Kurukshetra University, Kurukshetra

(Established by the State Legislature Act XII of 1956)

('A+' Grade, NAAC Accredited)

।। योगस्थः कुरु कर्माणि।।
समबुद्धि व योग युक्त होकर कर्म करो

(Perform Actions while Steadfasting in the State of Yoga)

DEPARTMENT OF INSTRUMENTATION (DOI)

LOCF/OBE/NBA CURRICULUM (2020 -2021)

Program Name: M. Tech. - Electrical and Instrumentation Engineering

(For the Batches from 2020-2021 in phased manner)

(UTD Only)

LOCF/OBE/NBA CURRICULUM (2020 -2021)

Program Name: M. Tech. - Electrical and Instrumentation Engineering

(For the Batches admitted from 2020-2021 in phased manner)

VISION

Be globally acknowledged as a distinguished centre of academic excellence.

MISSION

To prepare a class of proficient scholars and professionals with ingrained human values and commitment to expand the frontiers of knowledge for the advancement of society.

DEPARTMENT VISION AND MISSION

VISION

- To become a model department as a Centre of quality education, research with innovation and recognition at National and International level for serving society.

MISSION

- **M1:** To provide quality education to aspiring young minds for improving their skills, inculcating values, creating leadership qualities and enhance research with innovative methods.
- **M2:** To produce young engineers capable to be utilized in the areas of New Technological Design, Environment, ethics and sustainable technologies.
- **M3:** To develop Teaching-Learning methods which can produce socially committed good professional human being who can contribute effectively in Nation building and represent Country Internationally.

Mapping of University Vision and Mission to Department Vision and Mission

Acclaimed as modal Centre of Learning and Research by

University Vision and Mission	Department Vision and Mission
High quality knowledge delivery through state of art infrastructure and ethical values to the students	**Yes**
Students excellence will make them professionals and innovators emerging as global leaders	**Yes**
Research and development will help in furtherance of Faculty knowledge	**Yes**

Programme Educational Objectives (PEOs):

The Department of Instrumentation in consultation with various stakeholders have formulated the Programme Educational Objectives (PEO's) that are broad statements that describe the career and professional accomplishments that the program is preparing its Post Graduate to achieve in few years, subsequent to receiving the degree. The PEO's of the M. Tech. programme in Electrical and Instrumentation Engineering are as follows:

- **PEO1:** The Post Graduate will become competent by applying their technical and managerial skills.
- **PEO2:** The Post Graduate will be able to adapt to any environment and succeed in higher positions in contemporary rapidly evolving technologies in Electrical and Instrumentation engineering field.
- **PEO3:** The Post Graduate will engage themselves in the life-long learning by pursuing higher education and participation in research and development activities to meet all challenges to transform them as responsible citizens of the nation

Program Specific Outcomes (PSO's):

- **PSO1:** Clearly understand the fundamental concepts of Electrical and Instrumentation Engineering
- **PSO2:** Post Graduate will be able to formulate and solve real life problems in the area of Electrical and Instrumentation Engineering
- **PSO3:** Post Graduate will possess the skills to communicate effectively in both oral and written forms, demonstrating the practice of professional ethics, and responsive to societal and environmental needs.

PEOs to Mission statement mapping

PEO's	MISSION OF THE DEPARTMENT		
	M1	M2	M3
PEO1	3	3	1
PEO2	2	3	2
PEO3	2	2	3

Program Outcomes (PO) with Post Graduate Attributes

Programme Outcomes are attributes of the Post Graduate from the programme that are indicative of the Post Graduate' ability and competence to work as an engineering professional upon graduation. Program Outcomes are statements that describe what students are expected to know or do by the time of graduation, they must relate to knowledge and skills that the students acquire from the programme. The achievement of all outcomes indicates that the student is well prepared to achieve the program educational

objectives down the road. The Department of Instrumentation engineering has following twelve PO's. The course syllabi and the overall curriculum are designed to achieve these outcomes:

S. No.	Post Graduate Attributes	Program Outcomes (POs)
PO1	Knowledge	Capable of demonstrating comprehensive disciplinary knowledge gained during course of study
PO2	Research Aptitude	Capability to ask relevant/appropriate questions for identifying, formulating and analyzing the research problems and to draw conclusion from the analysis
PO3	Communication	Ability to communicate effectively on general and Technical topics with the engineering community and with society at large
PO4	Problem Solving	Capability of applying knowledge to solve Engineering and other problems
PO5	Individual and Team Work	Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings.
PO6	Investigation of Problems	Ability of critical thinking, analytical reasoning and research based knowledge including design of experiments, analysis and interpretation of data to provide conclusions
PO7	Modern Tool usage	Ability to use and learn techniques, skills and modern tools for scientific and engineering practices
PO8	Engineering and Society	Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional Engineering practices
PO9	Life-Long Learning	Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life
PO10	Ethics	Capability to identify and apply ethical issues related to one's work, avoid unethical behaviour such as fabrication of data, committing plagiarism and unbiased truthful actions in all aspects of work
PO11	Project Management	Ability to demonstrate knowledge and understanding of the engineering principles and apply these to manage projects

Mapping of PEO's with PO's

S. No.	Program Educational Objectives	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	The Post Graduate will become competent by applying their technical and managerial skills.	√	√	√	√	√	√	√	√	√	√	√	√	√	√
2	The Post Graduate will be able to adapt to any environment and succeed in higher positions in contemporary rapidly evolving technologies in Electrical and Instrumentation engineering field.	√	√	√	√	√	√	√	√	√	√	√	√	√	√
3	The Post Graduate will engage themselves in the life-long learning by pursuing higher education and participation in research and development activities to meet all challenges to transform them as responsible citizens of the nation			√	√		√	√	√	√		√	√	√	√

LOCF/OBE/NBA CURRICULUM (2020 -2021)

Program Name: M. Tech. - Electrical and Instrumentation Engineering

Post Graduate Degree Program

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

A. Definition of Credit:

1 Hour Lecture (L) per week	1 credit
1 Hour Tutorial (T) per week	1 credit
1 Hour Practical (P) per week and/or 2 Hours Practical(Lab)/week	0.5 credits 1 credit

B. Total credits:

Total credits for a student to be eligible to get Post Graduate degree in Engineering are 66.0 credits.

C. Structure of Undergraduate Engineering program:

S. No.	Category	Breakup of Credits (Total)
1.	**Professional Core Courses**	**52**
2.	**Program Elective Courses relevant to the branch**	**09**
3.	**Seminars**	**04**
4.	**Research Methodology &IPR**	**01**
	Total	**66**

D. Course code and definition:

Category of Course/ Code	Definitions
L	Lecture
P	Practical
C	Credit
CIE	Continuous Internal Evaluation
SEE	Semester End Examination
EI	Electrical and Instrumentation Engineering
RM	Research Methodology
PC	Professional Core Courses
PE	Professional Elective courses
PRPC/ PRPE/ PRS	Practical Professional Core/ Program Elective/Seminar
ADC	Mandatory Audit Courses

