation, and risk analysis and gain insights into the economic implications of engineering decisions on society and the environment.

Course Outcomes (CO):

HM HU 501.1	Students will **recall** and **explain** fundamental concepts of engineering economics.
HM HU 501.2	Students will **apply** economic principles and techniques to analyze engineering projects and make informed decisions based on economic criteria.
HM HU 501.3	Students will **analyze** project cost structures, estimate costs using appropriate methods, and evaluate cost-effectiveness of the engineering projects using NPV, IRR, BCR etc.
HM HU 501.4	Students will **integrate** economic sustainability considerations into engineering design and decision-making processes by assessing project risk through sensitivity analysis.

Module	Description of Topics	Hrs/ Unit	COs
1.	**Introduction to Engineering Economy:** Origin of Engineering Economy, Principles of Engineering Economy, Role of Engineers in Decision Making	5	1,2
2.	**Time Value of Money :** .Introduction to Time Value of Money, Simple Interest, Compound Interest, Nominal Interest rate, Effective Interest rate, Continuous Compounding, Economic Equivalence, Development of Interest Formulas, The Five Types of Cash flows, Single Cash flow Formulas, Uneven Payment Series, Equal Payment Series	**8**	1-4

3.	**Methods of comparison of alternatives:** NPV, Profitability Index or Benefit Cost Ratio, Payback Period Method, Equivalent Worth Methods, Present Worth Method, Future Worth Method, Annual Worth Method, Rate of Return Methods (IRR and ARR)	**8**	1-4
4.	**Engineering Costs:** Elements of cost (Fixed, Variable, Marginal & Average Costs, Sunk Costs, Opportunity Costs, Recurring And Nonrecurring Costs, Incremental Costs, Cash Costs vs Book Costs, Life-Cycle Costs)	3	1-5
5.	**Engineering Costs Estimation:** cost estimation models (Per-Unit Model, Segmenting Model, Cost Indexes, Power-Sizing Model, Improvement & Learning Curve), Concept of Revenue, Break even analysis, Cost sheet.	5	1-5
6..	**Inflation And Price Change:** Definition, Effects, Causes, Price Change with Indexes, Types of Index, Composite vs Commodity Indexes, Use of Price Indexes In Engineering Economic Analysis, Cash Flows that inflate at different Rates.	7	1-5

1. Donald Newnan, Ted Eschembach, Jerome Lavelle: Engineering Economics Analysis, OUP
2. R. Paneer Seelvan: Engineering Economics, PHI
3. Sullivan and Wicks: Engineering Economy, Pearson
4. John A. White, Kenneth E. Case, David B. Pratt: Principle of Engineering Economic Analysis, John Wiley
5. James L. Riggs, David D. Bedworth, Sabah U. Randhawa: Economics for Engineers 4e,Tata Mc Graw - Hill

Data Structure & Algorithm

Course Name: Data Structure & Algorithm	**Category:** Engineering Science Course
Course Code: ES-EI 401	**Semester:** 4TH
L-T-P: 3-0-0	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Continuous Assessment: 30 Marks
Tutorial: Nil	End Semester Exam.: 70 Marks
Total Lectures: 36	
Pre-Requisites: Concept of C-Language	

Objectives:

In view of the notable advancement of data structure in recent few years, it is essential for the students to be familiar with various algorithmic approaches to write program thereby solving problems. The objectives of the course are mentioned below:

1. To represent the significance of algorithms with its properties for solving problems in different engineering domains.
2. To provide the characteristics of various Abstract Data Type for creating the solution- strategies.
3. To demonstrate the significance of non-linear data structures with respect to the access and organization of records.
4. To clarify various sorting and searching algorithms.
5. To expose merits and demerits of altered algorithms in terms of time-complexity.
6. To enhance the ability of selecting appropriate data structure and algorithm for solving specific problems.

Course Outcomes (COs):

Upon successful completion of this course, a student will be able to:

Remembering:

- Students will be able to define basic concepts of data structures, such as arrays, linked lists, stacks, queues, and graphs, and recall the fundamental terminologies of algorithms and algorithm efficiency (e.g., Big-O notation, time and space complexity).

Understanding:

- Students will be able to explain the necessity of data structures and differentiate between various data structures (e.g., stacks, queues, trees, graphs) and their applications, including recursion and its principles. They will also be able to describe algorithm efficiency and common sorting and searching techniques.

Applying:

- Students will be able to implement various data structures such as arrays, linked lists, stacks, queues, trees, and graphs, and perform basic operations (e.g., insertion, deletion, traversal). They will also apply algorithm analysis techniques to evaluate time and space complexity.

Analyzing:

- Students will be able to analyze different sorting algorithms (e.g., merge sort, quick sort) and searching techniques (e.g., binary search), compare their performance, and select the most efficient algorithm for a given problem. Additionally, students will be able to break down complex data structures like AVL trees and graphs (BFS, DFS) to examine their properties and performance in solving computational problems.

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Introduction of Data Structure** Necessity of data structure. Concepts of data structures: a) Data and data structure b) Abstract Data Type and Data Type. Algorithms and properties of an Algorithm, Algorithm efficiency and analysis, time and space analysis of algorithms – order notations like Big-Oh, Big-Omega, Theta.	3	**1-2**
Module: 2	**Array and Linked List Array:** Different representations of arrays– row major, column major. Array representation of polynomials. **Linked List:** Singly linked list, Insertion-Deletion-Display (also in reverse order) Operations of Linked List, circular linked list, doubly linked list, linked list representation of polynomial.	5	**1-4**
Module: 3	**Linear DataStructure Stack and Queue:** Stack and its implementations (using array, using linked list), applications including prefix, infix and postfix expressions of arithmetic expressions. Queue, circular queue, dequeues. Implementation of queue- both linear and circular (using array, using linked list), applications. **Recursion:** Principles of recursion – use of stack, differences between recursion and iteration, tail recursion. Applications - The Tower of Hanoi, Eight Queens Puzzle.	**8**	**1-4**
Module: 4	**Nonlinear Data structures: Trees** Basic terminologies of trees, tree representation (using array, using linked list). Binary trees - binary tree traversal (pre-order, in-order, post- order), threaded binary tree (left, right, full) - non-recursive traversal, algorithms using threaded binary tree, expression tree. Binary search tree- operations (creation, insertion, deletion, searching). Height balanced binary tree – AVL tree explanation with example	**9**	**1-4**

Module: 5	**Module Name: Nonlinear Data structures: Graphs** Graph definitions and concepts (directed/undirected graph, weighted/un-weighted edges, sub-graph, degree, cut- vertex/articulation point, pendant node, clique, complete graph, connected components – strongly connected component, weakly connected component, path, shortest path).Graph representations/storage implementations – adjacency matrix, adjacency list, adjacency multi-list. Graph traversal and connectivity – **Depth-first search (DFS), Breadth-first search (BFS)**. Minimal spanning tree – Prim's and Kruskal's algorithm.	**5**	**1-4**
Module: 6	**Module Name: Searching, Sorting, Hashing Sorting Algorithms:** Bubble sort, insertion sort, selection sort, merge sort, quick sort, concept of max & min heap, heap sort. **Searching:** Sequential search, binary search. **Hashing:** Hashing functions, collision resolution techniques using chaining and open addressing.	**6**	**1-4**
	Total	**36**	

6. "Data Structures and Algorithm Analysis in C" by Mark Allen Weiss

Learning Resources Text Books:

1. "Data Structures And Program Design In C", 2/E by Robert L. Kruse, Bruce P.Leung.
2. "Data Structures and Algorithms Using C", R.S. Salaria, Khanna PublishingHouse.
3. "Fundamentals of Data Structures of C" by Ellis Horowitz, SartajSahni, Susan Anderson-freed.
4. "Data Structures in C" by Aaron M.Tenenbaum.
5. **"**Data Structure**s" by** S.Lipschutz**.**
6. "Data Structures and Algorithm Analysis in C" by Mark Allen Weiss

Reference Books:

1. "Expert Data Structures with C" by R.B. Patel, Khanna Publishing House
2. "Data Structures Using C" by Reema Thareja
3. "Data Structure Using C", 2/e by A.K. Rath, A. K.Jagadev.
4. "Introduction to Algorithms" by Thomas H. Cormen,Charles E. Leiserson,Ronald L. Rivest, Clifford Stein

Electrical & Electronic Measurements

Course Name: Electrical & Electronic Measurements	**Category:** Professional course
Course Code: PC-EI-401	**Semester: 4th**
L-T-P: 3-1-0	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Theory: 4 hrs./week	Continuous Assessment: 30Marks
Tutorial: Nil	End Semester Exam.: 70 Marks
Total Lectures: 40	
Pre-Requisites: Basic Electrical Engineering, Basic Electronics Engineering, Circuit Theory & Networks	

Objectives:

The objective of this course is to acquire the knowledge on how to select, connect, and adjust different types of measuring instruments. Understand the construction, working principle, and characteristics of electrical instruments.

The subject aims to encourage the students with the followings:-

1. To learn methods of measurement, errors in measurement and its classification.
2. To learn the principle of operation of analog and digital meters.
3. To learn the basic principle of operation of instrument transformers.
4. To learn the principle of operation of cathode ray oscilloscope and different sensors and transducers.
5. To learn the principle of measurement of power, energy and different electrical parameters
6. To acquire problem solving skills to solve problems on the topics studied.

Course Outcomes (COs):

On completion of this course, the student will be able to

CO.1. **Recall** and understand the methods of measurement, different types of errors, classification of instruments, and define key terms such as accuracy, precision, resolution, and speed of response.

CO.2. **Explain** the principles of operation and the construction of various analog meters such as moving coil, moving iron, and electrodynamometer, as well as the function of instrument transformers.

CO.3. **Analyse** and **apply** methods and techniques for measuring resistance, inductance, capacitance, frequency, power, and energy using appropriate instruments, and extend instrument ranges using shunt and multipliers.

CO.4. **Compare** and **evaluate** various knowledge of advanced measurement tools and techniques to measure inductance, capacitance, and frequency using AC bridges. Additionally, utilize digital instruments like cathode ray oscilloscope, digital voltmeters, multi-meters, frequency meters, and signal generators, understanding their advantages over analog meters.

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Module Name: Introduction to measurement System and analog meters** ○ **Introduction to measurement System:** Methods of measurement,	**8**	**CO 1, 2**

	Measurement system, Classification of instruments, Static and dynamic characteristics. Errors and compensation. Loading effect due to shunt and series connected instruments o **Measuring instruments:** General features, Construction, principle of operation and torque equation of moving coil, moving iron, electrodynamometer, Induction, and Electrostatic type instruments. Extension of instrument ranges using shunt, multipliers.Cathode Ray Oscilloscope- Cathode Ray tube-Time base generator-Horizontal and Vertical Amplifiers – Applications of CRO – Measurement of Phase , Frequency, Current & Voltage- Lissajous Patterns		
Module: 2	**Module Name:D.C & A.C Bridges** o Methods of Measuring Low, Medium and High Resistances – Sensitivity of Wheatstone's Bridge – Kelvin's Double Bridge for Measuring Low Resistance, Measurement of High Resistance – Loss of Charge Method. Measurement of Inductance – Maxwell's Bridge, Anderson's Bridge. Measurement of Capacitance and Loss Angle – De-Sauty's Bridge. Wien's Bridge – Schering Bridge.	**8**	**CO 3, 4**
Module: 3	**Module Name:Measurement of power and energy** o **Measurement of power**: Principle of operation of Electrodynamic & induction type wattmeter, wattmeter errors. o **Measurement of energy**: Construction, theory and operation of AC energy meter, testing of Energy meters.	**8**	**CO 3, 4**
Module: 4	**Module Name: Instrument transformers and potentiometers** o Current Transformers and Potential Transformers – Ratio and Phase Angle Errors – Methods for Reduction of Errors-Design Considerations. o Potentiometers: Principle and Operation of D.C. Crompton's Potentiometer – Standardization – Measurement of unknown Resistance, Current, Voltage. o A.C. Potentiometers: Polar and Coordinate types- Standardization – Applications	**8**	**CO 3, 4**
Module: 5	**Module Name: Magnetic measurements** o Ballistic Galvanometer – Equation of Motion – Flux Meter – Constructional Details, Comparison with Ballistic Galvanometer. Determination of B-H Loop - Methods of Reversals - Six Point Method – A.C. Testing – Iron Loss of Bar Samples.	**4**	**CO 3, 4**
Module: 6	**Module Name: Electronic instruments** o Electronic instruments: Digital voltmeter, Digital multimeter, Digital frequency meter, LCR meter, Impedance analyzer, Vector Network Analyzer, Spectrum Analyzers	**4**	**CO 3, 4**

Text Books:

1. A course in Electrical & Electronic Measurements & Instrumentation; A.K. Sawhney, DhanpatRai and sons.
2. Electrical Measurements and Measuring Instruments; E.W Golding & F.C. Wides, Wheeler Publishing
3. Electronic Instrumentation; H.S.Kalsi, Tata McGraw hill, 2nd edition

Reference Books:

1. Digital Instrumentation; A.J. Bouwens, Tata McGraw Hill
2. Modern Electronic Instrumentation & Measuring Instruments; A.D. Heltrick& W.D. Cooper, Wheeler Publishing
3. Rajput R.K., "Electrical and Electronic Measurement Instrumentation", S.Chand and Co.,
4. PrithwirajPurkait, Budhaditya Biswas, "Electrical and Electronics Measurements and Instrumentation"
5. J.B. Gupta, "Electrical and Electronics Measurements & Instrumentation", S.K.Kataria& Sons, New Delhi.

Microprocessors &Microcontroller

Course Name: Microprocessors & Microcontroller	**Category:** Professional Core Courses
Course Code: PC EI 402	**Semester:** 4TH
L-T-P: 3-1-0	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Continuous Assessment: 30Marks
Tutorial: 1 hrs./week	Attendance: 75% (Minimum)
Total Lectures: 45	End Semester Exam.: 70 Marks
Pre-Requisites: Digital Electronics	

Objectives:

The main objective of the subject "Microprocessors and Microcontroller" is to provide students with a comprehensive understanding of the architecture, functionality, and programming of microprocessors and microcontrollers. This course aims to equip students with the knowledge and skills necessary to design, develop, and implement microprocessor and microcontroller-based systems for various real-world applications. By the end of the course, students should be able to:

1. Understand the fundamental principles of microprocessors and microcontrollers, including their architecture and operation.
2. Develop proficiency in assembly language programming for microprocessors and microcontrollers.
3. Analyze and apply interfacing techniques to connect microprocessors and microcontrollers with external devices and peripherals.
4. Design and implement embedded systems using microprocessors and microcontrollers to solve engineering problems effectively.

Course Outcomes (COs):

On completion of this course, the student will be able to

PC-EI-402.1: **Define** the architecture of Microprocessors and Microcontroller (8051).

PC-EI-402.2: **Explain** the importance and function of different modules of Microprocessor and Microcontroller.

PC-EI-402.3: **Apply** the fundamentals of assembly level programming of Microprocessor and Microcontroller that perform specific tasks.

PC-EI-402.4: Students will be able to **analyze** and **evaluate** different interfacing techniques used to connect microprocessors and microcontrollers with peripheral devices, identifying the most suitable methods for specific applications.

Syllabus Details

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Module Name: Introduction to 8085 Microprocessor** Hardware Architecture, pinouts – FunctionalBuilding Blocks of Processor – Memory organization and interfacing–I/O ports and data transfer concepts– Timing Diagram – Interrupts.	**11**	**1-2**
Module: 2	**Module Name:Programming of 8085 Microprocessor** Instruction -format and addressing modes – Assembly language format – Data transfer, data manipulation & control instructions – Programming: Loop structure with counting & Indexing – Look up table – Subroutine instructions – stack.	**11**	**1-3**
Module: 3	**Module Name:Peripheral Interfacing:** Architecture, configuration and interfacing, with 8255.	**3**	**1-4**
Module: 4	**Module Name:8051 Micro Controller:** Schematic diagram of intel-8051, microcontroller-registers, oscillators, ports, memory, timers/counters, special function registers, Addressing modes. Instructions related to Data Transfer and Manipulation, Arithmetic, Logical and Brunch operations. Explanation with examples of programming related to topic.	**10**	**1-3**
Module: 5	**Module Name:8051 Micro ControllerPeripheral Interfacing:** Introduction to the Timer/Counter, Serial Communication and Interrupts: operations, special function registers and programming on required. Interfacing with Peripheral Input/Output Devices: ADC,DAC, Display	**10**	**1-4**
Module: 6	**Module Name:Architecture of Typical 16-Bit Microprocessors (Intel 8086):** Introduction to a 16 bit microprocessor, Architecture and Register Organization, Memory address space and data organization.	**3**	**1-2**
	Total	**48**	

Text Books:

1. Ramesh S. Gaonkar, Microprocessor Architecture, Programming and Applications with the 8085A /8080A, WILEY EASTERN LIMITED.
2. Mohamed Ali Mazidi, Janice GillispieMazidi, RolinMcKinlay, "The 8051 Microcontrollerand Embedded Systems: Using Assembly and C", Second Edition, Pearson education, 2011.
3. A.H. Mukhopadhyay, Microprocessor, Microcomputer and Their Applications, 3rd EditionAlpha Science International, Ltd.Digital Fundamentals by T.L. Floyd &R.P.Jain (Pearson).

Reference Books:

1. Soumitra Kumar Mandal, Microprocessor & Microcontroller Architecture, Programming &Interfacing using 8085, 8086, 8051, McGraw Hill Edu, 2013.
2. M. Rafiquzzman: Microprocessors: Theory & Applications (Intel & Motorola), PHI. 2. Berry.B. Bray INTEL 8086/88, 80186, 286, 386, 486, Pentium Pro & Pentium IV.

3. Berry .B. Bray INTEL 8086/88, 80186, 286, 386, 486, Pentium Pro & Pentium IV. Digital Circuit & Design by S. Aligahanan&S.Aribazhagan (Bikas Publishing)

Electromagnetic Theory

Course Name: Electromagnetic Theory	**Category: Professional Core**
Course Code: PC-EI-403	**Semester: 4th**
L-T-P: 3-0-0	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Continuous Assessment: 30Marks
Tutorial: Nil	End Semester Exam.: 70 Marks
Total Lectures: 36	
Pre-Requisites: Knowledge differential and integral calculus	

Objectives:

The objective of this course is to acquire the basic knowledge……

The subject aims to encourage the students with the followings:-

1. To introduce the basic mathematical concepts related to electromagnetic vector fields.
2. To impart knowledge on the concepts of Electrostatic fields, electrical potential, energy density and their applications. Magneto static fields, magnetic flux density, vector potential and its applications.
3. Different methods of e.m.f. generation and Maxwell's equations Electromagnetic waves and characterizing parameters.

Course Outcomes (COs):

On completion of this course, the student will be able to

PC-EI 403.1. To understand the basic laws of electromagnetism.

PC-EI 403.2. To obtain the electric and magnetic fields for simple configurations under static conditions.

PC-EI 403.3. To analyze Maxwell's equations in time varying electric and magnetic fields.

PC-EI 403.4. To understand the propagation of EM waves.

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Module Name: Coordinate Systems and Vector Calculus** ○ Introduction to Field Theory ○ Co-ordinate systems and transformation: Cartesian coordinates Circular cylindrical coordinates, Spherical coordinates & their transformation. Differential length, area and volume in different coordinate systems. Solution of problems. ○ Introduction to Vector calculus: DEL operator, Gradient of a scalar, Divergence of a vector & Divergence theorem, Curl of a vector & Strokes theorem, Laplacian of a scalar, Classification of vector fields, Helmholtz's theorem. Solution of problems.	**9**	**1**

Module: 2	**Module Name: Electrostatics** o Coulomb's Law and concept of Electric Field o The Divergence Theorem and Gauss' Law o Concept of Electrostatic Potential, Poisson's Equation o Energy Density in the Electrostatic Field o Dielectrics, dielectric boundary conditions o Solution of Laplace's Equation and Poisson's Equation	**6**	**1**
Module: 3	**Module Name: Magnetostatics** o Force due to a Magnetic field, , Biot-Savart Law. o Calculation of Magnetic Field for simple coil configurations. o Magnetic flux density Ampere's Law, calculation of magnetic flux density. o Force due to combined Electric and Magnetic fields. o Magnetic materials, magnetic boundary conditions, Solution of problems.	**6**	**1,2**
Module: 4	**Module Name: Electromagnetism** o Electromagnetic fields, Faraday's law, Transformer and motional e.m.f. o Displacement current, Maxwell's equations o Time varying Potential, Time harmonic fields. o Solution of problems.	**4**	**1,2,3**
Module: 5	**Module Name: Electromagnetic wave propagation** o Wave equation, Wave propagation in lossy dielectric, Plane waves in loss less dielectric, Plane wave in free space, Plane wave in good conductor, Skin effect, Skin depth, Power & Poynting vector. o Reflection of a plane wave at normal incidence, reflection of a plane wave at oblique incidence, Reflection of a plane wave at normal incidence, Polarization. o Solution of problems.	**7**	**1,2,3 ,4**
Module: 6	**Module Name: Transmission line** o Concept of lump & distributed parameters, Line parameters of transmission line, Transmission line equation & solutions. o Propagation constants, Characteristic impedance, Wavelength, Velocity of propagation of transmission line. o Solution of problems.	**4**	**1,2,3 ,4**

Text Books:

1. Principles and Applications of Electromagnetic Fields - Plonsey, R.and Collin, R.E., McGraw Hill.1961.
2. A. Pramanik, "Electromagnetism - Theory and applications", PHI Learning Pvt.Ltd, New Delhi, 2009.
3. A. Pramanik, "Electromagnetism-Problems with solution", Prentice Hall India,2012

Reference Books:

1. M. N. O. Sadiku, “Elements of Electromagnetics”, Oxford University Publication, 2014.
2. Engineering Electromagnetics - William H. Hayt, Jr. FifthEdition.TMH.1999.

POWER ELECTRONICS

Course Name: POWER ELECTRONICS	**Category:** Professional Elective Course-I
Course Code: PE-EI 401	**Semester: IV**
L-T-P: 3-0-0	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Continuous Assessment: 30
Tutorial: Nil	End Semester Exam.: 70 Marks
Total Lectures: 36	
Pre-Requisites: Basic Electronics, analog electronics	

Objectives:

1. To understand the functioning and characteristics of power switching devices.
2. To understand the principle of operation of converters.
3. To understand different triggering circuits and techniques of commutation of SCR
4. To find external performance parameter of converters.
5. To analyze methods of voltage control, improvement of power factor and reduction of harmonics of the converter
6. To understand various applications of converters

Course Outcomes (COs):

PE-EI 603.1.1. To **describe** the functioning and characteristics of power switching devices.
PE-EI 603.1.2. To **state** different triggering circuits and techniques of commutation of SCR
PE-EI 603.1.3. To **apply** the principle of operation of power electronic converters.
PE-EI 603.1.4. To **design** various applications of converters

Module No.	Description of Topics	Contact Hrs	CO
Module 1	**Introduction:** Concept of power electronics, application of power electronics, uncontrolled converters, advantages and disadvantages of power electronics converters, power electronics systems, power diodes, power transistors, power MOSFETS, IGBT	04	1
Module 2	**PNPN devices:** Thyristors, brief description of members of Thyristor family with symbol, V-I characteristics and applications. Two transistor model of SCR, SCR turn on methods, switching characteristics, gate characteristics, ratings, SCR protection, series and parallel operation, gate triggering circuits, different commutation techniques of SCR.	05	2
	Phase controlled converters: Principle of operation of single phase and three phase half wave, half		

Module 3	Controlled, full controlled converters with R, R-L and RLE loads, effects of freewheeling diodes and source inductance on the performance of converters. External performance parameters of converters, techniques of power factor improvement, single phase and three phase dual converters	06	1,2,3
Module 4	**DC-DC converters:** Principle of operation, control strategies, step up choppers, types of Choppers circuits based on quadrant of operation, performance parameters, multiphase choppers.	05	1,2,3
Module 5	**Inverters:** Definition, classification of inverters based on nature of input source, wave shape of output voltage, method of commutation & connections. Principle of operation of single phase and three phase bridge inverter with R and R-L loads, performance parameters of inverters, methods of voltage control and harmonic reduction of inverters. **Three-phase voltage source inverter:** 180° VSI & 120° VSI ,Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages, average output voltages over a sub Cycle. Cyclo-converters, Ac Voltage Controller and Static Switch	13	1,2,3
Module 6	**Applications:** Speed control of AC and DC motors, UPS.	03	1,2,3, 4

Text books:

1. Power Electronics, M.H. Rashid,4th Edition, Pearson
2. Power Electronics, P.S. Bhimra, , 3rd Edition, Khanna Publishers
3. Power Electronics, V.R. Moorthi, Oxford.
4. Power Electronics, M.D. Singh and K.B. Khanchandani, Tata McGraw Hill.

Reference books

1. Modern Power Electronics & AC drives, B.K. Bose, Prentice Hall
2. Power Electronics, Mohan,Undeland&Riobbins, Wiley India
3. Element of power Electronics, Phillip T Krein, Oxford.
4. Power Electronics systems, J.P. Agarwal, Pearson Education.
5. Analysis of Thyristor power conditioned motor, S.K. Pillai, UniversityPress.
6. Power Electronics, M.S. Jamal Asgha, PHI.
7. Power Electronics : Principles and applications, J.M. Jacob, Thomson

NANO ELECTRONICS

Course Code: PE-EI 402	**Category: Professional Elective Courses-V**
Course Name: NANO ELECTRONICS	**Semester: Fourth**
L-T-P: 3-0-0	**Credit: 3**
Total Lectures: 34	
Pre-Requisites: Basic Electronics	

Course outcomes:

1. **Recall and describe** the fundamental concepts of nanoelectronics, including the transition from microelectronics to nanoelectronics and the applications in industries like automotive, healthcare, and security. *(Remembering)*

2. **Explain** the classification of nanostructures (1D, 2D, 3D), their band structure, and the principles of electron transport in nanostructures such as nano diodes and nano lasers. *(Understanding)*
3. **Apply** knowledge of nano transistors and logic devices, including nano MOSFETs, CMOS devices, and FinFET, to solve basic design problems involving speed performance and power dissipation. *(Applying)*
4. **Analyze** the advantages and limitations of different nano memory devices (DRAM, NAND, Ferroelectric, Magnetic, Phase Change Memories, etc.) and emerging memory architectures. *(Analyzing)*

Module No.	Description of Topic	Contact Hrs.	COs
1	**Fundamentals on Nanoelectronics –** Concepts of of Nanoelectronics, Technological revolution from Microelectronics to Nanoelectronics and beyond, Moore's Law Trends and Limits, Technological advantages in various applications like - Automotive, Health Care, Biochips, Lab-on-Chips , Safety and Security, Industrial Applications, etc.	**4**	**1-2**
2	**Nano diode** – classification of nanostructure (1D or quantum well, 2D or quantum wire, 3D or quantum dot), band structure and energy level modification in various nanostructures, electron transport in nanostructures, design of nano diodes, Resonant-tunneling diodes, nano Light-emitting diodes, nano lasers, nano solar cell, etc.	**6**	**1-4**
3	**Nano transistor & Nano Display systems** – nano transistor, nano Field-effect transistors, Single-electron-transfer devices, Potential-effect transistors, nano display system, etc.	**6**	**1-4**
4	**Nano Logic Devices** – Nano MOSFET & CMOS Devices, Device structure and Speed Performance of nano FETs, Switching Delay Formulation, Power dissipation, Parasitic Capacitance in Logic Devices, FinFET and Double-Gate Devices, Choice of Materials for Advanced CMOS	**6**	**1-4**
5	**Nano Memory Devices** - Mainstream Memories (DRAM and NAND), Evolution and Scaling Limits, Various Memories Technologies like	**6**	**1-4**

	Ferroelectric Memories, Magnetic Memories, Phase Change Memories, Resistive RAMs, OxRAM and CBRAM, Emerging Memories Architectures, From Cell to Arrays, 3D RRAM Architectures, Opportunities for Emerging Memories etc.		
6	**Nano Integrated Sensors and Actuators** – Nano Mechanical sensors, Nano MEMS, Nano Pressure Sensors, Acceleration Sensors, Nano Gas Sensors, Biosensors, Electrostatic, Electromagnetic and Piezoelectric Sensors, Nano Optical Fibers, Integrated Fiber Sensors for Industrial applications.	**6**	**1-4**

Books:

1. Nanoelectronics - Materials,Devices,Applications – R. Puers, et al (Ed), Wiely VCH, 2016
2. Introduction to Nanoelectronics Science, Nanotechnology, Engineering, and Applications – V. V. Mitin, V.A. Kochelap and M. A. Stroscio, Cambridge University Press, 2008
3. Fundamentals of Nanoelectronics - G. W. Hanson, Pearson/Prentice Hall, 2008
4. Intersubband Transitions in Quantum Structures – R. Paiella (Ed), MaGraw-Hill, 2006
5. Nanophotonics and Nanostructured Fiber Sensors – A. B. Maity, Narosa, 2019
6. Sensors Based on Nanostructured Materials - F. J. Arregui (Ed), Springer, 2009

Advanced Language Lab

Name of the Course: Advanced Language Lab	**Category:**Humanities and Social Sciences including management courses
Course Code: HM-HU 481	**Semester:4th**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination scheme: Maximum marks:**
Tutorial: Nil	External Assessment:60
Practical: 2 hrs./week	Internal Assessment:40
Credit Points: 1	

Course Outcomes:	
CO. 1	To distinguish between various contexts of human communication, e.g., one-to-one, small group, organizational, formal, informal, media, family, intercultural communication, technologically mediated communication, etc.
CO. 2	To use knowledge of interview processes in answering typical HR questions and to demonstrate proper interview etiquette.
CO. 3	To analyze a given topic, enumerate main points and deliver a structured speech with proper introduction and conclusion.
CO. 4	To utilize the key skills like active listening, managing conflict, collaborative communication, and proper body language successfully while discussing any given topic in a group.
CO. 5	To defend opinions with evidence and argument while speaking to an audience or discussing a topic in a group.
CO. 6	To employ effective presentation skills to speak about general and academic topics in front of an audience and transfer this skill successfully to higher semester seminars and future career.
Pre-Requisite:	
1	**No pre-requisites**

Objective:

The overall aim of this course is to inculcate a sense of confidence in the students and help them to become good communicators in their social as well as professional lives.

EXP. NO.	Detailed Course Outlines	COs
1	**Introductory lecture** is to be given to the students so that they get a clear idea of the syllabus and understand the need for having such a practice lab in the first place (3 hours).	
2	**Listening Skills:** Audios & Videos related to current affairs will be shown from sources like British Council, BBC, NDTV, TOEFL, IELTS etc to hone the listening skills of students so that they may identify important points and effective strategies in preparation for their speaking skills.	

	Speaking Skills: 1. **Prerequisite for Speaking Activities:** Mastering Linguistic, Paralinguistic features, Pronunciation, Body Language Voice modulation Stress, Intonation, Pitch & Accent of connected speech. 2. **One Minute Speech:** Students will be taught to organize their thoughts and ideas and present them in a coherent manner in front of an audience on any given topic. While giving the speech they will be taught to demonstrate correct body language, voice modulation and appropriate pronunciation 3. **Group Discussion:** The students are made to understand proper language, etiquette and strategies for group discussion. Audio -Visual aids as pre-requisite for group discussion will be used to hone listening skills. After wards the class is divided into groups and the students have to discuss on given topic. 4. **Mock Interview:** Students are taught the strategies of a successful interview. They then have to face rigorous practices of mock-interviews.	
3	**Reading Skills:** News Paper Reading: Students are advised to how to read current affairs from leading newspapers, comprehend and summaries the news articles and express their opinion in their own words. This activity will help the students immensely to speak during one minute speech and group discussion.	
4	**Writing Skills:** Resume Writing: Students will be taught how to write a professional resume for campus placement & future career.	

Data Structure & Algorithm Lab

Name of the Course: Data Structure & Algorithm Lab	**Category:** Engineering Science Courses
Course Code: ES-EI 491	**Semester:** 4th
Duration: 6 months	**Maximum Marks:** 100
Teaching Scheme:	**Examination scheme:** Maximum marks:
Tutorial: Nil	External Assessment:60
Practical: 2 hrs./week	Internal Assessment:40
Credit Points: 1.0	

Course Outcomes:	
ES-CS 491.1.	**Recall and describe** the fundamental concepts of arrays, stacks, queues, and linked lists, including their operations such as insertion, deletion, and traversal. *(Remembering)*
ES-CS 491.2.	**Understand and explain** the working of various searching algorithms (Linear Search, Binary Search) and sorting techniques (Bubble Sort, Quick Sort, Merge Sort, etc.). *(Understanding)*
ES-CS 491.3.	**Apply** data structures like stacks, queues, and linked lists to solve computational problems such as infix-to-postfix conversion, Tower of Hanoi, and polynomial manipulation. *(Applying)*
ES-CS 491.4.	**Analyze** the efficiency of different sorting and searching algorithms in terms of time and space complexity, and evaluate their suitability for different applications. *(Analyzing)*
ES-CS 491.5.	**Implement** advanced data structures such as binary search trees, AVL trees, and B-trees, along with operations like insertion, deletion, and traversal to solve complex problems. *(Applying)*
ES-CS 491.6.	**Create and develop** a mini-project that integrates various data structures (arrays, linked lists, trees, hashing) to solve real-world problems efficiently. *(Creating)*
Pre-Requisite:	
1	**C-Programming**

Experiment No.	Laboratory Experiments	COs
1	**Array** Addition & Multiplication of Arrays Implementation of Sparse Matrices	1 - 4
2	**Abstract Data Type Stacks and Queues:** Implementation of Stack using Array, Conversion of infix notation into its corresponding prefix & postfix forms along with the evaluation of postfix expression Addition, Deletion of elements of Linear Queue & Circular Queue Implementation of Stack using Queue and vice-versa double ended queue. Implementation of Stack and Queue using array.	1 – 4
3	**Recursion** Tail-Recursion, Tower of Hanoii	1 – 4

4	**Linked List** Implementation of linked lists: inserting, deleting, and inverting a linked list. Implementation of stacks & queues using linked list, Polynomial addition, Polynomial multiplication	1 – 4
5	**Searching & Sorting Operations Searching:** Linear Search, Binary Search	1 - 6
	Sorting: Bubble Sort, Selection Sort, Insertion Sort, Quick Sort, Merge Sort & Heap Sort.	
6	**Nonlinear Data structures** Tree Traversal of Binary Search Tree, Threaded binary tree traversal Height balanced binary tree – AVL tree (insertion, deletion) & B- Trees – operations (insertion, deletion).	1 – 4
7	**Hashing** Hash tables implementation: searching, inserting and deleting, searching & sorting techniques.	1-4
8	Mandatory Design and Implementation of Mini Project.	1-6

Electrical & Electronic Measurements Lab

Course Name: Electrical & Electronic Measurements Lab	**Category:** Professional Core
Course Code: PC-EI 491	**Semester:** 4th
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination scheme**
Tutorial: Nil	External Assessment:60
Practical: 3 hrs./week	Internal Assessment:40
Credit Points: 1.5	

Course Outcomes:	
CO. 1	*Identify* different analogue digital instruments both AC and DC source and sink devices, their specifications and constructions using basic knowledge of electrical & electronic measurement.
CO. 2	*Demonstrate* the experiments, interpret measured data, *compare* them with the true value of an quantity, calculate error in measurement, draw calibration and error curve using appropriate techniques and prepare comprehensive technical laboratory reports.
CO. 3	*Analyze* the characteristics of various measurement systems to assess their static and dynamic performance.
CO. 4	*Apply* appropriate measurement techniques to determine electrical parameters such as resistance, frequency, inductance, and capacitance using specialized bridges and instruments.
CO. 5	*Designing and implementing* mini-projects that integrate multiple measurement and analysis techniques and assess their performance.
CO. 6	*Assess and ensure* adherence to safety standards in both simulations and hardware configurations, demonstrating a discerning approach to evaluating safety precautions in electrical network design and implementation.
Pre-Requisite:	
1	Mathematics Fundamentals

Exp. No.	Laboratory Experiments	COs
1.	Calibration of dynamometer type Ammeter and voltmeter by Potentiometer.	1,2,3
2.	Measurement of Low Resistance using Kelvin Double Bridge.	1,2,4
3.	Measurement of frequency by Wien Bridge.	1,2,4
4.	Measurement of inductance by Anderson Bridge.	1,2,4
5.	Measurement of capacitance by De Sauty Bridge.	1,2,4
6.	Study the Static Characteristics of a Measuring Instrument.	1,2,3
7.	Study the Dynamic Characteristics of a Measurement System.	1-3
8.	Acquaintance with basic Structure of Digital Multi Muter and Measurement of Different Electrical Parameters.	1-4
9.	Wave and Spectrum Analysis using Q – Meter.	1-4
10.	Study the static and dynamic characteristics of VCO.	1-3

11.	Mandatory Design and Implementation of Mini Project.	1-6

Text and reference books:

1. A course in Electrical & Electronic Measurements & Instrumentation; A.K. Sawhney, Dhanpat Rai and sons.
2. Electrical Measurements and Measuring Instruments; E.W Golding & F.C. Wides, Wheeler Publishing.
3. Electronic Instrumentation; H.S.Kalsi, Tata McGraw hill, 2nd edition.

Microprocessor and Microcontroller Laboratory

Course Name: Microprocessor and Microcontroller Laboratory	**Category:** Professional Core Courses
Course Code: PC-EI 492	**Semester:** 4th
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination scheme: Maximum marks:**
Tutorial: Nil	External Assessment:60
Practical: 3 hrs./week	Internal Assessment:40
Credit Points: 1.5	

Course Outcomes:	
CO. 1	**Recall** the fundamentals of assembly level programming for microprocessor and microcontroller.
CO. 2	**Explain** the programming logic with the help of algorithm or flowchart.
CO. 3	Perform **experiment with** the microprocessor and microcontroller trainer kit and other necessary peripherals.
CO. 4	Draw the **conclusion** after performing the experiment.
CO. 5	**Compare** the experimental out come with the developed program.
CO. 6	**Develop** a microprocessor and microcontroller based mini project.
Pre-Requisite:	
1	Digital Electronics

Experiment No.	**Laboratory Experiments**	COs
1.	a) Familiarization with 8085 trainer kit components. b) Familiarization with 8085 simulator on PC.	1 - 2
2.	Study of prewritten programs using 8085 Kit / Simulator for i. Logical operation (AND, OR, NOT, NAND, NOR, XOR, XNOR) ii. Arithmetic operation (Addition, Subtraction, Multiplication, Division) iii. Copying and Shifting a block of memory iv. Packing and unpacking of BCD numbers v. Find 1's and 2's complement of a 16-bit number vi. Reverse a 16 bit number vii. String Matching viii. Any other on need	1 – 3
3.	a) Familiarization with 8051 trainer kit components. b) Familiarization with 8051 simulator on PC.	1 – 3
4.	Study of prewritten programs using 8051 Kit / Simulator for i. Logical operation (AND, OR, NOT, NAND, NOR, XOR, XNOR) ii. Arithmetic operation (Addition, Subtraction, Multiplication, Division) iii. Convert an 8 bit number into Grey number iv. Check whether the given 16 bit number is palindrome or not v. Any other on need	1 – 4
5.	Interfacing with Peripherals and I/O modules: i. 8255 PPI ii. Stepper Motor	1 – 4

	iii. ADC iv. Temperature sensor v. Relay vi. Any other on need	
6.	Mandatory Design and Implementation of Mini Project	1 – 6

Control System

Course Name: Control System	**Category:** Professional Core Courses
Course Code: PC EI 501	**Semester:** 5TH
L-T-P: 3-1-0	**Credit:** 4
Teaching Scheme	**Examination Scheme**
Theory:3hrs./week	**Continuous Assessment:** 25Marks
Total Lectures: 48	**Attendance:** 5 Marks
	End Semester Exam.: 70 Marks
Pre-Requisites: Engineering mathematics that teaches complex variables and Laplace transform	

Objectives:

1. *To understand the use of transfer function models for analysis of physical systems and introduce the control system components.*
2. *To provide adequate knowledge in the time response of systems and steady state error analysis.*
3. *To accord basic knowledge in obtaining the open loop and closed–loop frequency responses of systems.*
4. *To introduce the concept of stability of physical systems.*
5. *To introduce design of compensators and non-linear systems.*

Course Outcomes (COs):

On completion of this course, the student will be able to

Remembering:
CO1: Students will be able to recall fundamental concepts of linear time-invariant (LTI) systems, including system components, differential equations, Laplace transforms, transfer functions, poles, and zeros.

Understanding:
CO2: Students will demonstrate an understanding of block diagram reduction techniques, signal flow graphs, and time-domain analysis by explaining how to reduce complex systems into simpler models for analysis.

Applying:
CO3: Students will apply Routh stability criterion, root-locus techniques, and Bode plot methods to analyze the stability and performance of feedback control systems in both time and frequency domains.

Analyzing:
CO4: Students will be able to analyze the design of compensators (lead, lag, and lead-lag) and identify the effects of feedback on system stability, robustness, and disturbance rejection through both transfer function and state-space models.