E. Details of Structure and distribution of credits to various courses:

S. No	Category	Course No.	Course Title	C	Teaching Schedule			
					L	T	P	Cont Hrs.
Professional Core Courses								
1	**PC**	**EI-PC-103**	Biomedical Instrumentation	3	3	0	0	3
2	**PC**	**EI-PC-105**	Advanced Electric Drive	3	3	0	0	3
3	**PC**	**EI-PC-107**	Advance Process Control	3	3	0	0	3
4	**PC**	**EI-PC-104**	Power Quality Monitoring and Conditioning	3	3	0	0	3
5	**PC**	**EI-PC-106**	PLC & DCS	3	3	0	0	3
6	**PC**	**EI-PC-108**	Embedded System Design	3	3	0	0	3
7	**PC**	**EI-PC-110**	Advanced Power System	3	3	0	0	3
8	**PC**	**EI-PC-201**	Smart & Micro Sensor Design	3	3	0	0	3
9	**PRPC**	**EI-PRPC-101**	Process Control Lab	1.5	0	0	3	3
10	**PRPC**	**EI-PRPC-103**	Advanced Electric Drive Lab	1.5	0	0	3	3
11	**PRPC**	**EI-PRPC-102**	Advanced Power System Lab.	1.5	0	0	3	3
12	**PRPC**	**EI-PRPC-104**	Embedded Systems Lab	1.5	0	0	3	3
13	**PRPC**	**EI-PRPC-203**	Dissertation Phase-1	06	0	0	12	12
14	**PRPC**	**EI-PRPC-204**	Dissertation	16	0	0	32	--
			Total	**52**	**24**		**56**	**48**
Program Elective Courses								
1	**PE**	**EI-PE-101**	**Program Elective-I**	3	3	0	0	3
			(i) Control system Design					
			(ii) Process Equipment Design					
			(iii) Industrial Environmental Engineering					
			(iv) Power Plant Engineering					
			(v) Energy Auditing and methodology					
			(vi) Energy Efficient Machines					
2	**PE**	**EI-PE-102**	**Program Elective-II**	3	3	0	0	3
			(i) Renewable & Non-Conventional Energy					
			(ii) Theory and Design of Neuro fuzzy controllers					
			(iii) Digital Control System					
			(iv) HVDC Transmission System					

			(v) Energy Management					
			(vi) Process Modeling and Control					
			(vii) Advance Power Electronics					
3	**PE**	**EI-PE-203**	**Program Elective-III**	3	3	0	0	3
			(i) Digital Signal Processing					
			(ii) Sensors and Transducers					
			(iii) Reliability Engineering					
			(iv) Electrical Vehicle Engineering					
			(v) System Theory					
			(vi) Intelligent Instrumentations					
			(vii) Industrial Power Electronics					
			Total	**09**	**09**	**0**	**0**	**09**
1	**RM**	**EI-RM-109**	Research Methodology & IPR	**1**	**2**	**0**	**0**	**2**
Seminars								
1	**PRS**	**EI-PRS-105**	Seminar-I	1	0	0	2	2
	PRS	**EI-PRS-106**	Seminar-II	1	0	0	2	2
	PRS	**EI-PRS-201**	Current Literature Report & Seminar	2	0	0	4	4
			Total	**04**	**0**	**0**	**08**	**08**

Department of Instrumentation

M. Tech Electrical and Instrumentation Engineering

SCHEME OF EXAMINATIONS

M. Tech. 1st YEAR (SEMESTER–I) (from 2020 – 2021 in phased manner)

Course No.	Course Title	C	Teaching Schedule			Allotment of marks			Exam Duration in Hrs.
			L	P	Cont. Hrs.	CIE	SEE	Total	
EI-PE-101	Program Elective-I	3	3	0	3	40	60	100	3 Hrs
EI-PC-103	Biomedical Instrumentation	3	3	0	3	40	60	100	3 Hrs
EI-PC-105	Advanced Electric Drive	3	3	0	3	40	60	100	3 Hrs
EI-PC-107	Advance Process Control	3	3	0	3	40	60	100	3 Hrs
EI-RM-109	Research Methodology & IPR	2	2	0	2	20	30	50	3 Hrs
EI-PRPC-101	Process Control Lab	1.5	0	3	3	20	30	50	3 Hrs
EI-PRPC-103	Advanced Electric Drive Lab.	1.5	0	3	3	20	30	50	3 Hrs
EI-PRS-105	Seminar-I	1	0	2	2	50	--	50	
	Total	**18**	**14**	**8**	**22**	**270**	**330**	**600**	