Syllabus Details

Module No.	Description of Topics	Contact Hrs.	CO

Module: 1	Mathematical modelling of linear time-invariant systems (LTI): System components and Differential equations of physical Systems – mechanical, electrical systems, thermal systems, electromechanical system, biological system; Concept of analogous systems. Laplace transforms, Transfer function, Solution of set of differential equations using Laplace transformation. Concept of poles and zeros. System order and type number. A brief introduction to non-LTI systems, distributed systems, discrete systems, time-delay system. Process plant characteristics parameters: Process potential, process quantity and process capacitance, process resistance, process time lag.	**12**	**1**
Module: 2	Block diagram and signal flow graph analysis: Block diagram reduction techniques, Mason's gain formula. Examples.	**4**	**1**
Module: 3	System analysis (time-domain): Time response of first-order and second-order systems. Steady-state errors and error constants.	**6**	**2**
Module: 4	Characteristics of feedback control: Feedback Principles, Effect of feedback in stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity, and robustness.	**7**	**1-4**
Module: 5	Stability analysis: Concepts of stability. Necessary conditions for Stability. Routh stability criterion. Relative stability analysis. Introduction to root-locus techniques.	**6**	**1-4**
Module: 6	System analysis (frequency-domain): Bode plots-phase and gain margins, Experimental determination of transfer function. Introduction to Polar Plots. Nyquist plots. Nyquist Stability criterion (including time delay systems).	**6**	**1-4**
Module: 7	Compensator Design: Design of lead, lag and lead-lag compensators, Design (and development) of the simple control system.	**4**	**1-4**
Module: 8	Disadvantages of Transfer function modelling, Introduction to state-space representation.	**4**	**1-4**
	Total	**48**	

Text/References:

1. Automatic Control System: Basic analysis and design by William A. Wolovich, The Oxford Series in Electrical and Computer Engineering.
2. B. C. Kuo, "Automatic Control System", 10th McGraw Hill.
3. K. Ogata, "Modern Control Engineering", Prentice Hall, 5th edition.
4. I. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International, 2009
5. Control Systems Engineering, 6th edition, ISV (WSE), by Norman Nise, Wiley
6. Control Systems, Ambikapathy, Khanna Publishing House, 2018.
7. Control Systems, N K Sinha, New Age International Pvt, 2013.

Industrial Instrumentation

Course Name: Industrial Instrumentation	**Category: Professional Core**
Course Code: PC-EI 502	**Semester: 5th**
L-T-P: 3-0-0	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Continuous Assessment: 30Marks
Tutorial: Nil	End Semester Exam.: 70 Marks
Total Lectures: 36	
Pre-Requisites: Elementary Physics, Sensor & Transducers and Basic Measurement.	

Objectives:

The subject aims to encourage the students to acquire knowledge about:-

1. To familiar the students with industrial instruments used in various industries.
2. To acquire knowledge about various techniques used for measurement of process variables such as temperature, pressure, flow and level.
3. To equip the students with the basic knowledge of industrial processes.
4. To learn the construction and working of different types of temperature, pressure, flow and level transducers.
5. To provide the concept of possible sources of error and possible remedies when performing measurements.

Course Outcomes (COs):

On completion of this course, the student will be able to

CO.1. Recall the fundamental principles of measurement techniques and instruments commonly used in industrial applications.

CO.2. Explain the working principle of measurement systems and transmitters used in industrial settings.

CO.3. Apply suitable measurement techniques and instruments to effectively meet industrial requirements.

CO.4. Analyze and **evaluate** measurement systems and instruments to solve practical problems in industrial instrumentation.

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Module Name: Measurement of Temperature:** Different types of thermometers: Bimetal, thermocouple, RTD, thermistors, IC temperature sensors, radiation thermometers, temperature switches. Thermowell, Temperature simulators and calibrators.	**7**	**1 - 4**
Module: 2	**Module Name: Measurement of Pressure and Vacuum**	**7**	**1 - 4**

	Concept of absolute, gauge and differential pressure. Pressure units and measurement principles. Elastic pressure sensors: bourdon tube, bellows, diaphragm and capsule. Manometers. Pressure gauge. Pressure switch. Electronic pressure transmitters: capacitive, piezo-resistive and resonator type. Calibration of pressure measuring devices. Installation of pressure measuring devices in different services. Measurement accessories - chemical seal and snubbers. Vacuum measurement: Mcleod gauge, thermal conductivity and ionization gauge.		
Module: 3	**Module Name: Measurement of Flow - I** General concepts - Laminar and turbulent flow, Reynolds's number, Effect of temperature and pressure on flow rate measurement, Calibration of flow meters. Head type flow measurement – analysis and calculation, and head producing devices - orifice, nozzle, venturi, pitot tube, multiport averaging pitot. Differential Pressure Transmitter (DPT): Types, Mounting (Installation), Variable Area Flowmeters – Glass and metal tube rotameters.	**8**	**1 - 4**
Module: 4	**Module Name: Measurement of Flow - II** Electromagnetic type, Ultrasonic type, Vortex type, Positive displacement type Mass flow meters: Coriolis, Thermal, Impeller type Weirs, Flumes and open channel flow measurement, measurement of flow of bulk solids. Accessories instruments required for installation in industrial application like manifolds.	**7**	**1 - 4**
Module: 5	**Module Name: Measurement of Level** Review of various level measurement methods, application considerations. Level measurement devices: Gauge glass, float & displacer type level sensors, D/P type level sensors, capacitive level sensors, ultrasonic & microwave level sensors, servo level gauges, conductivity level sensors, radiation level sensors, vibrating level switches. Tank gauging systems	**7**	**1 - 4**

Text Books:

1. Krishnaswamy. K & Vijayachitra. S, Industrial Instrumentation, New Age International.
2. Patranabis. D, Principle of Industrial Instrumentation, 2nd edition, Tata McGraw Hill, New Delhi.
3. Singh S.K, Industrial Instrumentation and Control, Tata McGraw Hill, New Delhi.

Reference Books:

1. B. G. Liptak, Instrument Engineers Handbook, vol-I and vol-II, Chilton Book Co. Philadelphia
2. D. M. Considine and G. D. Considine (Eds.) Process Instruments and controls Handbook, McGraw Hill, New York
3. C. R. Alavala, Principles of Industrial Instrumentation and Control Systems, Cengage Learning

Optical Instrumentation

Course Code: PE-EI 501	**Category: Professional Elective Courses-II**
Course Name: Optical Instrumentation	**Semester: 5th**
L-T-P: 3-0-0	**Credit: 3**
Total Lectures: 36	
Prerequisite: Knowledge of basic optics, Fundamentals of Electromagnetic theory	

Course Objective:

- To learn light propagation, signal loss, pulse dispersion in various optical fibers and their production / installation.
- To learn operation and design of various semiconductor optical sources (LED & Laser), optical modulators / switches / amplifiers.
- To learn design and operation of various photo-detectors along with their gain and noise performance.
- To learn design, operation, and industrial uses of different kinds of high / moderate power gas- and solid-state lasers.
- To learn operation and design of various fiber-based sensor systems for online measurements in diversieve industrial applications.

Course Outcome:

PE-EI 501.CO1: Describe - optical fiber, optical sources, photo-detectors, optical signal conditioning, optical modulators / switches / amplifiers, special types of lasers, optical fiber-based instrumentation applications.

PE-EI 501.CO2: Explain - types of optical fibers, signal loss & pulse dispersion in fibers; light generation & extraction from various LEDs / Lasers; light detection by photo detectors, operation of optical modulators / switches / amplifiers / high power laser, optical fiber based sensor systems.

PE-EI 501.CO3: Develop - arrangements of various optical fibers and connectors; LEDs, Lasers, photo detectors, optical modulators / switches / amplifiers, high power gas / solid state lasers, optical fiber based sensor systems.

PE-EI 501.CO4: Analyze - optical signal propagation / loss / dispersion in various optical fibers; spectral response / gain in different LEDs, Lasers; noise performances of photo detectors; comparative performances of various - optical modulators / switches / amplifiers, high power lasers, optical fiber based sensor systems.

Module No.	Description of Topics	Contact Hrs	CO

1.	**Optical Fiber:** Modern Optical Instrumentation, Role of optical fiber, Advantages, Light propagation through optical fiber, Types of optical fibers & properties, Signal losses in optical fiber, Pulse dispersion effects, Optical fiber production & packaging, Fiber connector and splices.	7	1-4
2.	**Optical light Sources:** Common optical sources – (i) LED, LED classifications, Design & operation, Spectral response & circuits, (ii) Semiconductor Laser, Stimulated emission & lasing process, Laser gain & modes, Laser classifications - DH laser, QW laser, DFB laser, Tunable laser, etc.	8	1-4
3.	**Photo Detectors:** Light detection technique, Photo detector's - responsivity, quantum efficiency & gain, Types of Photo detectors – Photoconductive detector, p-n jn detector, PIN photodetector, APD, Noise performances, Special class of photo detector – phototransistors, Quantum Well photo detector, Optocoupler.	6	1-4
4.	**Optical Modulators, Switches & Amplifiers:** Types of light modulation, Electro-optic, Magneto-optic & Acousto-optic Modulators, Electro-optic switches. Optical amplifiers - EDFA, Raman amplifier	4	1-4
5.	**High Power Laser & Industrial Applications:** Q-switching and mode locking techniques, Three-level & four-level gas lasers, solid state lasers, Applications in – Metallurgical & Manufacturing - Material processing, Laser heating, Welding, Melting, Holographic recording, Measurement of distance, etc.	5	1-4
6.	**Optical Fiber based Instrumentation:** Basic fiber sensor system, Interferometric & Non- Interferometric fiber sensor systems for online measurement of - temperature, pressure / strain, displacement / thickness, fluid flow / level, under water imaging, rotation, current / voltage. Fiber-optic chemical / bio sensors, Biomedical sensors, etc.	6	1-4

Text/Reference Books:

1. Introduction to Optoelectronics, J. Wilson and J.F.B. Hawkes, Prentice Hall of India, 2001.

2. Optoelectronics and Optical Fiber Sensors, A. B. Maity, PHI, 2013
3. Fiber Optics and Optoelectronics, R. P. Khare, Oxford Univ. Press, 2004.
4. Laser Fundamentals – W. T. Silfvast, Cambridge Univ. Press, 2004
5. Optical Fiber Communication – Principles and Practice, J.M. Senior, PHI, 1985.
6. Lasers Systems and Applications – S. K. Srivastava, New Age, 2019

Advanced Sensors

Course Name: Advanced Sensors	**Category: Professional Core**
Course Code: PE-EI 502	**Semester: 3rd**
L-T-P: 3-0-0	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Continuous Assessment: 30Marks
Tutorial: Nil	End Semester Exam.: 70 Marks
Total Lectures: 36	
Pre-Requisites: Basic knowledge of electronics, sensors and transducers	

Objectives:

This course aims to educate students with different advanced sensing technology and also make them familiar with manufacturing and fabrication technique of different silicon and micro sensors. Also it is expected that the knowledge of this course will encourage the students in designing different sensor based projects for application in the field of robotic and industrial automation.

Course Outcomes (COs):
After completing the course the student should be able to

PE-EI 502.1: Explain the principles of various transducers and sensor fabrication techniques.
PE-EI 502.2: Understand the operation of various environmental and bio sensors.
PE-EI 502.3: Apply knowledge in designing smart sensors.
PE-EI 502.4: Discuss the techniques of fabrication and application of MEMS.

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Fundamentals of sensors** Transducers for various parameters like temperature, pressure, flow, level, acceleration, vibration, orientation etc.	**8**	**1**
Module: 2	**Sensor Fabrication:** Design considerations and selection criterion as per standards, Sensor fabrication techniques, process details and latest trends in sensor fabrication. Thick film sensing and system design.	**7**	**2**
Module: 3	**Smart Sensors:** Smart sensor basics, signal conditioning and A/D conversion for sensors, examples of available ICs and their applications.	**5**	**3**
Module: 4	**Micro Electromechanical Sensors:** Construction, Features, Applications	**7**	**4**

Module: 5	**Advanced Sensing Technology:** Sensors, instruments and measurement techniques for emerging application areas such as environmental measurement like DO(dissolved oxygen), BOD (biological oxygen demand), COD(chemical oxygen demand), TOC(total organic carbon), Cox(carbon dioxides), NOx(nitrogen oxide), SOx (Sulpher Oxides)	**5**	**5**
Module: 6	**Bio Sensors:** Sensors agricultural measurements such as soil moisture, wind speed, leaf wetness duration, sensors for food processing like smell or odour, taste.	**4**	**6**
	Total	**36**	

Text Books:

1. Chang Liu, Foundations of MEMS, Pearson Education Inc., 2012.
2. Stephen D Senturia, Microsystem Design, Springer Publication, 2000.
3. Tai Ran Hsu, MEMS & Micro systems Design and Manufacture Tata McGraw Hill, New Delhi, 2002.
4. Jacob Fraden /Handbook of Modern Sensors, 2nd Ed.
5. S. M. Sze, Semiconductor Sensors.
6. M J Usher, Sensors and Transducers, MacMillan, 1985.

Reference Books:

1. NadimMaluf, An Introduction to Micro Electro Mechanical System Design, Artech House, 2000.
2. Mohamed Gad-el-Hak, editor, The MEMS Handbook, CRC press Baco Raton, 2001.
3. Julian W. Gardner, Vijay K. Varadan, Osama O.Awadelkarim, Micro Sensors MEMS and Smart Devices, John Wiley & Son LTD, 2002.
4. James J.Allen, Micro Electro Mechanical System Design, CRC Press Publisher, 2005.
5. Thomas M. Adams and Richard A.Layton, Introduction to MEMS, Fabrication and Application, Springer, 2010.

Analog and Digital Communication

Course Name: Analog and Digital Communication	**Category:** Professional Elective Course-II
Course Code: PE-EI 503	**Semester: 5th**
L-T-P: 3-0-0	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Continuous Assessment: 30 Marks
Tutorial: Nil	Attendance:
Total Lectures: 36	End Semester Exam.: 70 Marks
Pre-Requisites: Basic knowledge of analog and digital electronic circuits, signals and systems.	

Objectives: This course aims to equip the students with basic concept of communication system. It emphasizes on technical details of different analog and digital modulation and detection techniques, their performance in different noise conditions. The evolution of mobile communication is also introduced.

Course Outcomes (COs):

After study through the course, students will be able to:

PE-EI 503.1: Express components of analog and digital communication system.

PE-EI 503.2: Describe various analog and digital modulation and demodulation techniques, the performance of modulation and demodulation techniques in various transmission environments.

PE-EI 503.3: Differentiate transmitter and receiver circuits used in communication systems, design issues, advantages, disadvantages and limitations of analog and digital communication systems

PE-EI 503.4: Evaluate different generations of mobile communication system and their technicalities.

Course Details

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Modulation Techniques:** Introduction to Communication Process, Communication Channels – transmitter, channel and receiver,Modulationadvantages,effectofnoiseincommunication system	3	**1**

Module: 2	**Amplitude Modulation:** 1. Amplitude Modulation Techniques: Mathematical representation of Amplitude Modulation (AM), modulation index, total power, side band power, efficiency, generation of AM, Demodulation of AM, Envelop Detection, Limitations of AM. 2. Introduce DSB-SC, SSB-SC, Generation, with non linear device, switching modulator, ring modulator, De-generation of DSB-SC, SSB-SC,synchronous demodulation, effect of phase and frequency error, filter method, Hilbert transform, VSB generation and degeneration, spectra and band-width application in communication, QAM	9	**1,2**
Module: 3	**Frequency Modulation:** 1. Angle Modulation**:** Mathematical representation of Angle modulation, FM, PM Concept of Narrow and Wide-band angle modulation, Calculation of Bandwidth for FM and PM with Narrow and Wide-band modulation. 2. Basic block diagram representation of generation and detection of FM & PM, Concept of VCO & Reactance modulator Angle Modulation, Frequency Modulation (FM), Phase Modulation (PM), Narrowband and wide-band FM,	5	2,3
Module: 4	**Pulse Modulation:** 1. Sampling process. Types of sampling, Aliasing effect. 2. PAM, PCM, Quantization, quantization error, Differential pulse code modulation. Delta modulation.	7	3
Module: 5	**Digital Modulation:** 1. Line coding technique, on-off, polar, bipolar, ISI, Nyquist criterion for zero ISI, eye pattern 2. Concept of M-ary Communication, M-ary phase shift keying, the average probability of symbol error for coherent M-ary PSK, power spectra of MPSK, 3. Digital modulation technique: (Coherent communication with waveforms) ASK, BPSK, FSK, QPSK, DPSK, MSK.	**6**	2,3

Module: 6	**Mobile Communication:** 1. Wireless Standards: Overview of 2G, 3G, 4G, 5G cellular, spectrum, comparison. Cellular concepts-Cell structure, frequency reuse, cell splitting, handoff, interference. 2. Multicarrier modulation, TDM,FDM,OFDM 3. MIMO and space time signal processing, spatial multiplexing, concept of multipath fading, Performance measures- Outage, average SNR, average capacity, bit error rate.	**6**	4

Text Books:

1. Haykin S., "Communications Systems", John Wiley and Sons, 2001.
2. Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education, 2002.
3. B.P. Lathi, “Modern Digital and Analog Communication Systems”, Oxford University Press.
4. WCY Lee, Mobile Communications Design Fundamentals, Prentice Hall, 1993.
5. Dr. M. Radhika C.K. Sanmathi, 4G/5G Communication Networks, Magnus Publication

Reference Books:

1. Sanjay Sharma, “Communication Systems (Analog and Digital)”, Katson Books.
2. Raymond Steele, Mobile Radio Communications, IEEE Press, New York, 1992.
3. AJ Viterbi, CDMA: Principles of Spread Spectrum Communications, Addison Wesley, 1995.
4. VK Garg&JE Wilkes, Wireless & Personal Communication Systems, Prentice Hall, 1996.

Telemetry & Wireless Sensor Network

Course Name: Telemetry & Wireless Sensor Network	**Category:** Professional Elective Course-II
Course Code: PE-EI 504	**Semester: 5th**
L-T-P: 3-0-0	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Continuous Assessment: 30Marks
Tutorial: Nil	End Semester Exam.: 70 Marks
Total Lectures: 36	
Pre-Requisites: Basic knowledge of Laplace transformation & Fourier transformation analog and digital communication, sensor and transducer, computer networks.	

Objectives: Study of telemetry aims to make the students capable to apply different modulation and multiplexing techniques in the field of measurement system. Telemetry plays an important role in remote monitoring and control of industrial processes. Advancement of telemetry leads to more complex but efficient system called Wireless Sensor Network where large amount of measurement data from large number of sensors are efficiently and securely stored, transmitted and analyzed. This course aims to make students able to apply the knowledge of telemetry and WSN in solving different industrial, domestic and healthcare related problems.

Course Outcomes (COs):

After completing the course the student should be able to

CO.1. **Identify** the system functional blocks of telemetry system and wireless sensor nodes.
CO.2. **Describe** utilities of various modulation and multiplexing processes in telemetry systems and their technicalities.
CO.3. **Apply** the knowledge of Fiber optic and Satellite communication in the field of Telemetry and wireless sensing and **demonstrate** various applications of WSN.
CO.4. **Evaluate** performance of various transport control protocols for WSN.

Module No.	Description of Topics	Contact Hrs.	CO
Module : 1	Purpose of telemetry, basic scheme, voltage, current and frequency telemetry. **Modulation**, multiplexing: FM-AM, FM-FM, PAM-AM, PAM-FM, PCM-AM, etc.	**6**	**1,2**
Module: 2	**FDM systems:** IRIG standards in FDM systems. SCO's, Mux and Demux circuits, Detectors and Demodulators, Pulse averaging, Quadrature FM and PLL, Mixers.	**6**	**2**

Module: 3	**TDM systems:** TDM- PAM, PAM- PM, TDM- PCM systems, synchronization. **Fiber optic Communication-** The Fiber as transmission medium, Interconnections, Repeaters, Sources, Detectors **Satellite Communication:** TT and C services, subsystems, The earth station	**8**	**2,3**
Module: 4	**Introduction to Wireless Sensor Networks:** Motivation, Performance Requirement, Challenges **Sensor nodes:** Components, Mode of detection, Behavior of nodes, Sensor Web, Social sensing in WSN	**6**	**1**
Module: 5	**Applications of WSN:** Healthcare, Surveillance, Agriculture, Wireless Multimedia sensor networks, Wireless Nano-Sensor networks, Acoustic Sensor networks. WSN Coverage	**5**	**3**
Module: 6	**Transport Control Protocols for Wireless Sensor Networks:** Transport Protocol Design Issues, Examples of Existing Transport Control Protocols, CODA (Congestion Detection and Avoidance), ESRT (Event-to-Sink Reliable Transport), RMST (Reliable Multi segment Transport), PSFQ (Pump Slowly, Fetch Quickly), GARUDA, ATP (Ad Hoc Transport Protocol), and Problems with Transport Control Protocols.	**5**	**4**
	Total	**36**	

Text Books:

1. D. Patranabis, Telemetry principles, TMH, New Delhi
2. E. L. Gruenberg, Handbook of Telemetry and Remote control, McGraw Hill
3. Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons, Ltd, 2005
4. Jeeva Jose, "Intrenet of Things", Khanna Publishing
5. KazemSohraby, Daniel Minoli and TaiebZnati, " Wireless Sensor Networks Technology, Protocols, and Applications", John Wiley & Sons, 2007.

Reference Books:

1. Swobada G – Telecontrol Method and Application of Telemetering and Remote Control, Von Nostrand, 1971
2. A. Hac, *Wireless Sensor Network Designs*, John Wiley & Sons , 2009

Journals:

3. K. Akkaya and M. Younis, "A survey of routing protocols in wireless sensor networks", Elsevier Ad Hoc Network Journal, Vol. 3, no. 3, pp. 325--349
4. R.Swain and P.M.Khilar,"Heterogeneous Fault Diagnosis for Wireless Sensor Networks," International Journal of Adhoc Networks, Elsevier Science, Vol. 69, Feb 2018, PP. 15-3

Object Oriented Programming Language

Course Name: Object Oriented Programming Language	**Category:** Open Elective Course-I
Course Code: OE-EI501	**Semester: 5th**
L-T-P: 3-0-0	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Continuous Assessment: 25Marks
Tutorial: Nil	End Semester Exam.: 70 Marks
Total Lectures: 36	
Pre-Requisites:	

Course Objective:

1. To understand Object Oriented Programming concepts and basic characteristics of Java.
2. To know the principles of packages, inheritance and interfaces.
3. To define exceptions and use I/O streams.
4. To develop a java application with threads and generics classes.
5. To design and build simple Graphical User Interfaces

Course Outcome:

Remembering (Knowledge Level):

- Students will be able to define fundamental object-oriented programming concepts such as classes, objects, inheritance, polymorphism, and encapsulation. They will also recall basic Java programming structures, data types, operators, and control flow mechanisms.

Understanding (Comprehension Level):

- Students will be able to explain the core principles of object-oriented programming and the characteristics of Java, such as inheritance, interfaces, exception handling, and multithreading. They will also describe how Java handles I/O streams and event-driven programming using Swing and AWT components.

Applying (Application Level):

- Students will be able to apply object-oriented principles by designing and implementing Java classes, interfaces, and inheritance hierarchies. They will also develop programs that handle exceptions, manage threads, and use generics, along with creating simple graphical user interfaces (GUIs) using Java Swing and event handling mechanisms.

Analyzing (Analysis Level):

- Students will be able to analyze and compare different OOP features in Java, such as the use of interfaces vs. inheritance, exception handling mechanisms, and multithreading models. They will also evaluate the efficiency of various input/output operations and design robust event-driven programs.

Module No.	Description of Topics	Contact Hrs	COs
Module 1	**Introduction to oop and java fundamentals** Object Oriented Programming – Abstraction – objects and classes – Encapsulation- Inheritance – Polymorphism- OOP in Java	5	1,2

Module 2	**Characteristics of Java** – The Java Environment – Java Source File Structure – Compilation. Fundamental Programming Structures in Java – Defining classes in Java – constructors, methods -access specifiers – static members -Comments, Data Types, Variables, Operators, Control Flow, Arrays, Packages – Java Doc Comments.	5	1-3
Module 3	**Inheritance And Interfaces** Inheritance – Super classes- sub classes –Protected members – constructors in sub classes- the Object class – abstract classes and methods- final methods and classes – Interfaces – defining an interface, implementing interface, differences between classes and interfaces and extending interfaces – Object cloning –inner classes, Array Lists – Strings	9	2
Module 4	**Exception Handling And I/O** Exceptions – exception hierarchy – throwing and catching exceptions– built-in exceptions, creating own exceptions, Stack Trace Elements. Input / Output Basics – Streams – Byte streams and Character streams – Reading and Writing Console – Reading and Writing Files	8	3
Module 5	**Multithreading And Generic Programming Differences:** Between multi-threading and multitasking, thread life cycle, creating threads, synchronizing threads, Inter-thread communication, daemon threads, and thread groups. Generic Programming–Generic classes– generic methods – Bounded Types – Restrictions and Limitations.	9	4
Module 6	**Event Driven Programming** Graphics programming – Frame – Components – working with 2D shapes – Using color, fonts, and images • Basics of event handling – event handlers – adapter classes – actions – mouse events – AWT event hierarchy • Introduction to Swing – layout management – Swing Components – Text Fields , Text Areas – Buttons- Check Boxes – Radio Buttons – Lists- choices- Scrollbars – Windows– Menus – Dialog Boxes.	9	5

Text/Reference Books:

1. Herbert Schildt, ―Java The complete reference‖, 8th Edition, McGraw Hill Education, 2011.
2. Steven Holzner, ―Java 2 Black book‖, Dreamtech press,2011.
3. Timothy Budd, ―Understanding Object-oriented programming with Java‖, Updated Edition, Pearson Education,2000.
4. R.S. Salaria – Mastering Object-Oriented Programming using C++, Khanna Publishing House, 2018.

1.

Database Management Systems

Course Name: DatabaseManagement Systems	**Category:** Open Elective Course-I
Course Code: OE-EI 502	**Semester:** 5th
L-T-P: 3-0-0	**Credit:** 3
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Continuous Assessment: 30 Marks
Tutorial: Nil	End Semester Exam.: 70 Marks
Total Lectures: 36	
Pre-Requisites:	

Course Objective:

1. To understand the different issues involved in the design and implementation of a database system.
2. To study the physical and logical database designs, database modeling, relational, hierarchical, and network models
3. To understand and use data manipulation language to query, update, and manage a database
4. To develop an understanding of essential DBMS concepts such as: database security, integrity, concurrency, distributed database, and intelligent database, Client/Server (Database Server), Data Warehousing.
5. To design and build a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS.

Course Outcomes:

At the end of the course, students will demonstrate following abilities

Remembering (Knowledge Level):

- Students will be able to recall and define fundamental concepts of database management systems, including data models, database languages (DDL, DML, DCL), ER models, and basic database architecture (Three Schema architecture).

Understanding (Comprehension Level):

- Students will be able to explain the key elements of the relational model, relational algebra, and SQL operations, as well as discuss the significance of database integrity constraints, normalization, and ER diagrams. They will also understand the role of a database administrator and transaction processing concepts.

Applying (Application Level):

- Students will be able to design ER diagrams, write SQL queries, and apply relational algebra to manipulate and retrieve data from relational databases. They will also implement normalization techniques (1NF, 2NF, 3NF, BCNF) to eliminate anomalies in database design.

Analyzing (Analysis Level):

- Students will be able to analyze the efficiency of different file organization techniques, index structures (B-trees, B+ trees), and query optimization methods. They will evaluate database designs based on functional dependencies and transaction control mechanisms to ensure concurrency and recovery management in database systems.

Syllabus Details

Module No.	Description of Topics	Contact Hrs	COs
Module 1.	**Introduction:** Concept & Overview of DBMS, View of data, Data Models, Database Languages, Database Administrator, Database Users, Three Schema architecture of DBMS.	3	1-2
Module 2.	**Entity-Relationship Model :** Basic concepts, Design Issues, Mapping Constraints, Keys, Elements of Entity-Relationship Diagram(including Weak Entity Sets, derived attribute, etc.) and ER Diagram Design, Extended E-R features.	5	1-4
Module 3.	**Relational Model:** Structure of relational Databases, Relational Algebra and its operations, Relational Calculus, Extended Relational Algebra Operations, Views, Modifications of the Database.	5	1-4
Module 4.	**SQL and Integrity Constraints:** Concept of DDL, DML, DCL. Basic Structure, Set operations, Aggregate Functions, Null Values, Domain Constraints, Referential Ir	7	1-4
Module 5.	**Relational Database Design:** Different anomalies in designing Database, Decomposition using Functional Dependencies, Normalization using functional dependencies- 1NF, 2NF, 3NF, Boyce-Codd Normal Form, Normalization using multivalued dependencies- 4NF, 5NF.	7	1-4
Module 6.	**Internals of RDBMS** Physical data structures, Query optimization: join algorithm, statistics and cost based optimization. Transaction Processing System and its properties, Concurrency control and Recovery Management: transaction model properties, state serializability, lock base protocols, two phase locking.	5	1-4
Module 7.	**File Organization & Index Structures:** File & Record Concept, Placing file and records on Disk, Fixed and Variable sized Records, Types of Single-Level Index (primary, secondary, clustering), Multilevel Indexes, Dynamic Multilevel Indexes using B tree and B+ tree.	4	1-4
	Total	36	

Text/References:

1. "Database System Concepts", 6th Edition by Abraham Silberschatz, Henry F. Korth, S. Sudarshan, McGraw-Hill.
2. "Fundamentals of Database Systems", 5th Edition by R. Elmasri and S. Navathe Pearson Education

3. “Principles of Database and Knowledge – Base Systems”, Vol 1 by J. D. Ullman, Computer Science Press.
4. “Foundations of Databases”, Reprint by Serge Abiteboul, Richard Hull, Victor Vianu, Addison-Wesley

Signals and Systems

Course Name: Signals and Systems	**Category:** Open Elective Course-II
Course Code: OE-EI 503	**Semester:** 5th
L-T-P: 3-1-0	**Credit:** 4
Teaching Scheme	**Examination Scheme**
Theory: 4 hrs./week	**Continuous Assessment:** 30 Marks
Tutorial: 1	**End Semester Exam.:** 70 Marks
Total Lectures: 45	
Pre-Requisites: Knowledge of basic calculus, differential equations, linear algebra, circuit theory, introductory signals and systems, and complex number operations.	

Objectives:

This course aims to introduce fundamental signal and system concepts, mathematical analysis, practical signal processing techniques, and prepares students for advanced studies and professional engineering practice.

The subject aims to encourage the students with the followings:-

1. **Understand Signals and Systems**: To introduce fundamental concepts of signals, their representations, and basic system classifications.
2. **Master Mathematical Tools**: To develop proficiency in using Fourier and Laplace transforms for signal and system analysis.
3. **Analyze and Design Systems**: To enhance understanding of system behavior and design, focusing on efficient signal transmission and processing.
4. **Apply Signal Processing Techniques**: To explore practical applications of signal processing, including sampling, convolution, and system realization.
5. **Prepare for Advanced Studies**: To prepare students for further studies and professional practice in signal processing and related fields.

Course Outcomes (COs):

On completion of this course, the student will be able to

CO.1. **Recall** the fundamental definitions and classifications of signals and systems, including key concepts such as impulse response, transfer functions, and singularity functions.

CO.2. **Understand** the principles of Fourier and Laplace transforms and their applications in analyzing the spectral properties of signals and the behavior of linear time-invariant (LTI) systems.

CO.3. **Apply** convolution and correlation techniques to evaluate the performance of linear systems and to design systems for efficient signal transmission and processing.

CO.4. **Analyze** the effects of sampling, aliasing, and signal reconstruction on discrete-time systems, using Z-transforms and structural realizations to ensure system stability and performance in real-world digital signal processing applications.

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	Signals: Signals and their representation, classification of signals, singularity functions – Impulse, step, ramp functions, Signum function, representation of signals with singularity functions, exponential functions. Basic Operation on the signals. Signal Approximation: Approximation of a function by a set of mutually orthogonal functions, mean square error, complete set of orthogonal functions orthogonality in complex functions, Trigonometric and exponential Fourier series, representation of periodic functions by Fourier series, complex Fourier spectrum.	**8**	**CO 1, 2**
Module: 2	Systems: Definition and Classification of Systems. Impulse response, response of a linear system, linear time invariant system, linear time variant system, transfer function of LTI system. Fourier Transforms and their applications to systems: Fourier transform definition, properties of F.Ts , energy spectral density, parsevals theorem, power spectral density, Hilbert transforms and properties.	**8**	**CO 1, 2, 3**
Module: 3	The Sampling Theorem and Its Implications: Spectra of sampled signals. Graphical and analytical proof for Band Limited Signals, Impulse Sampling, Natural and Flat top Sampling. Reconstruction: Ideal interpolator, zero-order hold, first-order hold, and so on. Reconstruction of signal from its samples, Effect of under sampling – Aliasing and its effects. Introduction to Band Pass Sampling, Relation between continuous and discrete time systems. Discrete Time Signals & Systems: Discrete time signals, representation, operations on sequences, Discrete time systems and classification, LTI systems, Linear Convolution, Difference equations.	**5**	**CO 1, 2, 3**
Module: 4	Continuous Time System Analysis: Continuous Time LTI systems, Laplace Transform, Region of Convergence, Properties, Analysis and characterization of LTI systems using the Laplace Transform. Z-Transforms: Concept of Z- Transform of a Discrete Sequence, Distinction between Laplace, Fourier and Z Transforms, Region of Convergence in Z-Transform, Constraints on ROC for various	**9**	**CO 1, 2, 3**

	classes of signals, Inverse Z-transform, Properties of Z-transforms.		
Module: 5	**Signal Transmission Through Linear Systems:** Introduction to Systems, Classification of Systems, Linear Time Invariant (LTI) systems, system, impulse response, Transfer function of a LTI system. Filter characteristics of linear systems. Distortion less transmission through a system, Signal bandwidth, System bandwidth, Ideal LPF, HPF and BPF characteristics. **Convolution and Correlation of Signals:** Concept of convolution in time domain, Cross correlation and auto correlation of functions, properties of correlation function, Energy density spectrum, Parseval's theorem, Power density spectrum, Relation between convolution and correlation	**5**	**CO 1, 2, 3, 4**
Module: 6	**Realization of Discrete Systems:** Structural realization of discrete systems – Direct form – I, Direct form-II, Cascade and parallel forms **Discrete Fourier Transform:** Concept and relations for DFT, Twiddle factors and their properties, computational burden on direct DFT, multiplication of DFTs, circular convolution. **Digital Filter:** Basic Idea of Digital Filters like IIR and FIR filters.	**10**	**CO 1, 2, 3, 4**

Text Books:

1. Text Books: 1. I. J. Nagrath, S. N. Sharan, " Signals and Systems" , Tata Mc Graw Hill Publication
2. Alan V Oppenheim, Alan S Willsky and A Hamid Nawab, "Signal and Systems", Pearson Education Asia/ PHI.

Reference Books:

1. B. P. Lathi, "Linear Systems and Signals", Oxford University Press.
2. Ganesh Rao and Satish Tunga, "Signals and Systems", Sanguine Technical Publishers.
3. N. G. Palan, "Digital Signal Processing", Tech Max Publication.
4. Proakis, Digital Signal Processing: Principles, Algorithms and Applications.(PHI).

Digital Image Processing

Course Name: Digital Image Processing	**Category:** Open Elective Course-V
Course Code: OE-EI 501	**Semester: 5th**
L-T-P: 4-0-0	**Credit: 4**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Continuous Assessment: 30 Marks
Tutorial: Nil	End Semester Exam.: 70 Marks
Total Lectures: 48	
Pre-Requisites:	

Objectives:

- To understand the different representation of digital images.
- To understand the importance of adequate sampling frequencies and the appearance of artifacts.
- To study the image fundamentals and mathematical transforms necessary for image processing.

Course Outcomes (COs):

1. Mathematically represent the various types of images and **formulate** them for further processing.
2. **Evaluate** images for enhancement of certain properties or for optimized use of the resources.
3. **Analyze** images in the frequency domain using various transforms.
4. **Implement** the algorithms related to morphological image processing.

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Introduction:** Introduction to structure of human eye, Imageformation in the human eye, Brightness adaptation and discrimination, Image sensing and acquisition, storage, Processing, Communication, Display Image Sampling and quantization, Basicrelationships between pixels.	**5**	**1**
Module: 2	**Image Transforms (implementation):** Introduction to Fourier transform, DFT and 2-D DFT, Properties of 2-D DFT, FFT, IFFT, Walsh transform, Hadamard transform, Discrete cosine transform, Slant transform, Optimum transform: Karhunen- Loeve (Hotelling) transform.	**8**	**CO 1-4**
Module: 3	**Image Enhancement:** 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.	**8**	**CO 1-4**
Module: 4	**Image Compression**: Fundamental s, Redundancies: Coding, Interpixel Psycho-visual, fidelity criteria, Image compression models, Error free compression, Lossy compression, Image compression standards:	**8**	**CO 1-4**

	Binary image and Continuous tone Still Image compression standards, Video compression standards.		
Module: 5	**Morphological Image Processing:** Introduction, Dilation, Erosion, Opening, closing, Hit -or-misses transformation, Morphological algorithm operations on binary Images, and Morphological algorithm operations on gray-scale Images.	**6**	**CO 1-4**
Module: 6	**Image Segmentation:** Representation and Description: Detection of discontinuities, Edge linking and Boundary detection, Thresholding Region based segmentation, Image Representation schemes, Boundary descriptors, and Regional descriptors.	**8**	**CO 1-4**

Text Books:

1. R.C Gonzalez and R. Woods :-Digital Image Processing, (Indian reprint: Pearson publication,2001)
2. Anil K. Jain :- Digital Image Processing (Prentice-Hall,India)

Reference Books:

1. W. K. Pratt :-Digital Image Processing, - 2nd Edition, (John Wiley &Sons).
2. B. Chanda& D. DuttaMajumder, Digital Image Processing andAnalysis, (Prentice-Hall, India)
3. M. A. Sid-Ahmed :- Image Processing- Theory, Algorithms &Architecture, (McGraw-Hill)

Indian Constitution and Culture

Course Name: Indian Constitution and Culture	**Category:** Mandatory Course
Course Code: MC-ES 501	**Semester:** 5TH
L-T-P: 1-0-0	**Credit: 0**
Teaching Scheme	**Examination Scheme**
Theory: 1 hrs./week	
Tutorial: Nil	
Total Lectures:12	Sessional Papers: 100 marks
Pre-Requisites: No-prerequisite	

Objectives:

1. To provide basic knowledge about the Indian Constitution.
2. To have working idea about the functioning of the Executive, Legislative and Judiciary bodies in our country.

Course Outcome:

After the completion of this course learners will be able to:

MC-ES 401.1: Identify the authority to redress the problems in their profession or society.
MC-ES 401.2: Describe: The features of Indian Constitution.
MC-ES 401.3: Workings of the various Legislative, Executive and Judicial bodies in the country appreciate the democratic workings at the grassroots level.
MC-ES 401.4: Understand the jurisdiction and procedures of our courts.

Syllabus details

Module No.	Description of Topic	Contact Hrs.
Module 1	**Indian Constitution** Sources of Constitutional history, Preamble and its Salient Features, Citizenship, Fundamental Rights and Duties, Directive Principles of State Policy	2
Module 2	**Union Government and its administration.** Structure of the Indian Union. Legislative bodies: LokSabha and the RajyaSabha, The Speaker and the Chairperson of the RajyaSabha. Executive Bodies. The President and the Vice-President - Role, Power and the method of Election and Amenities and Removal Procedure The Prime Minister and the Council of Ministers. Central Secretariat	2

Module 3	**State Government/s and its administration.** Federalism. Centre-State relationship The Governor – Role and Function The Chief Minister and the State Council of Ministers State Secretariat	2
Module 4	**The Judiciary** The Supreme Court – Organization, Procedure, Jurisdiction and Power Chief Justice and otherJudges High Court/s - Organization, Procedure, Jurisdiction and Power Chief Justice and otherJudges Subordinate Courts – Structure, Jurisdiction and Procedure Lok Adalats PIL – Scope, Principle and Features	2
Module 5	**Local Administration – Urban** Municipalities, Municipal Corporations, Town Area, Notified Area Mayor – Role and Function	2
Module 6	**Local Administration – Rural** ZillaParishad, AanchalParishad and Gram Panchayats Powers, Functions and Key Functionaries Grassroot Empowerment	2
	Total	12

Learning resources

Text books:

1. Indian Polity, M Laxminath, Mcgraw Hill Publications, 5th Edition.

Reference books:

1. Introduction to the Constitution of India, D DBasu, Lexis Nexis Publications of India, 21st Edition.

Control System Lab

Name of the Course: Control System Lab	Category: Professional Core Courses
Course Code:PC-EI 591	**Semester:5th**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination scheme:**
Tutorial: Nil	External Assessment:60
Practical: 3 hrs./week	Internal Assessment:40
Credit Points: 1.5	

Course Outcomes:	
CO. 1	• **Remembering :** Describe the fundamental tools and functions available in MATLAB Control System Toolbox, SIMULINK, and PSPICE for analyzing and simulating control systems.
CO. 2	• **Understanding :** Explain the step response characteristics of first- and second-order systems with unity feedback, identifying key parameters like rise time, peak time, and settling time using MATLAB and PSPICE simulations.
CO. 3	• **Applying :** Simulate and interpret impulse responses of systems with types 0, 1, and 2 using MATLAB and PSPICE, demonstrating an understanding of system response variations with unity feedback.
CO. 4	• **Analyzing :** Analyze the stability and performance of a given second-order transfer function by constructing and interpreting root-locus, Bode plot, and Nyquist plot using MATLAB, and extract system specifications from these plots.
CO. 5	• **Evaluating :** Evaluate the effects of Proportional (P), Integral (I), and Derivative (D) control actions on a first-order system by interpreting changes in system behavior from Bode plots and transfer function adjustments.
CO 6	• **Creating :** Construct state-space models for linear continuous systems and implement them in MATLAB, demonstrating the ability to convert transfer functions to state-space representations for dynamic analysis and control design.
Pre-Requisite:	
1	MATLAB programming, Engineering Mathematics

.