M. Tech. 1stYEAR (SEMESTER–II)

Course No.	Course Title	C	Teaching Schedule			Allotment of marks			Exam Duration in Hrs.
			L	P	Cont. Hrs.	CIE	SEE	Total	
EI-PE-102	Program Elective-II	3	3	0	3	40	60	100	3 Hrs
EI-PC-104	Power Quality Monitoring and Conditioning	3	3	0	3	40	60	100	3 Hrs
EI-PC-106	PLC & DCS	3	3	0	3	40	60	100	3 Hrs
EI-PC-108	Embedded System Design	3	3	0	3	40	60	100	3 Hrs
EI-PC-110	Advanced Power System	3	3	0	3	40	60	100	3 Hrs
EI-PRPC-102	Advanced Power System Lab.	1.5	0	3	3	20	30	50	3 Hrs
EI-PRPC-104	Embedded Systems Lab	1.5	0	3	3	20	30	50	3 Hrs
EI-PRS-106	Seminar-II	1	0	2	2	50	--	50	
	Total	**19**	**15**	**8**	**23**	**290**	**360**	**650**	

Program Elective-1	Program Elective-II
(i) Control system Design	(i) Renewable & Non-Conventional Energy
(ii) Process Equipment Design	(ii) Theory and Design of Neuro fuzzy controllers
(iii) Industrial Environmental Engineering	(iii) Digital Control System

(iv) Power Plant Engineering	(iv) HVDC Transmission System
(v) Energy Auditing and methodology	(v) Energy Management
(vi) Energy Efficient Machines	(vi) Process Modeling and Control

NOTE:

i) A program may have one or two laboratory courses spread over 3 periods.

ii) Sufficient number of electives to be offered subject to the condition that each elective should have at least five students.

M. Tech. 2nd YEAR (SEMESTER–III)

Course No.	Course Title	C	Teaching Schedule			Allotment of marks			Exam Duration in Hrs.
			L	P	Cont. Hrs.	CIE	SEE	Total	
EI-PC-201	Smart & Micro Sensor Design	3	3	0	3	40	60	100	3 Hrs
EI-PE-203	Program Elective-III	3	3	0	3	40	60	100	3 Hrs
EI-PRS-201	Current Literature Report & Seminar	2	0	4	4	50	--	50	
EI-PRPC-203	Dissertation Phase-1	6	0	12	12	50	--	50	
	Total	**14**	**6**	**16**	**22**	**180**	**120**	**300**	

Program Elective-III	
(i)	Digital Signal Processing
(ii)	Sensors and Transducers
(iii)	Reliability Engineering
(iv)	Electrical Vehicle Engineering
(v)	System Theory
(vi)	Intelligent Instrumentations
(vii)	Industrial Power Electronics

NOTE: The Preparatory Work for Dissertation Phase-I shall be evaluated by a committee comprising the following {on the basis of one mid semester seminar and one end semester seminar presented and one end semester report submitted by the candidate.

1. Chairperson or faculty nominee proposed by Chairperson
2. Dissertation Supervisor (and co-supervisor).
3. Two senior most faculty members of the department

M. Tech. 2nd YEAR (SEMESTER–IV)

Course No.	Course Title	C	Teaching Schedule	Allotment of marks			Exam Duration in Hrs.
			P	CIE	SEE	Total	
EI-PRPC-204	Dissertation	16	32	100	200	300	Final Viva Voce Exam

NOTE: The Dissertation shall be evaluated by a committee comprising the following through presentation cum viva-voce examination.