Experiment No.	Laboratory Experiments	COs
1	Familiarization with MATLAB control system toolbox, MATLAB-SIMULINK toolbox and PSPICE	1 - 2
2	Study of step response for first and second order system with unity feedback with display on CRT screen and calculation of parameters for different system	1 - 6

	designs.	
3	Simulation of impulse response for types 0, 1 and 2 with unity feedback using MATLAB and PSPICE.	1 - 6
4	Determination of root-locus, Bode plot, Nyquist plot using MATLAB toolbox for a given second order transfer function and listing of the specifications.	1 - 6
5	Determine the effect of P, I, D actions on first order simulated process and obtaining the system transfer functions from Bode plot	1 - 6
6	Lag and lead compensation – Magnitude and phase plot	1 – 6
7	Create the state space model of a linear continuous system.	1 – 6

Industrial Instrumentation Lab

Course Name: Industrial Instrumentation Lab	**Category:** Professional Core Courses
Course Code: PC EI 592	**Semester:** 5th
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination scheme: Maximum marks:**
Tutorial: Nil	External Assessment:60
Practical: 3 hrs./week	Internal Assessment:40
Credit Points: 1.5	

Course Outcomes:	
CO. 1	**Recall** the fundamental concepts and principles of various industrial instrumentation systems.
CO. 2	**Explain** the working principles of various industrial instruments and their applications.
CO. 3	**Apply** appropriate measurement techniques to acquire accurate data from industrial processes.
CO. 4	**Analyze** the data obtained from instrumentation systems to assess system performance and reliability.
CO. 5	**Evaluate** the suitability of various sensors and transducers for specific industrial applications.
CO. 6	**Discuss** trouble shooting problems associated with the measurement and control of industrial processes.
Pre-Requisite:	
1	Elementary Physics, Sensor & Transducers and Basic Measurement.

Experiment No.	**Laboratory Experiments**	COs
1.	Measurement of Temperature using RTD and Thermistor type temperature instruments.	1 - 6
2.	Measurement of Temperature using Thermocouple type temperature instruments.	1 – 6
3.	Measurement of Temperature using LM 35 and AD 590 IC Sensor.	1 – 6
4.	Calibration of Pressure Gauge using Dead Weight Tester.	1 – 6
5.	Measurement of low pressure using McLeod gauge / Pirani gauge.	1 – 6
6.	Measurements of flow rate using Variable head type Flow meters (Orifice, Venturi, Pitot Tube) and Calculate their discharge coefficient.	1 – 6
7.	Measurements of flow rate using Variable Area type Flow meter.	1 – 6
8.	Measurements of flow rate using Electromagnetic Flow meter.	1 – 6
9.	Measurement of liquid level using float type sensor and ultrasonic sensor.	1 – 6
10.	Measurement of level using capacitive type level instrument.	1 – 6

Object Oriented Programming language Lab

Name of the Course: Object Oriented Programming language Lab	**Category:** Open Elective Courses-I
Course Code: OE-EI 591	**Semester: 5th**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination scheme:**
Tutorial: Nil	External Assessment:60
Practical: 3 hrs./week	Internal Assessment:40
Credit Points: 1.5	

Course Outcome:

Remembering (Knowledge Level):

- Students will be able to recall and implement basic object-oriented programming concepts such as classes, constructors, method overloading, inheritance, and method overriding through hands-on programming exercises in Java.

Understanding (Comprehension Level):

- Students will be able to explain the use of wrapper classes, arrays, and the differences between inheritance and interface-based programming, demonstrating their understanding through practical assignments.

Applying (Application Level):

- Students will be able to apply object-oriented principles by writing Java programs that implement multiple inheritance using interfaces, extend interfaces, and create and access Java packages to develop modular, reusable code.

Analyzing (Analysis Level):

- Students will be able to analyze the behavior of multithreaded programs by implementing thread synchronization, inter-thread communication, and thread life cycle management in Java, ensuring proper functionality under concurrent execution.

Evaluating (Evaluation Level):

- Students will be able to evaluate the efficiency and robustness of Java programs that involve multithreading, interface-based design, and applet programming by testing and debugging the code to ensure correctness and performance optimization.

Creating (Creation Level):

- Students will be able to design and develop Java applets and multithreaded applications that incorporate advanced object-oriented concepts, graphical interfaces, and real-time functionality, demonstrating creativity and problem-solving skills in software development.

Laboratory Experiments:

Exp. No.	Title of the Experiment	COs
1	Assignments on class, constructor, overloading, inheritance, overriding	1-6
2	Assignments on wrapper class, arrays	1-6
3	Assignments on developing interfaces- multiple inheritance, extending interfaces	1-6

4	Assignments on creating and accessing packages	1-6
5	Assignments on multithreaded programming	1-6
6	Assignments on applet programming	1-6

Data Base Management System Lab

Name of the Course: Data Base Management System Lab	**Category:** Open Elective Courses-I
Course Code: OE-EI 592	**Semester: 5th**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination scheme:**
Tutorial: Nil	External Assessment:60
Practical: 3 hrs./week	Internal Assessment:40
Credit Points: 1.5	

Course Outcome:

Remembering (Knowledge Level):

- Students will be able to recall and define SQL syntax for creating databases, tables, and relational data types. They will also list the steps for specifying constraints and indexes in a database.

Understanding (Comprehension Level):

- Students will be able to explain the use of SQL commands like INSERT, DELETE, UPDATE, and SELECT, along with logical operators and various clauses (e.g., WHERE, ORDER BY, GROUP BY). They will understand how to retrieve data using queries and aggregate functions.

Applying (Application Level):

- Students will be able to apply SQL commands to create and manipulate databases and tables, execute queries using different conditions and logical operators, and perform operations like INSERT, DELETE, and UPDATE to manage records in relational databases.

Analyzing (Analysis Level):

- Students will be able to analyze complex queries involving subqueries and JOIN operations to retrieve data from multiple tables efficiently. They will also evaluate the performance and logical correctness of queries involving aggregate functions and conditions.

Evaluating (Evaluation Level):

- Students will be able to evaluate database security by managing database users, implementing access control through GRANT and REVOKE commands, and analyzing the use of views to restrict data access. They will assess how well different indexing methods and constraints improve query performance.

Creating (Creation Level):

- Students will be able to design and create a fully functional database system, including tables, constraints, indexes, and views, that meets specific requirements. They will also be able to create custom queries using subqueries, joins, and aggregate functions to solve complex data retrieval problems.

EXP. No.	**Laboratory Experiments:**	**COs**
1.	**Creating Database** • Creating a Database • Creating a Table • Specifying Relational Data Types • Specifying Constraints • Creating Indexes	1-6

2.	**Table and Record Handling** • INSERT statement • Using SELECT and INSERT together • DELETE, UPDATE, TRUNCATE statements • DROP, ALTER statements	1-6
3.	**Retrieving Data from a Database** • The SELECT statement • Using the WHERE clause • Using Logical Operators in the WHERE clause • Using IN, BETWEEN, LIKE , ORDER BY, GROUP BY and HAVING Clause • Using Aggregate Functions • Combining Tables Using JOIN • Sub queries	1-6
4.	**Database Management** • Creating Views • Creating Column Aliases • Creating Database Users • Using GRANT and REVOKE	1-6

Process Control

Course Name: Process Control	**Category:** Professional Core
Course Code: PC-EI 601	**Semester: VI**
L-T-P: 3-0-0	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Continuous Assessment: 30 Marks
Tutorial: Nil	End Semester Exam.: 70 Marks
Total Lectures: 36	
Pre-Requisites: To understand this course, the learner must have idea of sensor and transducer, industrial instrumentation and control theory.	

Objectives:

1. To study the operation of different types of industrial processes.

2. To study the different control strategies used in industrial applications.

Course Outcomes (COs):

PC-EI 601.1: **Describe** the block diagrams of different control loops with response curves, and **identify** their components, process characteristic parameters, types of controllers, control valves, control schemes, and modern control systems like PLC, DCS, and SCADA communicated by HART protocol, fieldbus.

PC-EI 601.2: **Apply** the principles and knowledge of control loops, process characteristics, controllers, control valves, control schemes, and modern control systems (PLC, DCS, SCADA with HART protocol) to practical process control scenarios.

PC-EI 601.3: **Develop** control loops, process parameters, controllers, control valves, and control schemes to determine their performance and suitability for specific process control applications, and **evaluate** the integration and communication efficiency of modern control systems.

PC-EI 601.4: **Analyze** comprehensive solutions by combining knowledge of control loops, process parameters, controllers, control valves, and control schemes, and **evaluate** these solutions using modern control systems like PLC, DCS, and SCADA with HART protocol to optimize process control systems.

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Module Name: Introduction to process control** Details: Introduction, Evolution of process control, process control and automation, classification of process variables, open loop and closed loop systems, servo and regulatory control, compensatory and anticipatory control	**3**	**1,2**

	configuration.		
Module: 2	**Module Name: Different control modes** Details: Discontinuous type: On-off, multi-position, floating control mode. Continuous type: proportional, proportional-integral, proportional-derivative, proportional-integral-derivative, inverse derivative control mode. Some special characteristics like integral windup, integral tracking, bump less transfer, derivative overrun etc. Controller selection guideline, offset minimization. Enhance set point tracking and load rejection in process control.	**9**	**1-4**
Module: 3	**Module Name: Tuning and design of controllers** Details: Controller performance indices, concept of good control, closed loop and open loop tuning methods, comparison of tuning methods. Electronic and Computer-based implementation of Controller.	**6**	**1-4**
Module: 4	**Module Name: Final control elements** Details: Classification of control valves, performance and application of different control valves, valve type and construction, valve sizing, valve characteristics, Cavitation, Flashing, valve testing, valve selection guidelines, safety valve and their selection. Control valve accessories: Air filter regulator, I/P converter, and P/I converter.	**7**	**1-4**
Module: 5	**Module Name: Modern control** Special control features such as Ratio Control, Cascade Control, Split Range Control, and Feedback & Feed forward Control. Introduction to Programmable Logic Controllers – Basic Architecture and Functions; Input-Output Modules and Interfacing; CPU and Memory; Relays, Timers, Counters and their uses; PLC Programming and Applications. Overview of DCS.	**6**	**1-4**
Module: 6	**Module Name: Introduction to Process transmitter:** Need of transmitter (concept of field area & control room area), Concept of live & dead zero. Types of transmitters: Two, three and four wire transmitters, Electronic transmitters. Smart transmitters - features & advantages, HART protocol. Overview of field device networks - Field bus. Third-Party Transmission and Nucleonic Instrumentation.	**5**	**1-4**

Text Books:

1. Curtis D Johnson – Process Control Instrumentation Technology, - Pearson Education/PHI
2. Chemical process control, G. Stephanpoulos, PHI.
3. Process Control-Principles and application, S. Bhanot, Oxford University press.
4. Principle of Process control, D. Patranabis, TMH.
5. Automatic Process Control, D.P. Eckman, John Wiley.
6. Instrumentation and Process Control, D.C. Sikdar, Khanna Publishing House.

Reference Books:

1. Harriot – Process zcontrol, MGH
2. Process control instrumentation technology, C.D. Johnson, PHI
3. Process Control, S.K. Singh, PHI.
4. Instrument Engineers Handbook, B.G. Liptak, Chilton Book Co. Philadelphia
5. Elements of Chemical Process Technology, O.P. Gupta, Khanna Publishing House

Electrical Machine

Course Name: Electrical Machine	**Category:** Professional Core
Course Code: PC-EI 602	**Semester:** VI
L-T-P: 3-0-0	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Continuous Assessment: 25Marks
Tutorial: Nil	Attendance: 5 Marks
Total Lectures: 36	End Semester Exam.: 70 Marks
Pre-Requisites: Basic Electrical, Circuit Theory , Electromagnetic Theory	

Objective:

1. To review the concept of magnetic fields and magnetic circuits
2. To learn the principle of production of electromagnetic force and torque.
3. To learn the basic principle of operation of DC machine
4. To learn the principle of operation and characteristics of DC motor and generator
5. To learn the principle of operation, connections and different tests on Transformers
6. To acquire problem solving skills to solve problems of DC machines and Transformers

Course Outcomes (COs):

After study through the course, students will be able to

PC-EI 602.1: Describe Electromechanical Energy Conversion & concepts in Rotating Machines
PC-EI 602.2: Describe the basic principle of operation of DC machine
PC-EI 602.3: Understand and applythe principle of operation, connections and different tests on Transformers&single & three phase Induction machines
PC-EI 602.4: Design special eletro-mechanical devices

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Electromechanical Energy Conversion** : Energy Balance ,Laws of Electromagnetism , Energy Flow , Types of Magnetic system : Singly Excited Magnetic System , Multiple Excited Magnetic System , Detailed Analysis ,Advantages of field Energy Method Basic Concepts of Rotating Machine	**6**	**1**
Module: 2	**DC machines:** Basic construction of a DC machine, linear commutation Derivation of back EMF equation, armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution with armature reaction.	4	**1,2**

Module: 3	**DC machine - motoring and generation:** Armature circuit equation for motoring and generation, Types of field excitations – separately excited, shunt and series. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed. V-I characteristics and torque- speed characteristics of separately excited, shunt and series motors. Speed control through armature voltage. Losses, load testing and back-to-back testing of DC machines	6	**1,2**
Module: 4	**Transformers:** Principle, construction and operation of single- phase transformers, Three-phase transformer - construction, types of connection and their comparative features, Parallel operation of single-phase and three-phase transformers, Autotransformers - construction, principle, applications and comparison with two winding transformer, Magnetizing current, effect of nonlinear B-H curve of magnetic core material, harmonics in magnetization current, Series operation of three phase Transformer, Phase conversion - Scott connection, three-phase to six- phase conversion, Tap-changing transformers - No-load and on-load tap-changing of transformers, Three-winding transformers.	6	**1,2,3**
Module: 5	**Induction Machines:** Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit. Phasor Diagram, Losses and Efficiency. Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors. Generator operation. Self-excitation. Doubly-Fed Induction Machines. Single-phase induction motors: Constructional features, double Revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications	10	**1,2,3**
Module: 6	**Special Electromechanical devices:** Principle and construction of switched Reluctance motor, , Brushless DC machines, Hysteresismotor, Servo Motor ,Stepper motor,	4	**1-4**

Text books:

1. Electrical Machines-I, P.S. Bimbhra, Khanna Publishing House (AICTE)
2. Electrical Machinery, P.S. Bimbhra, 7th Edition, Khanna Publishers
3. Electric machines, D.P. Kothari & I.J Nagrath, 3rd Edition, Tata McGraw-Hill Publishing Company Limited
4. Electrical Machines, P.K. Mukherjee & S. Chakrabarty, 2nd edition, DhanpatRai Publication.

Reference books:

1. Electric Machinery & Transformers, Bhag S. Guru and H.R. Hiziroglu, 3rd Edition, Oxford University press.
2. Electrical Machines, R.K. Srivastava, Cengage Learning
3. Theory of Alternating Current Machinery, Alexander S Langsdorf, Tata McGraw Hill Edition.

4. The performance and Design of Alternating Current Machines, M.G.Say, CBS Publishers & Distributors.
5. Electric Machinery & transformer, Irving L Koskow, 2nd Edition, Prentice Hall India

Course Name: Plant Instrumentation and Control

Course Name: Plant Instrumentation and Control	**Category: Professional Elective Course- VI**
Course Code: PE-EI 601	**Semester: VI**
L-T-P: 3-0-0	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Continuous Assessment: 25 Marks
Tutorial: Nil	Attendance: 5 Marks
Total Lectures: 36	End Semester Exam.: 70 Marks
Pre-Requisites: To understand this course, the learner must have idea of Sensor and Transducer, Industrial instrumentation and Process control.	

Objectives: To acquaint the Process Plant Professionals with theory and working principles of different types of instruments used in the power plant, Steel Plant , Petrochemical Plant and their applications.

Course Outcomes (COs):

PE-EI603.1. Create an overall perception about Thermal power plant, Steel Plant & Petrochemical Plant associated with various functional blocks of the process.

PE-EI603.2. Evaluate the functioning of a Thermal power plant, Steel Plant & Petrochemical Plantby knowing the working principle of each functional blocks.

PE-EI603.3. Analyze various control techniques of power plant Thermal power plant, Steel Plant & Petrochemical Plant.

PE-EI603.4. Understand the main and special control & measurement strategies adopted for the functioning of Thermal power plant, Steel Plant & Petrochemical Plant.

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Module Name: General Concepts** Details: Power Plants of different types: Setups, energy conversions and measurement requirements, Process Description of Thermal power plant including steam generation , steam and water circuits , Flue , air and flue gas circuits	**6**	**1,2**
Module: 2	**Module Name: Instrumentation for different sections of Thermal Power Plant** Boilers, Turbines , Condensers , Alternators , Coal handling , Water treatment , Feed water , combustion air and flue gases	**6**	**1,2**

Module: 3	**Module Name: Control schemes of Thermal Power plant** Details: Boiler Drum Level Control - Steam pressure control, combustion and draught control, Steam temperature Control, Feed water control & Instrumentation, Setting the demand for the steam generation	**8**	**1,2,3 ,4**
Module: 4	**Module : Steel Manufacturing Industry** Process description , coke oven plant , blast furnace , steel smelting shop , casting ,rolling etc.	**4**	**1,2,3**
Module: 5	**Module : Instrumentation and Control in Steel Manufacturing Industry** Various field instruments , Measurements & controls at coke oven plant , blast furnace , steel smelting shop , Thickness measurement and Control	**5**	**1,2,3 ,4**
Module: 6	**Module : Petroleum Industry** :Brief survey of petroleum formation, petroleum exploration, petroleum production, petroleum refining and its methods, refining capacity and consumption in India, constituents of crude oil, recovery techniques – oil- Gas separation, processing wet gases. P & I diagram of petroleum refinery, Atmospheric distillation process, Vacuum distillation process, Thermal cracking, Catalytic reforming, and Utility plants – Air,N_2 and cooling water. Basics of field instruments, Distillation column control, Re-boiler control, Reflux control, Control of catalytic crackers, Control of heat exchanger, Control of cooling tower. Safety interlocks in furnace, separator, pump, and compressor, Basics of SIL, Introduction to standards.	**7**	**1,2,3 ,4**

Text Books:

1. Power Plant Instrumentation, K. Krishnaswamy, M. PonniBala, PHI Learning Private Limited.
2. Principles of Industrial Instrumentation, D. Patranabis, TMH New Delhi.

Reference Books:

1. Electric Power Engineering Handbook – Edited by L. L. Grigsby.
2. Instrument Engineers Handbook, B. G. Liptak, Chilton Book Co., Philadelphia

Advanced Control System

Course Name: Advanced Control System	Category: Professional Elective Course IV
Course Code: PE-EI-602	**Semester: 6th**
L-T-P: 3-0-0	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Continuous Assessment: 30Marks
Tutorial: 1 hr/week	End Semester Exam.: 70 Marks
Total Lectures: 36	
Pre-Requisites: Linear Control System	

Objectives:

The objective of this course is to provide a strong foundation on advanced control methods for modeling, time domain analysis, and stability analysis of linear and nonlinear systems. The course also includes the design of feedback controllers and observers.

The subject aims to encourage the students with the followings:-

1. **Develop** the state variable representation of physical systems and **analyze** the performance of linear and nonlinear systems using state variable approach.
2. **Design** state feedback controller for a nonlinear system and explain its characteristics.
3. **Apply** Lyapunov method for the stability analysis of physical systems.

Course Outcomes (COs):

On completion of this course, the student will be able to

PE-EI-604.1 Develop the state variable representation of physical systems and **analyze** the performance of linear and nonlinear systems using state variable approach

PE-EI-604.2 Design state feedback controller for a given system

PE-EI-604.3 Explain the characteristics of nonlinear systems

PE-EI-604.4 Apply the tools like describing function approach or phase plane approach for assessing the performance of nonlinear systems and also apply Lyapunov method for the stability analysis of physical systems.

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Module Name: State Space Representation of Systems** o Introduction to state space and state model concepts- State equation of linear continuous time systems, matrix representation- features- Examples of electrical circuits and dc servomotors. o Phase variable forms of state representation- features- controllable and observable companion forms.	**7**	**1**

	○ Diagonal Canonical forms- Similarity transformations to diagonal canonical form.		
Module: 2	**Module Name: State Space Analysis** ○ State transition matrix- Properties of state transition matrix- Computation of state transition matrix using Laplace transform and Cayley Hamilton method. ○ Derivation of transfer functions from state equations. ○ Solution of time invariant systems: Solution of time response of autonomous systems and forced systems. ○ State space analysis of Discrete Time control systems: Phase variable form and Diagonal canonical form representations. ○ Pulse transfer function from state matrix- Computation of State Transition Matrix (problems from 2nd order systems only).	**9**	**1**
Module: 3	**Module Name: State Feedback Controller Design** ○ Controllability & observability: Kalman's, Gilbert's and PBH tests- Duality principle. ○ State feedback controller design: State feed-back design via pole placement technique ○ State observers for LTI systems- types- Design of full order observer	**6**	**2**
Module: 4	**Module Name: Nonlinear Systems** ○ Types and characteristics of nonlinear systems- Jump resonance, Limit cycles and Frequency entrainment ○ Describing function method: Analysis through harmonic linearization. ○ Determination of describing function of nonlinearities. ○ Application of describing function for stability analysis of autonomous system with single nonlinearity (relay, dead zone and saturation only).	**7**	**3**
Module: 5	**Module Name: Phase Plane and Lyapunov Stability Analysis** ○ Phase plots: Concepts- Singular points – Classification of singular points. ○ Definition of stability- asymptotic stability and instability. ○ Construction of phase trajectories using Isocline method for linear and nonlinear systems. ○ Lyapunov stability analysis: Lyapunov function- Lyapunov methods to stability of nonlinear systems- Lyapunov methods to LTI continuous time systems.	**7**	**4**

Text Books:

1. Nagarath I. J. and Gopal M., Control System Engineering, 5/e, New Age Publishers, 2007

2. Ogata K., Modern Control Engineering, 5/e, Prentice Hall of India, 2010.

3. Gopal M, Modern Control System Theory, 2/e, New Age Publishers, 1984

4. Kuo B.C, Analysis and Synthesis of Sampled Data Systems, Prentice Hall Publications, 2012.Poole, Computational Intelligence, OUP

Reference Book:

1. Khalil H. K, Nonlinear Systems, 3/e, Prentice Hall, 2002

2. Gibson J.E. Nonlinear Automatic Control, Mc Graw Hill, 1963.

3. Gopal M., Control Systems Principles and Design, 4/e, Tata McGraw Hill, 2012.

4. Slotine J. E and Weiping Li, Applied Nonlinear Control, Prentice-Hall, 1991,

5. Gopal M, Digital Control and State Variable Methods, 2/e, Tata McGraw Hill, 2003

6. Thomas Kailath, Linear Systems, Prentice-Hall, 1980.

7. Ogata K., Discrete Time Control Systems, 2/e, Pearson Education, Asia, 2015

Biomedical and Analytical Instrumentation

Course Name: Biomedical and Analytical Instrumentation	**Category: Professional Elective-V**
Course Code: PE-EI 603	**Semester: 6th**
L-T-P: 4-0-0	**Credit: 4**
Teaching Scheme	**Examination Scheme**
Theory: 4	Continuous Assessment: 30Marks
Tutorial: Nil	End Semester Exam.: 70 Marks
Total Lectures: 48	
Pre-Requisites: Students should have knowledge in Biology, signal processing, and engineering communication.	

Course Outcomes (COs):

CO.1. **State** the human physiology system the principle operation of the background knowledge of biomedical and analytical instruments and **identifies** the applications of biomedical and analytical engineering.

CO.2. **Describe** the operating principles of electrical and other transducers, analog and digital instrumentation, electrical properties of nerve and muscle physiology and **understand** the working principles of different analysers.

CO.3. **Use** different instrumentation in cardiopulmonary, neurological, surgical, and rehabilitation areas of medicine, and imaging technique, signal transmission and **differentiate** between online and offline process and categories suitable instruments for analysis gaseous, liquid or solid substance.

CO.4. Evaluate performance of a different cardio-vascular, muscular instruments (like EEG, ECG, EMG etc.) and different analyser and select a suitable analyser for particular industrial application.

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Human Systems and Electrodes and Transducers** Details: Introduction to physiology of cardiac, nervous, muscular and respiratory systems; Different types of transducers and their selection for biomedical applications, Electrode theory, different types of electrodes Hydrogen Calomel, Ag-AgCI, pH, PO2 Pco2 electrodes	**8**	**1, 2**
Module: 2	**Measurements of Important Human parameters** Details: Measurement of electrical activities of heart, brain and muscle: ECG measurement and instrumentation techniques; Measurement of Blood Pressure & Blood flow; Defibrillator	**8**	**2, 3,4**
Module: 3	**Signal Processing, transmission and Imaging** **Details:** Instrumentation in clinical laboratory Ultrasound imaging and IR Imaging. Biotelemetry: Transmission and Reception	**8**	**1,2**

	aspects of Biological signals via long distances.		
Module: 4	**Gas Analysis :** Thermal Conductivity Type, Heat of Reaction Method, Paramagnetic for O2, Dumbell and Servomax for O2, Thermomagnetic for O2, Zirconia Cell Type for O2, Cell for Continuous O2 analysis microelectrodes, Spectroscopic Techniques, IR Radiation Absorption Type, Dual-Channel IR Spectrometry, Single-Channel IR Spectrometry, IR Sources, Comparison of their performances, IR detectors.	**10**	**2,3,4**
Module: 5	**Liquid and Solid Analysis:** Dissolved Oxygen Analysis Cells, pH electrodes, circuits and applications, Spectroscopic Techniques: Absorption in Visible and UV-range, monochromators and detectors, Sources and their ranges, Colorimetry, Viscosity and Density Measurement. Atomic Spectral Methods: Emission and Absorption: Visible, UV and X-rays; sources, principles, detectors, sample preparation etc.	**6**	**4**
Module: 6	**Special Topics:** Chromatography, GC, GLC, LC, HPLC, Columns, Detectors; X-ray methods of analysis; Introduction to NMR and ESR.	**8**	**3,4**

Text Books:

1. Cromwell L – Biomedical Instrumentation and Measurement, Pearson
2. Khandpur R S – Handbook of Biomedical Instrumentation, TMH, N. Delhi 1991
3. Principles of Industrial Instrumentation- D.C. Patranabis, Publisher: Tata McGraw Hill
4. Principles of Instrumental Analysis- Skoog, Holler, Nieman, Publisher: Thomson Brooks/Cole
5. Handbook of Analytical Instruments- R.S. Khandpur, Publisher: Tata McGraw Hill

Reference Books:

1. Carr – Introduction to Biomedical Equipment Technology 4/e – Pearson
2. Introduction to Instrumental Analysis-Robert D. Braun, Publisher: Pharma Book Syndicate

Course Name: Non Destructive Testing	**Category:** Professional Elective Courses- **V**
Course Code: PE-EI 604	**Semester: 6th**
L-T-P: 4-0-0	**Credit: 4**
Teaching Scheme	**Examination Scheme**
Theory: 3hrs./week	**Continuous Assessment:** 30 Marks
Total Lectures:36	**End Semester Exam.:** 70 Marks
Pre-Requisites: Engineering Physics	

Objectives:

- **To provide foundational knowledge of various Non-Destructive Testing (NDT) techniques and their applications** – Students will learn about essential NDT methods such as visual, magnetic, eddy current, and ultrasonic testing, enabling them to assess material properties and detect flaws without damaging the material.
- **To introduce hazardous area instrumentation and safety standards** – Students will understand classifications of hazardous environments and protection methods, ensuring safe application of NDT techniques in explosive and sensitive areas, following IEC, NEMA, and IP standards.

Course Outcomes (COs):

On completion of this course, the student will be able to

1. **Remembering:**
   Describe the basic principles, importance, and general applications of various Non-Destructive Testing (NDT) techniques, including visual, chemical, and mechanical inspection methods.
2. **Understanding :**
   Explain the working principles of ultrasonic waves, their propagation, and the different ultrasonic testing methods (e.g., Echo, Transit time, Resonance, Direct contact, and immersion) in various testing applications.
3. **Applying :**
   Demonstrate the application of NDT techniques such as magnetic, electro potential, eddy current and ultrasonic methods to inspect and measure material properties, thickness, depth, and detect flaws in different types of surfaces.
4. **Analyzing:**
   Analyze the effects of various parameters on ultrasonic testing accuracy and interpret the suitability of different hazardous area protection methods (e.g., explosion-proof, intrinsic safety) based on classification systems (IEC, NEMA, IP codes) for specific industrial applications.

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Module 1: Introduction to Non-Destructive Testing (NDT)** Importance and applications of NDT in various industries. General principles, types, and basic elements of NDT.	**4**	**1,2**
Module: 2	**Module 2: Surface Inspection Techniques** Overview of surface feature inspection methods. Detailed study of visual, chemical, and mechanical inspection techniques. Introduction to magnetic-magnetization and flux techniques.	**6**	**1-4**
Module: 3	**Module 3: Electrical and Electromagnetic Testing Techniques** Principles and applications of electro-potential and electrical resistivity techniques. Fundamentals and applications of electromagnetic and eddy current testing.	**6**	**1-4**
Module: 4	**Module 4: Ultrasonic Testing Principles and Methods** Basic principles of ultrasonic wave propagation. Key ultrasonic test methods: Echo, Transit time, Resonance, Direct contact, and immersion types.	**8**	**1-4**
Module: 5	**Module 5: Ultrasonic Testing Applications and Parameters** Techniques for ultrasonic measurement of thickness, depth, flow, and level. Parameters affecting ultrasonic testing, remedies for measurement accuracy. Applications of ultrasound in medical diagnostics and therapy.	**6**	**1-4**
Module: 6	**Module 6: Hazardous Area Instrumentation and Safety Standards** Classification of hazardous areas based on site, material, and temperature. Methods of protection: explosion-proof, intrinsic safety, purging, and pressurization. IEC and North American standards, Equipment Protection Level (EPL), NEMA, and IP codes.	**6**	**1-4**

Reference Books:

1. Mclutive p (Ed) – NDT Handbook, American Society for NDT, 1989.
2. Hull B and John V – Non Destructive Testing, FI BS/McMillan.
3. Krantkramer - Ultrasonic Testing of materials, Springer 2005
4. Handbook of Nondestructive Testing, McGraw Hill, 1998
5. U. Schnars, W. Jeuptner - Digital Holograpy, Springer, 2005
6. W. J. Price – Nuclear radiation Detection, McGraw Hill, New York, 1958
7. Krauthsamer J and Krauthsamer H – Ultrasonic Testing of Materials, Springer Verlag, Berlin, New York.
8. Wells N T – Biomedical Ultrasonics, Academic Press,London 1977

Computer Networking and Internet of Things (IoT)

Course Name: Computer Networking and Internet of Things (IoT)	**Category:** Open Elective Courses -III
Course Code: OE-EI 601	**Semester: VI**
L-T-P: 4-0-0	**Credit: 4**
Teaching Scheme	**Examination Scheme**
Theory: 4 hrs./week	Continuous Assessment: 30Marks
Tutorial: Nil	Attendance:
Total Lectures: 48	End Semester Exam.: 70 Marks
Pre-Requisites: Basic knowledge of computer systems, programming and digital logic	

Course Overview:

This course provides a comprehensive understanding of computer networking principles and the emerging field of the Internet of Things (IoT). Students will explore the fundamental concepts of networking, including protocols, architectures, and security, as well as the design, development, and deployment of IoT systems. The course is structured into six modules, integrating both theoretical knowledge and practical skills to equip students with the ability to work on modern networked systems and IoT applications.

Course Objectives:

1. Understand the principles and architecture of computer networks and IoT systems.
2. Learn about various networking protocols and technologies used in both traditional and IoT environments.
3. Develop skills in designing, implementing, and managing networked systems and IoT solutions.
4. Explore the security challenges and solutions in networking and IoT.
5. Gain hands-on experience with networking tools and IoT platforms.
6. Analyze and apply networking and IoT concepts to real-world scenarios.

Course Outcomes (COs):

By the end of this course, students will be able to:

1. Understand and describe the core concepts and architecture of computer networks IoT systems.
2. Explain the core components, protocols, and architectures of IoT systems.
3. Apply knowledge of IoT communication protocols and security practices in real-world applications.
4. Analyze IoT data and make informed decisions for effective IoT system management and development.

Course Details

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Introduction to Computer Networking** • **1.1 Overview of Computer Networks** o Definition and importance of computer networks o Types of networks: LAN, WAN, MAN, PAN o Network topologies (star, ring, mesh, hybrid) • **1.2 Network Models** o OSI and TCP/IP models o Layered architecture and functionality of each layer o Encapsulation and decapsulation processes • **1.3 Networking Devices** o Routers, switches, hubs, repeaters, and gateways o Functions and differences between devices	8	**1,2**
Module: 2	**Networking Protocols and Technologies** • **2.1 Data Link Layer Protocols** o Ethernet, MAC addressing, and ARP o Error detection and correction techniques • **2.2 Network Layer Protocols** o IPv4/IPv6 addressing and subnetting o Routing protocols (RIP, OSPF, BGP) • **2.3 Transport Layer Protocols** o TCP and UDP: Features, differences, and applications o Flow control, congestion control, and error handling • **2.4 Application Layer Protocols** o HTTP, FTP, SMTP, DNS, and DHCP o Overview of client-server and peer-to-peer architectures	8	**1, 2, 3**
Module: 3	**Network Security and Management** • **3.1 Network Security Fundamentals** o Threats, vulnerabilities, and attack vectors o Cryptography basics: Symmetric and asymmetric encryption • **3.2 Security Protocols and Practices** o SSL/TLS, IPSec, VPNs, and firewalls o Intrusion detection and prevention systems (IDS/IPS) • **3.3 Network Management** o SNMP and network monitoring tools o Network performance metrics and troubleshooting	8	**1, 2, 3**
Module: 4	**Introduction to Internet of Things (IoT)** • **4.1 IoT Overview and Applications** o Definition and characteristics of IoT	8	**1-4**

	○ IoT applications: Smart cities, healthcare, agriculture, and industrial automation • **4.2 IoT Architecture** ○ Layers of IoT architecture: Perception, network, and application layers ○ IoT communication models and paradigms (M2M, P2P) • **4.3 IoT Devices and Components** ○ Sensors, actuators, and microcontrollers (Arduino, Raspberry Pi) ○ IoT gateways and cloud services ○ Basics of edge computing and its role in IoT		
Module: 5	**IoT Communication Protocols and Technologies (8 Hours)** • **5.1 IoT Communication Protocols** ○ MQTT, CoAP, AMQP, and HTTP/HTTPS for IoT ○ Comparison of protocols based on performance, reliability, and security • **5.2 Wireless Technologies for IoT** ○ Overview of Wi-Fi, Bluetooth, Zigbee, LoRaWAN, and cellular networks (4G/5G) ○ Low-power wide-area networks (LPWAN) for IoT • **5.3 IoT Data Management** ○ Data collection, storage, and processing in IoT ○ Cloud-based IoT platforms (AWS IoT, Azure IoT, Google Cloud IoT) ○ Introduction to big data analytics in IoT	8	**1-4**
Module: 6	**IoT Security, Privacy, and Applications (8 Hours)** • **6.1 IoT Security Challenges** ○ Common IoT security threats and vulnerabilities ○ Secure boot, encryption, and authentication in IoT devices • **6.2 Privacy and Ethical Considerations in IoT** ○ Data privacy laws and regulations ○ Ethical implications of IoT data collection and usage • **6.3 IoT Application Development and Deployment** ○ Designing and developing IoT solutions using development platforms (Node-RED, Blynk) ○ Deployment strategies for IoT systems ○ Capstone project: Design and implement a complete IoT-based application (e.g., smart home, environmental monitoring)	8	**1-4**
	Total	36	

Learning Resources

Text books:

1. "Computer Networking: A Top-Down Approach" by James F. Kurose and Keith W. Ross
2. "Data Communications and Networking" by Behrouz A. Forouzan
3. Adrian McEwen, Hakim Cassimally, “Designing the Internet of Things”, Wiley publication, 1st Edition, November 2013.
4. Jeeva Jose, Internet of Things, Khanna Publishing House, New Delhi (AICTE Recommended – 2018)
5. Michale Miller , “The Internet of Things: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World”, Pearson Education
6. Hanes David, Salgueiro Gonzalo, Grossetete Patrick, Barton Rob , “IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things” , Pearson Education
7. RMD Sundaram Shriram, K Vasudevan, Abhishek S Nagarajan,“Internet of Things” , Wiley publication,

Reference books:

1. Yasuura, H., Kyung, C.-M., Liu, Y., Lin, Y.-L., Smart Sensors at the IoT Frontier, Springer International Publishing
2. Kyung, C.-M., Yasuura, H., Liu, Y., Lin, Y.-L., Smart Sensors and Systems, Springer International Publishing

Artificial Intelligence

Course Name: Artificial Intelligence	**Category: Open Elective-III**
Course Code: OE-EI-602	**Semester: 6th**
L-T-P: 3-1-0	**Credit: 4**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Continuous Assessment: 30Marks
Tutorial: 1 hr/week	End Semester Exam.: 70 Marks
Total Lectures: 48	
Pre-Requisites: Mathematics	

Objectives:

The objective of this course is to acquire the basic knowledge of Artificial Intelligence algorithms and analyzing the behavior of nonlinear control systems with the help of AI based controller.

The subject aims to encourage the students with the followings:-

1. Compare AI with human intelligence and traditional information processing and discuss its strengths and limitations.
2. Apply the basic principles, models, and algorithms of AI to recognize, model.
3. Design AI functions and components involved in intelligent systems.

Course Outcomes (COs):

On completion of this course, the student will be able to

OE-EI 602.1 Compare AI with human intelligence and traditional information processing and discuss its strengths and limitations.

OE-EI 602.2 Discuss the core concepts and algorithms of advanced AI, including various searching, knowledge and reasoning, decision making, various learning process, natural language processing, robotics, and so on.

OE-EI 602.3 Analyze the structures and algorithms of a selection of techniques related to searching, reasoning, machine learning, and language processing.

OE-EI 602.4 Explain various search techniques, knowledge & reasoning, and leanings used in expert systems

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Module Name: Introduction to AI** o Overview of Artificial intelligence- Problems of AI, AI technique, Tic - Tac - Toe problem. o Agents & environment, nature of environment, structure of agents, goal based agents, utility based agents, learning agents. o Problems, Problem Space & search: Defining the problem as state space search, production system, problem characteristics,	**6**	**1,3**

	issues in the design of search programs.		
Module: 2	**Module Name: Search techniques** o Solving problems by searching: problem solving agents, searching for solutions; uniform search strategies: breadth first search, depth first search, depth limited search, bidirectional search, comparing uniform search strategies. o Greedy best-first search, A* search, memory bounded heuristic search: local search algorithms & optimization problems: Hill climbing search, simulated annealing search, local beam search, genetic algorithms; constraint satisfaction problems, local search for constraint satisfaction problems. o Games, optimal decisions & strategies in games, the minimax search procedure, alpha-beta pruning, additional refinements, iterative deepening.	**14**	**2,3,4**
Module: 3	**Module Name: Knowledge & reasoning** o Knowledge representation issues, representation & mapping, approaches to knowledge representation, issues in knowledge representation	**5**	**2,3,4**
Module: 4	**Module Name: Using predicate logic** o Representing simple fact in logic, representing instant & ISA relationship, computable functions & predicates, resolution, natural deduction. o Representing knowledge in an uncertain domain, the semantics of Bayesian networks, Dempster-Shafer theory, Fuzzy sets & fuzzy logics.	**8**	**1,2,3**
Module: 5	**Module Name: Natural Language processing** o Introduction, Syntactic processing, semantic analysis discourse & pragmatic processing. o Learning-Forms of learning, inductive learning, learning decision trees, explanation based learning, learning using relevance information, neural net learning & genetic learning. o Expert System--Representing and using domain knowledge, expert system shells, knowledge acquisition	**10**	**1,2,3,4**

Text Books:

1. Artificial Intelligence, Ritch & Knight, TMH
2. Artificial Intelligence A Modern Approach, Stuart Russel Peter Norvig Pearson
3. Introduction to Artificial Intelligence & Expert Systems, Patterson, PHI
4. Poole, Computational Intelligence, OUP
5. Logic & Prolog Programming, Saroj Kaushik, New Age International

Reference Book:

1. Expert Systems, Giarranto, VIKAS
2. Artificial Intelligence, Russel, Pearson

Embedded System

Course Name: Embedded System	**Category: Open Elective Course-IV**
Course Code: OE-EI 603	**Semester: 6th**
L-T-P: 3-0-0	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Continuous Assessment: 30Marks
Tutorial: Nil	End Semester Exam.: 70 Marks
Total Lectures: 36	
Pre-Requisites: Microprocessor and Microcontroller	

Objectives:

The subject aims to encourage the students with the followings:-

1. The basics of Embedded Systems and Real Time Systems.
2. The basics of embedded system development tools
3. The concept of AVR microcontroller
4. The concept of ARM microcontroller
5. The concepts of RTOS
6. The basics of multicore microcontroller

Course Outcomes (COs):

On completion of this course, the student will be able to

CO.1. **Understand** the basic concept of embedded system and its design process.
CO.2. **Relate** the concepts of embedded systems with AVR and ARM processor.
CO.3. **Differentiate** the general-purpose operating system and RTOS
CO.4. **Analyze** real-time applications using embedded-system concepts

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Module Name: Introduction to Embedded System :** o History of embedded systems, Classification of embedded systems based on generation and complexity, Purpose of embedded systems. o The embedded system design process-requirements, specification, architecture design, designing hardware and software, components, system integration, Applications of embedded systems, and characteristics of embedded systems.	**4**	**1**
Module: 2	**Module Name: Introduction to AVR microcontroller** o Introduction to AVR (ATmega 328p-pu) microcontroller, pin layout, architecture, program memory, Data Direction register , Port Registers (PORTx), PWM registers (8-bit), ADC registers, basics of communication, overview and interfacing I/O devices	**10**	**2, 4**

	with I2C Bus, UART and Serial Peripheral Interchange (SPI) bus, Programming Embedded Systems with AVR (ArduinoAPI). o Case Studies: o Interfacing with Temperature Sensor o Interfacing with Servo Motor o Interfacing with Gas Sensor o Interfacing with LDR light sensor		
Module: 3	**Module Name: Introduction to ARM microcontroller** o Architecture of ARM Embedded microcontroller, ARM instruction set, Introduction to ARMv8-A based embedded development board (i.e. Raspberry Pi rev.4), Programming a Raspberry Pi rev.4 using Python 2.7, User defined LED blink using Raspberry Pi GPIOs, communication between an Arduino UNO rev.3 with Raspberry Pi 4 over USB serial. o Case Studies: o Interfacing with Temperature Sensor o Interfacing with Servo Motor o Interfacing with Gas Sensor o Interfacing with LDR light sensor	**10**	**2, 4**
Module: 4	**Module Name: RTOS based Embedded System Design** o Operating system basics, types of operating systems, tasks, process and threads, multiprocessing and multitasking, task scheduling: non-pre-emptive and pre-emptive scheduling; task communication-shared memory, message passing, Remote Procedure Call and Sockets, Task Synchronization: Task Communication/ Synchronization Issues, Task Synchronization Techniques	**8**	**3**
Module: 5	**Module Name: Introduction to Multicore Microcontroller** o Propeller Chip, Introduction to Propeller Programming, Debugging Code for Multiple Cores	**4**	**2**

Text Books:

1. Introduction to Embedded Systems - shibu k v, Mc Graw Hill Education.
2. Qing Li with Caroline Yao "Real-Time Concepts for Embedded Systems " CMP books 2011
3. Barnett, Cox, &O'Cull "Embedded C Programming and the Atmel AVR" Thomson Delmar learning 2006

Reference Books:

1. Raj Kamal, Embedded systems- Architecture, Programming and Design, McGraw Hill Education (India) Pvt.Ltd.
2. Dhananjay Gadre, "Programming and Customizing the AVR Microcontroller"; McGraw Hill Education, 2014.
3. Elliot Williams, "AVR Programming: Learning to Write Software for Hardware", Maker Media, Incorporated, 2014
4. An Embedded Software Primer – David E. Simon, Pearson Ed., 2005.
5. Embedded System Design -frank vahid, tony grivargis, john Wiley.
6. Embedded Systems- An integrated approach - Lyla b das, Pearson education 2012.