1. Chairperson or faculty nominee proposed by Chairperson.
2. Dissertation Supervisor (and co-supervisor).
3. One external expert appointed by the department.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-101	Course Name: Program Elective-I CONTROL SYSTEM DESIGN (i)	L	T	P	C
		3	-	-	3
Year and Semester	1st Yr. 1st Semester	Contact hours per week: (3Hrs) Exam: (3 Hrs)			
Pre-requisite of course	Control System	Evaluation			
		CIE: 40	SEE: 60		

Course Objectives:

1. Study Design Specifications of control system.
2. Study the concept of multi-criteria optimization, norms of scalar & vector signals, norms of SISO LTI & MIMO LTI systems, state space methods for computing norms.
3. Study closed loop convex design specifications, convexity & duality.
4. Study the concept of Reliability & closed loop stability, regulation specifications, differential sensitivity specifications, robustness specifications.
5. Study, analysis and design of Compensators & controller using various techniques including Root locus & Bode plots
6. Study the state variable analysis, controllability and observability, state feedback for SISO system and MIMO systems and their design
7. Introduction to design of non-linear system.

Course Outcomes: On completion of the course, student would be able to:

CO1	Ability to understand the concept of multi-criteria optimization, norms of scalar & vector signals, norms of SISO LTI & MIMO LTI systems, state space methods for computing norms.
CO2	Ability to understand the concept of closed loop convex design specifications, convexity & duality.
CO3	Ability to understand the concept of Reliability & closed loop stability, regulation specifications, differential sensitivity specifications, robustness specifications.
CO4	Ability to analysis and design of Compensators& controllers by different techniques.
CO5	Ability to understand concept of state feedback for SISO system and MIMO systems and their design.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	INTRODUCTION: Control System Architecture, Design Specifications Functional in-equally specifications, multi-criteria optimization, norms of scalar & vector signals, norms of SISO LTI & MIMO LTI systems, state space methods for computing norms, design specifications as sets, affine & convex sets and functions, closed loop convex design specifications, convexity & duality	**8**	**CO1, CO2**
2	DESIGN SPECIFICATIONS: Reliability & closed loop stability, I/O specifications, regulation specifications, actuator effort, combined effect of disturbances & commands, differential sensitivity specifications, robustness specifications via gain bounds.	**9**	**CO1, CO3**
3	Compensators & CONTROLLERS DESIGN: Selection criteria and design of lead, lag, lead-lag and cascade type of compensators using Root locus & Bode	**10**	**CO3 CO4 CO5**

	plots, Rate feedback. Controllers – configuration and fundamentals of design, cascade and feedback compensation using various controllers.		
4	STATE VARIABLE FEED BACK DESIGN: Introduction to state variable analysis, controllability and observability, state feedback for SISO system, state feedback design of SISO system using control canonical form. State variable feedback _ steady state error analysis, Use of steady state error coefficients, design of state observers, Introduction to design of MIMO systems. Introduction to design of non-linear system and software.	**10**	**CO4 CO5**

TEXT BOOKS/REFERENCE BOOKS:

1. Modern Control Systems – A manual of design methods by John A. Borrie (Prentice Hall International)
2. Control Systems – Principle & Design by M. Gopal (TMH publication)
3. Introduction to feed back control system by Pericles E. Manuel & Edward Leff (International Student Edition)
4. Linear controller designs – limits of performance by Stephen P. Boyd & Craig H. Barratt (Prentice Hall International).
5. Linear control analysis & design By John J. D'azzo & C. H. Houpis (McGraw Hill)

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-101	**Course Name: Program Elective I, Process Equipment Design (ii)**		**L**	**T**	**P**		**C**
			3	**-**	**-**		**3**
Year and Semester	**1st Yr. 1st Semester**		**Contact hours per week:** (3 Hrs) Exam: (3 Hrs)				
Pre-requisite of course	**Process Control Systems**		**Evaluation**				
		CIE: 40			**SEE: 60**		
Course Objectives:							
1. It aims to equip the students with Equipment design							
2. To provide adequate knowledge about various types of equipment							
Course Outcomes: On completion of the course, student would be able to:							
CO1	Distinguish between various process devices and equipments						

CO2	Control and optimize process equipments
CO3	Characterize storage equipments
CO4	Design heat exchange equipment