VLSI & MICROELECTRONICS

Course Name: VLSI & MICROELECTRONICS	**Category: Open** Elective Course-IV
Course Code: OE-EI 602	**Semester: 6th**
L-T-P: 3-0-0	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Continuous Assessment: 30 Marks
Tutorial: Nil	End Semester Exam.: 70 Marks
Total Lectures: 36	
Pre-Requisites: Knowledge in Basic Electronics, MOS, Transistors, FETs etc.	

Objectives:

This course aims to introduce with the VLSI technology, IC design through VHDL.

Course Outcomes (COs):

At the end of the course, a student will be able to:

PE-EI 602.1: Tell about the technology, design concepts, design style, design principles, and design domains.
PE-EI 602.2: Describe and distinguish various Microelectronics circuit fabrication process for VLSI circuit design.
PE-EI 602.3: Differentiatethe concepts of digital circuit design for designing VLSI circuits using MOS transistors, sticks diagram and Layout diagrams to represent VLSI design process.
PE-EI 602.4: Evaluatecombinational and sequential digital circuits, digital VLSI circuit design using VHSL languageVHDL language.

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Introduction to VLSI Design**: VLSI Design Concepts, Moor's Law, Scale of Integration (SSI, MSI, LSI, VLSI, ULSI – basic idea only), Types of VLSI Chips (Analog & Digital VLSI chips, General purpose, ASIC, PLA, FPGA), Design principles (Digital VLSI – Concept of Regularity, Granularity etc), Design Domains (Behavioral, Structural, Physical), Y-Chart, Digital VLSI Design Steps.	**7**	**CO 1,2**
Module: 2	**MOS Formation:** Thin and Thick Film Integrated Circuits, Methods of producing film, monitoring and control of film thickness; Design and fabrication of individual components; Processing steps for realization of systems. Monolithic IC Technology : Planner processing steps for realization of integrated circuit using bipolar, MOS and CMOS technology; Epitaxy; Diffusion; Ion-Implantation; Oxidation and passivation; Masking and lithography; Etching; Metallisation and ohmic contacts; Die and wire bonding, packaging and encapsulation; Advantages and disadvantages of bipolar, MOS and CMOS systems.	**8**	**CO 2, 3**

Module: 3	**MOS structure**: E-MOS & D-MOS, Charge inversion in E-MOS, Threshold voltage, Flatband voltage, Potential balance & Charge balance, Inversion, MOS capacitances. **Three Terminal MOS Structure:** Body effect. **Four Terminal MOS Transistor**: Drain current, I-V characteristics. Current-voltage equations (simple derivation). **Scaling in MOSFET**: Short Channel Effects, General scaling, Constant Voltage & Field scaling. **CMOS**: CMOS inverter, Simple Combinational Gates - NAND gate and NOR Gate using CMOS.	**8**	**CO 2,4**
Module: 4	**Micro-electronic Processes for VLSI Fabrication**: Silicon Semiconductor Technology- An Overview, Wafer processing, Oxidation, Epitaxial deposition, Ion-implantation & Diffusion, Cleaning, Etching, Photo-lithography – Positive & Negative photo-resist	**3**	**CO 3,4**
	Basic CMOS Technology – (Steps in fabricating CMOS), Basic n-well CMOS process, p-well CMOS process, Twin tub process, Silicon on insulator **Layout Design Rule**: Stick diagram with examples, Layout rules.	**2**	**CO 2,3,4**
Module: 5	**Hardware Description Language**– VHDL or Verilog Combinational & Sequential Logic circuit Design.	**8**	**CO 3,4**

Text Books:

1. Physical design automation of VLSI systems - B. T. Press and M.J. Lorenzetti Benjamin (Eds.)
2. Logic Minimization for VLSI Synthesis - R.K. Brayton et al – Klumer Academic Publisher.
3. VLSI Design - D.P.Das - – Oxford University Press
4. Digital Integrated Circuit, J.M.Rabaey, Chandrasan, Nicolic, Pearson Education.
5. CMOS Digital Integrated Circuit, S.M.Kang&Y.Leblebici, TMH.
6. Modern VLSI Design, Wayne Wolf, Pearson Education.

Reference Books:

1. Advance Digital Design Using Verilog , Michel D. Celliti, PHI
2. Digital Integrated Circuits, Demassa& Ciccone, John Willey &Sons .
3. Modern VLSI Design: system on silicon, Wayne Wolf; Addison Wesley Longman Publisher
4. Basic VLSI Design, Douglas A. Pucknell& Kamran Eshranghian, PHI
5. CMOS Circuit Design, Layout & Simulation, R.J.Baker, H.W.Lee, D.E. Boyee, PHI

Process Control Lab

Name of the Course:Process Control Lab	**Category: Professional Core**
Course Code: PC-EI 691	**Semester: VI**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination scheme: 100 marks**
Tutorial: Nil	External Assessment:60
Practical: 3 hrs./week	Internal Assessment:40
Credit Points: 1.5	

Course Outcomes:	
CO. 1	**Define** P&I diagram for different types of Process control loops like Temperature, Pressure, Flow and Level.
CO. 2	**Demonstrate** the operations of different types of Process control loops.
CO. 3	**Operate** various field instruments related to different types of Process control loops.
CO. 4	**Compare** the merits and demerits among conventional control action with PLC and DCS.
CO. 5	**Perform** effectively as an individual and as a member in teams at the time of executing laboratory experiments.
CO. 6	**Conclude** the safety and maintenance issues related to those processes.
Pre-Requisite:	
1	Sensor and Transducer
2	Industrial Instrumentation
3	Control Theory

Experiment No.	**Laboratory Experiments**	COs
1	Study of Flow, Level, Pressure, Temperature processes and construction of the P&I diagrams in accordance with ISA guidelines / standards.	1
2	Study of a typical Temperature control loop with PLC compatibility & PC interface.	1-6
3	Study of a typical Pressure control loop with PC interface with PLC compatibility	1-6
4	Study of a typical Flow control loop with PC interface with PLC compatibility	1-6
5	Study of a typical Level control loop with PC interface with PLC compatibility	1-6
6	Study the PLC Programming through PC.	1-6
7	Study of a PC based Automation Software / Simulation Software (PLC Trainer S7-1200).	1-6
8	PLC and DCS based instrumentation experiments.	1-6

Text and reference books:

B. W. Bequette, Process Control – Modeling, Design and Simulation, PHI
W. Bolton, Programmable Logic Controllers, Elsevier
B. G. Liptak, Instrument Engineers Handbook, Chilton Book Co.,
Philadelphia**.**

Instrumentation System Design & AICTE IDEA Lab

Course Name: Instrumentation System Design & AICTE IDEA Lab	**Category:** Professional Core Courses
Course Code: PC-EI 692	**Semester:** 6th
Duration: 6 months	**Maximum Marks:** 100
Teaching Scheme	**Examination scheme: Maximum marks:**
Tutorial: Nil	External Assessment:60
Practical: 3 hrs./week	Internal Assessment:40
Credit Points: 1.5	

Course Outcomes:	
CO. 1	• **Remembering (Level 1):** Describe the basic principles of P, PI, PD, and PID controllers, regulated power supplies, and signal conditioning circuits used for various sensors, including RTDs, thermocouples, and strain gauges.
CO. 2	• **Understanding (Level 2):** Explain the functioning and applications of signal conditioning circuits for RTDs, thermocouples, and strain gauges, as well as instrumentation amplifiers, V/I and I/V converters, and cold junction compensation circuits.
CO. 3	• **Applying (Level 3):** Design basic controllers (P, PI, PD, PID) using operational amplifiers and construct regulated power supply circuits for specific instrumentation applications.
CO. 4	• **Analyzing (Level 4):** Analyze the characteristics of control valves, both installed and non-installed, using MATLAB to understand their impact on control system stability and performance.
CO. 5	• **Evaluating (Level 5):** Evaluate the performance of instrumentation amplifiers, liberalizing circuits, and signal conditioning circuits for accuracy, stability, and compatibility with different sensors, such as RTDs and strain gauges.
CO. 6	• **Creating (Level 6):** Design and fabricate PCB circuits for specific instrumentation applications in IDEA lab, and demonstrate familiarity with 3D printing and scanning technology for prototyping.
Pre-Requisite:	
1	Mathematics Fundamentals, Various sensor fundamentals and electronic circuit knowledge

Experiment No.	**Laboratory Experiments**	COs
1.	Design of P/PI/PD/PID controller using OPAMP.	[CO 1, 4, 5, 6]

2.	Study of a signal conditioning circuits for Resistance Temperature Detector (RTD)/ Strain gauge using instrumentation amplifier	[CO2]
3.	Study and design of liberalizing circuit and cold junction compensation circuit for thermocouple.	[CO 1-6]
4.	Design of V-I and I-V converter (all configurations)	1-6
5.	Design of F-V and V-F converter	1-6
6.	Design of PCM telemetry system.	1-6
7.	Study of control valve non-installed and installed characteristics using MATLAB.	[CO3]
8.	Familiarize with PCB making by chemical process, the use of Milling machine in IDEA lab	1-6
9.	Familiarize with Additive Manufacturing by using 3D printer and 3d Scanning machine in IDEA lab	1-6

References:

1. Johnson, C.D., 2014. *Process control instrumentation technology*. Pearson.
2. Sawhney, A.K. and Sawhney, P., 2016. *A course in Electrical and Electronic Measurements and Instrumentation*. Dhanpat Rai & Company.
3. Ramakant A. Gayakwad, Op-Amps and Linear Integrated Circuits, PHI Learning,New Delhi.

Internet of Things Lab (IoT)

Course Name: Internet of Things Lab(IoT)	**Category: Open Elective -II**
Course Code: OE-EI 691	**Semester: Sixth**
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination scheme: Maximum marks:**
Tutorial: Nil	External Assessment:60
Practical: 3 hrs./week	Internal Assessment:40
Credit Points: 1.5	

Laboratory Experiments:

Exp. No.	Name of the Experiment	COs
1	Familiarization with Arduino IDE and writing a program using Arduino IDE forLED blinking.	1-2
2	Traffic Light Control by using Arduino UNO	1-3
3	Study of DHT-11 temperature sensors and write programs to monitor them with Arduino with Thing Speak.	1-4
4	Study of MQ135 air quality sensors and write programs to monitor air quality with Arduino.	1-4
5	Setup Raspbian on the Raspberry Pi and write a program to blink an LED using Python.	1-2
6	writing a program using Raspberry Pi forLED blinking.	1-2
7	Traffic Light Control by using Raspberry Pi	1-3
8	Study of DHT-11 temperature sensors and write programs to monitor them with Raspberry Pi.	1-4
9	Upload the DHT-11 sensor data to server by BLYNK.	1-5
10	Study of MQ135 air quality sensors and write programs to monitor air quality with Raspberry Pi	1-5
11	IoT based mini project	1-6

Course Outcome:

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

1. **Recall** engineering knowledge related to IoT.
2. Students can **analyse** the problem and able to **explain** the solutions
3. **Sketch** basic IoT applications on embedded platform
4. Able to **explain** the revolution of Internet in Mobile Devices, Cloud & Sensor Networks
5. Ableto**reframe**buildingblocksofInternetofThingsandcharacteristics.
6. **Design** IoT applications in different domain and be able to analyze their performance

Artificial Intelligence Lab

Course Name: Artificial Intelligence Lab	**Category:** Open Elective
Course Code: OE-EI 692	**Semester:** 6th
Duration: 6 months	**Maximum Marks:**
Teaching Scheme	**Examination scheme: Maximum marks:**
Tutorial: Nil	External Assessment:60
Practical: 3 hrs./week	Internal Assessment:40
Credit Points: 1.5	

Course Outcomes:	
CO. 1	Apply AI algorithms to solve real world problems
CO. 2	Understand the implementation procedures for the machine learning algorithms
CO. 3	Design Python programs for various Learning algorithms
CO. 4	Apply appropriate data sets to the Machine Learning algorithms.
CO. 5	Identify Machine Learning algorithms to solve real world problems.
CO. 6	Apply Machine Learning algorithms to solve real world problems.
Pre-Requisite:	
1	Basic Electronics

Exp. No.	**Laboratory Experiments**	COs
1.	Implement AI algorithm for the following problems: i) 8 puzzle ii) Missionaries and Cannibals.	CO 1
2.	Implement and test-hill climbing based search algorithms to solve Travelling Salesman Problem.	CO 1
3.	Solve and implement map coloring problem by backtracking and constraint propagation	CO 2
4.	Solve and implement the game of tic-tac-toe using mini-max.	CO 2
5.	Solve and implement towers of Hanoi problem by planning.	CO3
6.	Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and use it to classify a new sample.	CO 3
7.	Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets.	CO 4
8.	Write a program to implement the naive Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets. Calculate the accuracy, precision, and recall for your data set.	CO 4
9.	Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using any standard Heart Disease Data Set.	CO 5
10.	Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering.	CO 5
11.	Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions.	CO 6

12.	Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw the corresponding graphs.	CO 6

Renewable Energy Sources

Course Name Renewable Energy Sources	**Category:** Professional Elective Course-V
Course Code: PE-EI 701	**Semester: 7th**
L-T-P: 3-0-0	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Theory: 3hrs./week	Continuous Assessment: 30Marks
Tutorial: Nil	End Semester Exam.: 70 Marks
Total Lectures: 36	
Pre-Requisites: Electrical and Electronics Engineering	

Objectives:

The objective of non-conventional energy sources is to provide sustainable, environmentally friendly, and reliable energy alternatives to conventional fossil fuels.

The subject aims to encourage the students with the followings:-

1. Educate students about the environmental impact of conventional energy sources.
2. Provide knowledge about various non-conventional energy technologies such as solar, wind, hydro, geothermal, and biomass energy.
3. Encourage students to think critically about the challenges and opportunities in the energy sector.
4. Develop an understanding of the global energy landscape as well as local energy needs and resources, enabling students to appreciate the role of renewable energy in different contexts.

Course Outcomes (COs):

On completion of this course, the student will be able to

CO.1. ***Recall*** the importance of Renewable Energy sources such as solar, wind, biomass, Ocean and tidal energy.

CO.2. ***Explain and Compare various*** renewable energy sources.

CO.3. ***Identify and apply the*** applications of different renewable energy sources.

CO.4. ***Analyse and evaluate*** self -learning capability to design & establish renewable energy systems.

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Module Name: Basics of Non-Conventional Enegy Sources** o Classification of Energy Sources, Advantages of Non- o Conventional Energy Sources over Conventional Sources Economics, Impact on Environment.	**3**	**1,2**

Module: 2	**Module Name: Solar Energy** o Thermal Energy Generation from Solar Energy: Solar radiation and its Characteristics. Solar Collector: flat Plate, evacuated tube, focusing, Solar Energy use for water heating, solar thermal power generation. o Principle of energy conversion in Solar Photovoltaic cells, Different types of PV Cells, Mono-poly crystalline and amorphous Silicon solar cells. Design of PV array. Efficiency and cost of PV systems.	**7**	**1,2**
Module: 3	**Module Name: Wind Energy** o Electricity Generation from Wind Energy: Wind as energy source, Design of Wind turbine, Selection of site of Wind Farm. o Characteristics of different types of wind generators used with wind turbines.	**8**	**1,2,3**
Module: 4	**Module Name: Biomass** o Electricity Generation from Bio Energy: Resources and conversion process: bio gas conversion, bio gas plant, bio-mass gasifier, co-generation. o Bio diesel: Sources, usability and advantages over mineral product.	**8**	**1,2,3**
Module: 5	**Module Name: Tidal, Wave & Geothermal Energy** o Electricity Generation from Tidal Energy: Principle, selection of site, economics and future prospect. o Electricity Generation from Wave Energy: Principle, selection of site and future prospect. o Electricity Generation from Geo Thermal Energy: Principle , location , economics and prospect.	**5**	**1,2,3**
Module: 6	**Module Name: Energy Audit** o Introduction to Energy Conservation & Audit.	**5**	**3,4**

Text Books:

1. Bansal, Kleeman & Melisa - "Renewable Energy Sources & Conversion Technology" - TMH New Delhi.
2. S P Sukhatme - "Solar Energy"

Reference Books:

1. Twidell & Weir - "Renewable Energy Resources"; ELBS
2. Non Conventional Energy Sources – G. D. Rai
3. Non-Conventional Energy Resources – Chandra & Chandra, Khanna Publishing House Energy Technology, O.P. Gupta, Khanna Publishing House 8. Wells N T – Biomedical Ultrasonics, Academic Press,London 1977.

Virtual Instrumentation

Course Name: Virtual Instrumentation	**Category:** Professional course
Course Code: PE-EI-702	**Semester: 7th**
L-T-P: 3-0-0	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Continuous Assessment: 30Marks
Tutorial: Nil	End Semester Exam.: 70 Marks
Total Lectures: 36	
Pre-Requisites: Basic of Instrumentation Engineering	

Objectives:

The subject aims to encourage the students with the followings:-

- To introduce the fundamental concepts of Virtual Instrumentation (VI) and its applications.
- To enable students to design VI systems using graphical programming languages like LabVIEW.
- To provide hands-on experience in developing data acquisition, processing, and control applications.

Course Outcomes (COs):

On completion of this course, the student will be able to

Remembering

- **Define** Virtual Instrumentation and related terminologies.
- **List** the components of a DAQ system.
- **Describe** the basic features of LabVIEW.

Understanding

- **Explain** the differences between traditional and virtual instrumentation.
- **Illustrate** the data flow in a LabVIEW block diagram.
- **Summarize** the role of communication protocols like GPIB and RS232 in VI.

Applying

- **Develop** basic VIs using loops, case structures, and data types.
- **Use** LabVIEW tools to acquire and log real-time data from sensors.
- **Apply** filters for noise reduction in acquired signals.

Analyzing

- **Compare** the performance of traditional and virtual systems in a given application.
- **Distinguish** between different DAQ hardware options based on specifications.
- **Analyze** real-time data from a sensor to extract meaningful insights.

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	○ **Module 1: Introduction to Virtual Instrumentation** • Definition and Concept of VI • Traditional vs. Virtual Instrumentation	**6**	**CO 1, 2**

	• Advantages of VI in Industrial Automation • Overview of Graphical Programming Languages (e.g., LabVIEW)		
Module: 2	**Module 2: Graphical Programming Concepts (6 Hours)** • Basics of LabVIEW Environment • Controls, Indicators, and Block Diagrams • Data Types and Structures (Numeric, Boolean, Arrays, and Clusters) • Loops and Case Structures in VI	**6**	**CO 1-4**

Module: 3	**Module 3: Data Acquisition and Instrument Control**
	• Basics of Data Acquisition Systems (DAQ)
	  ○ Signal Conditioning and Sampling
	  ○ DAQ Hardware Overview
	• Interfacing with Sensors and Transducers
	• Communication Protocols: GPIB, RS232, USB, Ethernet
	• Signal Generation and Data Logging
		8	**CO 1-4**

Module: 4	**Module 4: Signal Processing and Analysis** • Fourier Analysis and Filters in LabVIEW • Real-time Signal Monitoring • Waveform Analysis Tools • Basics of Image Processing in VI	**8**	**CO 1-4**
Module: 5	**Module 5: Applications of Virtual Instrumentation** • Industrial Applications: Process Monitoring and Control • Biomedical Applications: Data Acquisition from Biosensors • Robotics and Automation Applications • Internet of Things (IoT) in VI	**8**	**CO 1-4**

Text Books:

1. Virtual Instrumentation Using LabVIEW, Sanjay Gupta and Joseph John, McGraw Hill Education
2. LabVIEW for Everyone: Graphical Programming Made Easy and Fun", Jeffrey Travis and Jim Kring, Pearson Education
3. Virtual Instrumentation Using LabVIEW", Jovitha Jerome, PHI Learning

Name of the Subject

Course Name: Micro Electro Mechanical Systems (MEMS)	**Category: Theory**
Course Code: OE-EI 701	**Semester: 7th**
L-T-P: 3-0-0	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Theory: 3	Continuous Assessment: 30Marks
Tutorial: Nil	End Semester Exam.: 70 Marks
Total Lectures: 36	
Pre-Requisites: Mathematics, Physics, Chemistry, Electronics, Sensors and Transducers.	

Objectives:

The objective of this course is to acquire the basic knowledge……

The subject aims to encourage the students with the followings: -

1. The importance and characteristics of MEMS in engineering and technology.
2. Explain the fabrication process of microelectronics.
3. Different etching processes.
4. Explain different types of sensors used in MEMS.
5. Various MEMS devices in different commercial applications.

Course Outcomes (COs):

On completion of this course, the student will be able to

CO.1. **Understand** the operation of micro devices, different elements of MEMS, applications of micro and nanoelectromechanical systems.
CO.2. **Explain** standard micro fabrication techniques like deposition, lithography and etching.
CO.3. **Discuss** the mechanical and electrical characteristics of MEMS and different types of sensors used in MEMS
CO.4. **Develop** advanced MEMS models using any specific tools, considering manufacturing constraints and scalability.

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Module Name: Introduction to MEMS:** Overview of MEMS, intrinsic characteristics of MEMS, elements of MEMS: micro sensors and micro actuators, microelectronics fabrication process, energy domains, materials for MEMS: silicon, polymers, metals; Packaging and integration: glass encapsulation, MEMS process integration strategies, applications of micro and nanoelectromechanical systems.	**10**	**1**

Module: 2	**Module Name: Fabrication Technologies:** **Surface micromachining**: Sacrificial layer processes, micro motors; Bulk micromachining: micro needles, micro nozzles; **Etching**: dry etching, plasma etching; Wet etching: principle and process architect; High Aspect-Ratio Processes: LIGA process, Deep Reactive Ion Etching (DRIE); **Thin film deposition:** Chemical Vapor Deposition (CVD), Physical Vapor Deposition (PVD); Evaporation and sputtering.	**8**	**1,2**
Module: 3	**Module Name:** **Mechanical concepts:** Crystal planes and orientation, Internal force analysis, mechanical properties of silicon and related thin films, flexural beam bending analysis under simple loading conditions, torsional deflections, spring constant and resonant frequency. **Electrical concepts:** semiconductor materials, calculation of charge carrier concentration, conductivity and resistivity of semiconductor.	**10**	**3**
Module: 4	**Module Name:** **Sensing and Actuation Techniques:** **Micro sensors**: Electrostatic sensor, principle of parallel plate capacitors and its applications, Thermal sensor: Fundamentals of thermal transfer, thermal bimorph principle, Piezoresistive sensor: Materials, piezo resistivity, Piezoelectric sensor: Materials and Piezoelectric effect, **Micro actuators:** Actuation using thermal forces, Actuation using shape memory alloys, Actuation using piezoelectric crystals, Actuation using electrostatic forces (Parallel plate, torsion bar), Actuation using electrostatic forces (Comb drive actuators), Micromechanical motors and pumps	**10**	**3**
Module: 5	**Module Name:** **Case Studies of MEMS:** MEMS accelerometer. Sensors are use in biomedical and automobile industry. **Devices in commercial applications:** digital micromirror devices (DMD), MEMS microphones,MEMS pressure sensors and micro-gyroscopes	**7**	**4**

Text Books:

1. Chang Liu,"Foundation of MEMS", 2 nd edition, Pearson Education Inc.,2012. (UNITS-I, III and V)
2. Tai Ran Hsu, "MEMS and Microsystems Design and Manufacture", 2 nd edition, Tata McGraw Hill, 2008. (UNIT-II and UNIT-IV)
3. G. K. Ananthasuresh, K. J. Vinoy, S. Gopalkrishnan K. N. Bhat, V. K. Aatre, Micro and Smart Systems, Wiley India, 2012.

Reference Books:

1. Reza Ghodssi, Pinyen, “MEMS Materials and Processes Handbook”, Springer Science Business Media, 2011.
2. Rai-Choudhury P., “MEMS and MOEMS Technology and Applications”, Prentice Hall of India Learning Private Limited, 2009

Course Name: Mechatronics

Course Name: Mechatronics	**Category:** Open Elective Course-IV
Course Code: OE-EI 702	**Semester: Seventh**
L-T-P: 3-0-0	**Credit: 3**
Teaching Scheme	**Examination Scheme**
Theory: 3 hrs./week	Continuous Assessment: 30 Marks
Tutorial: Nil	End Semester Exam.: 70 Marks
Total Lectures: 36	
Pre-Requisites: To understand this course, the learner must have an idea of basic Mathematics and Physics, Sensor and Transducer, Measurement, Control System and computer programming.	

Objectives: The objectives of this course are as follows:

Interdisciplinary Integration: Equip students with the ability to integrate mechanical, electronic, and computer systems to design and develop advanced mechatronic systems, such as robotics and automated machinery.
Practical Problem-Solving: Develop hands-on skills and problem-solving abilities to analyze, simulate, and optimize mechatronic systems for real-world applications.
Industry Readiness: Prepare students for careers in industries like automotive, aerospace, and manufacturing by providing knowledge and experience with cutting-edge tools and technologies used in mechatronics.

Course Outcomes (COs):

- **CO.1. Understand** the basic concept of mechatronics for designing the mechatronics system.
- **CO.2. Understand** the knowledge of robotic systems and robot design.
- **CO.3. Analysis** and **apply** the robot kinematics in real-time problem.
- **CO.4. Apply** the knowledge in different application for mankind.

Module No.	Description of Topics	Contact Hrs.	CO
Module: 1	**Module Name: General Concepts of Mechatronics** Details: Introduction, Definition of Mechatronics, Mechanical Systems: Introduction to various systems of units, mathematical modeling of mechanical systems, Newton's laws, moment of inertia, forced response and natural response, rotational systems, spring mass system, free vibration, spring mass damper system, mechanical systems with dry friction, work energy and power, passive elements and active elements an energy method for deriving equations of motion, energy and power transformers.	**6**	**1**

Module: 2	**Module Name: General Concepts of Robotics** Details: Introduction, Definition of robot, classification of robots according to coordinate system (Robot configurations: Polar, Cartesian, cylindrical and Jointed-arm configuration) and control method, Main components of robots – manipulator, sensors, controller etc, Robot characteristics –payload, reach, repeatability, accuracy, resolution.	**8**	**2**
Module: 3	**Module Name: Transmission** Details: Kinematics of Robot: Homogenous coordinates, Homogeneous transformation matrices, Direct and Inverse Kinematics of robots, Trajectory Planning.	**10**	**3**
Module: 4	**Module Name: Robot End effecters & Actuators**: Details: Types, mechanical grippers, other types of grippers, Tools as end effecters. Characteristics of actuating systems, Actuating System – Hydraulic devices, pneumatic devices, electric motors, other special actuators.	**8**	**4**
Module: 5	**Module Name: Application** Details: Application of Robots: Handling, loading and unloading, Welding, Spray painting, Assembly, Machining, Inspection, Rescue robots, Underwater robots, Parallel robot, and Medical robot.	**4**	**4**

Text Books:

1. Bolton, W, Mechatronics. 3rd edn, Addison-Wesley.
2. Robotics: Control, Sensing, Vision and Intelligence by Fu, Gonzalez and Lee
3. Introduction to Robotics: Mechanics and Control (3rdEdition) by John J. Craig
4. Robot Dynamics and Control: by Spong and Vidyasagar
5. Introduction to Robotics, S K Saha, McGrew Hill

Reference Books:

1. Fuller, J, Robotics: Introduction, Programming and Projects, 2nd edn, Prentice-Hall.
2. Schuler, C, &McNammee, W, Industrial Electronics & Robotics, McGraw-Hill.
3. Karnopp DC, Margolis DL & Rosenberg RC, System Dynamics: Modeling and Simulation of Mechatronics Systems. 3rd edn. Wiley Interscience.
4. Control of Robot Manipulations: F.I.Lewis, C.T.Abdallah, D.M.Dawson
5. Kinematic Analysis of Robot Manipulators: Carl D. Crane and Joseph Duffy
6. Robotics for Engineers: Koren Y.Robot Modelling: Control and Application with software: by P.G.Ranky and C.Y.Ho

Name of the Course: PROJECT-I	**Category: Project Phase -I**
Course Code: PROJ-EI 781	**Semester: 7th**
Duration: 6 months	**Maximum Marks:** 100
Teaching Scheme	**Examination scheme:**
Tutorial: Nil	Midterm Assessment: 40
Practical: 6 hrs./week	End Semester Assessment: 60
Credit Points: 6	

Objectives:

Final Year Projects are the culmination of the Bachelor of Engineering degree, allowing students to apply theoretical knowledge to solve real-world problems, develop innovative solutions, and gain hands-on experience in instrumentation systems, electronics, and control mechanisms. Some key objectives include:

1. **Practical Application of Concepts**: Utilize the principles of electronics, sensors, instrumentation, and control systems learned throughout the course to design, develop, and implement a functional project.
2. **Problem Solving**: Identify and address a specific problem related to automation, measurement, or control using instrumentation and electronics. This could involve optimizing processes, developing new measurement techniques, or improving control systems.
3. **Innovation and Creativity**: Encourage innovative thinking to design new devices, systems, or techniques that can contribute to the field of instrumentation and electronics engineering.
4. **Teamwork and Collaboration**: Provide opportunities to work in teams, simulating a real-world engineering environment where collaboration is essential.
5. **Technical Skills Development**: Enhance skills in areas like embedded systems, signal processing, data acquisition, sensor design, and control algorithms. This also includes programming, simulation, and prototyping.
6. **Research and Development**: Develop research skills by reviewing literature, analyzing data, and testing various solutions to validate project outcomes.
7. **Communication and Documentation**: Improve technical writing and presentation skills by documenting the project, preparing reports, and presenting findings to peers and faculty.
8. **Industry Readiness**: Prepare for careers in industries such as automation, process control, electronics design, and instrumentation by gaining practical experience and solving industry-relevant problems.

The project should reflect an integration of technical skills, creativity, and the ability to apply theoretical concepts to practical situations.

Course Outcomes:

At the endofthecourse,astudent willbe ableto:

CO1: Identify and summarize relevant research and engineering literature in the project domain.

CO2: Formulate engineering problems from identified gaps in literature and propose feasible solutions using foundational principles.

CO3: Apply engineering concepts, tools, and methodologies to develop a project prototype or solution.

CO4: Evaluate project requirements, resource constraints, and safety standards to ensure compliance during prototype development.

CO5: Collaborate and lead project teams efficiently, managing project timelines and deliverables while ensuring productive teamwork.

CO6: Create and present a comprehensive project report, including design, results, and future improvements, with clear documentation and communication.

Industrial Training Evaluation

Name of the Course: Industrial Training Evaluation	**Category:**Industrial Training
Course Code:PROJ-EI 782	**Semester: 7th**
Duration:	**Maximum Marks: 100**
Teaching Scheme	**Examination scheme: Maximum marks:**
Tutorial: Nil	External Assessment:60
Practical: hrs./week	Internal Assessment:40
Credit Points: 1	

Course Outcomes:	
CO. 1	**Recognize** the different instruments and modern tools used in the industry.
CO. 2	**Relate** theoretical knowledge by hands-on learning from practitioners in the areas of specialization.
CO. 3	**To expose** students to a work environment, common practices, employment opportunities and work ethics in their relevant field.
CO. 4	**To enhance** the employability skills of the students.
CO. 5	**Familiar** with Modern tool usage, The engineer and society
CO. 6	**Develop** soft skills in management, team skill & leadership skill and responsibilities in the work environment.
Pre-Requisite:	
1	Knowledge and skills developed in previous courses.

Project Management and Entrepreneurship

Course Name: Project Management and Entrepreneurship	**Category:** Humanities and social sciences including Management Courses
Course Code: HM-HU 801	**Semester: 8th**
L-T-P: 2-0-0	**Credit: 2**
Teaching Scheme	**Examination Scheme**
Theory: 24	Continuous Assessment: 30Marks
Tutorial: Nil	End Semester Exam.: 70 Marks
Total Lectures: 24	
Pre-Requisites:	

Course Objectives:

1. The course aims to bridge the gap between project management principles and entrepreneurial practices, enabling students to apply project management methodologies within the dynamic and innovative context of entrepreneurship.
2. Another key objective is to foster the development of entrepreneurial skills, such as creativity, leadership, and adaptability, and cultivate an entrepreneurial mind-set characterized by resilience, risk-taking, and opportunity recognition.
3. The course seeks to prepare students for launching and managing start-up ventures by equipping them with the knowledge, tools, and practical experience needed to identify viable business opportunities, develop comprehensive business plans, and execute entrepreneurial projects effectively.

Course Outcomes (CO):

CO 1	Students will demonstrate the ability to integrate project management principles, methodologies, and tools with entrepreneurial practices to effectively plan, execute, and manage projects within startup ventures.
CO 2	Students will be able to identify and evaluate business opportunities by applying project management techniques such as feasibility analysis, market research, and risk assessment, enabling them to make informed decisions regarding new venture creation.
CO 3	Students will develop an entrepreneurial mindset characterized by creativity, innovation, and adaptability, as well as leadership skills necessary to drive entrepreneurial initiatives, lead project teams and navigate uncertainties inherent in startup environments.
CO 4	Students will acquire the knowledge and skills needed to effectively execute and manage entrepreneurial projects, including project planning, resource allocation, time management and stakeholder communication, ensuring successful project delivery within budget and schedule constraints.

Module No.	Description of Topic	Contact Hrs.	COs

1	**Basic Concepts of Project Management:** Definition and types of project, Project life cycle, Project constraints, Organizational structures for projects, Responsibilities of project manager, Project risk analysis, Project appraisal. Environmental and social aspects of project: Environmental considerations in project evaluation, Primary issues and secondary issues in Feasibility study, Social cost benefit analysis, Managing Project Risks, Contingency Planning, Project Audit Process and Closure.	**6**	**1-6**
2	**Network analysis:** Network modeling of a project, Activity on Arrow (AOA), Forward and backward pass computation, Critical paths, floats and slack, Project Scheduling Techniques, PERT, CPM Models, Time-Cost Trade-off in a project, Project Monitoring Techniques, Gnatt chart, Line of Balance (LoB).	**8**	**1-6**
3	**Foundation of Entrepreneurship:** Entrepreneurship and Intrapreneurship (comparisons), India's Start up Revolution, Rural and Social Entrepreneurship, Key attributes of an entrepreneur, women entrepreneurship, Myths and realities of entrepreneurship, Transition from college/ regular job to the world startups.	**5**	**1-6**
4	**Project Financing for entrepreneurs:** Venture Capitalist, Role of Incubators and Angel Investors, Private Equity, Crowd sourcing, Overview of debt financing, Examples of project management software.	**5**	**1-6**

Learning Resources:

Text Books and Reference Books:

1. Project Management by Prasanna and Chandra, Tata McGraw Hill.
2. Elements of Project Management by Pete Spinner, Prentice Hall, USA.
3. A course in PERT and CPM by R. C. Gupta, Dhanpat Rai Publications(P) Ltd, Delhi.
4. Project Management for Engineering, Business and Technology: Nicholas, J.M., and Steyn, H.; PHI
5. Innovation and Entrepreneurship by Drucker, P.F.; Harper and Row
6. Business, Entrepreneurship and Management: Rao, V. S. P Vikas

PROJECT-II

Name of the Course: PROJECT-II	**Category:** Project Phase -II
Course Code: PW-EI 881	**Semester:** 8th
Duration: 6 months	**Maximum Marks: 100**
Teaching Scheme	**Examination scheme:**
Tutorial: Nil	Midterm Assessment:40
Practical: 12 hrs./week	End Semester Assessment:60
Credit Points: 6	

Objectives:

Final Year Projects are the culmination of the Bachelor of Engineering degree, allowing students to apply theoretical knowledge to solve real-world problems, develop innovative solutions, and gain hands-on experience in instrumentation systems, electronics, and control mechanisms. Some key objectives include:

Practical Application of Concepts: Utilize the principles of electronics, sensors, instrumentation, and control systems learned throughout the course to design, develop, and implement a functional project.

Problem Solving: Identify and address a specific problem related to automation, measurement, or control using instrumentation and electronics. This could involve optimizing processes, developing new measurement techniques, or improving control systems.

Innovation and Creativity: Encourage innovative thinking to design new devices, systems, or techniques that can contribute to the field of instrumentation and electronics engineering.

Teamwork and Collaboration: Provide opportunities to work in teams, simulating a real-world engineering environment where collaboration is essential.

Technical Skills Development: Enhance skills in areas like embedded systems, signal processing, data acquisition, sensor design, and control algorithms. This also includes programming, simulation, and prototyping.

Research and Development: Develop research skills by reviewing literature, analyzing data, and testing various solutions to validate project outcomes.

Communication and Documentation: Improve technical writing and presentation skills by documenting the project, preparing reports, and presenting findings to peers and faculty.

Industry Readiness: Prepare for careers in industries such as automation, process control, electronics design, and instrumentation by gaining practical experience and solving industry-relevant problems.

The project should reflect an integration of technical skills, creativity, and the ability to apply theoretical concepts to practical situations.

Course Outcomes:

At the endofthecourse,astudent willbe ableto:

CO1: Identify and summarize relevant research and engineering literature in the project domain.

CO2: Formulate engineering problems from identified gaps in literature and propose feasible solutions using foundational principles.

CO3: Apply engineering concepts, tools, and methodologies to develop a project prototype or solution.

CO4: Evaluate project requirements, resource constraints, and safety standards to ensure compliance during prototype development.

CO5: Collaborate and lead project teams efficiently, managing project timelines and deliverables while ensuring productive teamwork.

CO6: Create and present a comprehensive project report, including design, results, and future improvements, with clear documentation and communication.

Internship Evaluation

Name of the Course: Internship	**Category:**Internship
Course Code:PW-EI 882	**Semester:8th**
Duration:	**Maximum Marks: 100**
Teaching Scheme	**Examination scheme: Maximum marks:**
Tutorial: Nil	External Assessment:60
Practical: 2-4 months	Internal Assessment:40
Credit Points: 2	

Course Outcomes:	
CO. 1	**Recognize** the different instruments and modern tools used in the industry.
CO. 2	**Relate** theoretical knowledge by hands-on learning from practitioners in the areas of specialization and also learn some modern software tools those are important in real world.
CO. 3	**To expose** students to a work environment, common practices, employment opportunities and work ethics in their relevant field.
CO. 4	**To enhance** the employability skills of the students.
CO. 5	**Familiar** with Modern tool usage, The engineer and society
CO. 6	**Develop** soft skills in management, team skill & leadership skill and responsibilities in the work environment.
Pre-Requisite:	
1	Knowledge and skills developed in previous courses.

Key Guidelines for AEIE Student Internship Program

1. **Internship Scope & Relevance**
   - The internship must align with the core disciplines of Applied Electronics and Instrumentation Engineering (AEIE), covering areas like embedded systems, IoT, automation, instrumentation, control systems or software domain
2. **Eligibility & Duration**
   - Students should be in their **third or final year** of study.
   - The internship duration should be a **minimum of 4 weeks and up to 6 months**, depending on the type and intensity of the program.
3. **Type of Internship**
   - Internships can be classified as:
   - a) **Core AEIE Internships** – Focused on automation, sensors, instrumentation, and control systems.
   - b) **Software-Based Internships** – Covering programming, AI/ML, data analytics, and industrial software applications.
   - c) **On-Job Training (OJT) Internships** – Hands-on training at industrial sites, including manufacturing plants and R&D units.
4. **Selection & Approval Process**
   - Internships must be **approved by the department** before commencement.
   - Students must provide an **offer letter or acceptance letter** from the host company/organization.

5. **Mentorship & Supervision**
    - Each student will have a **faculty mentor** from the college and a **company supervisor** for guidance and evaluation.
6. **Internship Learning Outcomes**
    - Students must gain knowledge in **industry tools, automation technologies, software development, and real-world applications** of AEIE principles.
    - The internship should enhance **problem-solving skills, teamwork, and adaptability** in professional settings.
7. **Assessment & Documentation**
    - Students must maintain a **daily logbook** of activities and progress.
    - A final **internship report** and **presentation** must be submitted at the end of the internship for evaluation.
8. **Ethical Conduct & Professionalism**
    - Interns must adhere to **workplace ethics, confidentiality agreements, and professional behavior** as per company policies.
9. **Certification & Credit Recognition**
    - Upon successful completion, students will receive an **internship completion certificate** from the host company.
    - The internship may be considered for **academic credit** based on university guidelines.
10. **Post-Internship Review & Feedback**
    - Students must submit feedback on their experience, and companies may provide **performance evaluations** to assess technical and professional skills.
    - Exceptional internships may be considered for **placement opportunities** or extended training programs.