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	Valve Noise calculation and reduction: Sources of valve noise, noise control, path treatment, valve treatment, valve noise calculation. Design & construction of Globe valve: valve trends, trim design, trim flow characteristics, flow range ability, standard trim configuration, valve plug stems, Body form of single and double seated globe valve, Bonnet design of global valve. Construction and flow characteristics of butterfly valve.	**8**	**CO1**
2	Boiler control and optimization, compressor control and optimization, cooling tower control and optimization, distillation controls, evaporator controls Basics of Process Equipment Design: General design procedure, Computer design, Fabrication techniques, Equipment classification, Power of rotational motion, Drives for process equipment.	**8**	**CO1, CO2**
3	Pressure Vessels: Pressure vessel code, Operating conditions – at low temperatures, at elevated temperatures, Design considerations and stresses, fabrication, inspection and tests, unfired vessel codes, High pressure vessels: Constructional features, materials, solid walled, multi shell, vessel closures, Jacket for vessels, Examples. Storage Vessels: Storage of fluids, Non-volatile liquids, volatile liquids and gases, Design of tanks, rectangular tanks, nozzles and mounting, Large capacity storage tanks, Examples. Reaction Vessels: Materials for construction, agitation, classification of reaction vessels, heating systems.	**8**	**CO1, CO3**
4	Heat Exchangers: Types of heat exchangers, design of shell and tube heat exchangers. Evaporators and Crystallisers: Types of evaporators, entrainment separators, materials and design considerations, crystallisers, Examples. Process Hazards and Safety Measures in Equipment design. Process flow diagrams.	**8**	**CO1 CO4**

Text Books:

1. Instrument Computer Aided Process control by S.K. Singh PHI
2. Computer Based Industrial Control by Krishna Kant PHI
3. Instrument Engineers Handbook- Process Control by Bela G. Liiptak

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.

2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.

3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.

2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-101	**Course Name: Program Elective-I** INDUSTRIAL ENVIRONMENTAL ENGINEERING (iii)	**L** 3	**T** -	**P** -	**C** 3
Year and Semester	**1st Yr. 1st Semester**	**Contact hours per week: (3Hrs)** Exam: (3 Hrs)			
Pre-requisite of course	**Nil**	**Evaluation**			
		CIE: 40	**SEE: 60**		

Course Objectives:	
1. To introduce the concept of air, water and noise pollution monitoring	
2. To study the concepts of emission type pollution controls	
3. To study the various air pollution monitoring instruments and methods for process industries.	
4. To introduce the pollution control and monitoring methods for pulp and paper industries.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	Identify sources of air ,noise and water pollution and their effects
CO2	Sample and analyze air pollutants
CO3	Understand the air quality monitoring instruments
CO4	Sample and analyze water borne pollutants
CO5	Understand the water quality monitoring instruments

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	INTRODUCTION: Source and classification of Air Pollution, Effect of Air Pollution in Human Health, Effect of Air Pollution on Animals, Effect of Air Pollution on Plants, Economics Effects of Air Pollution, Control of Air Pollution by Equipment, Control of Air Pollution by Process Changes, Air Pollution from Major Industrial Operations, Air Pollution legislation and regulation, Environment Protection Act, Air Pollution in Indian cities, Water & Noise Pollution. & its control, Green House effects & its control.	**8**	**CO1**
2	POLLUTION CONTROL FOR SPECIFIC POLLUTANTS: Industrial Pollution Emission and Indian Standards, Analysis of Pollutants, Control of BOD, Removal of Chromium, Removal of Mercury, Removal of Ammonia / urea, Treatment of Phenolic Effects, Removal of particular matter, Removal of Sulphur Dioxide, Removal of Oxides of Nitrogen, Removal of Vapour from Efficient case, Control of CO2 and CO.	**8**	**CO1, CO2**
3	POLLUTION CONTROL IN SELECTED PROCESS INDUSTRIES: General considerations of Pollution Control in Chemical Industries, Pollution Control aspects of fertilizer industries, Pollution Control in Petroleum & Petrochemical Units.	**8**	**CO2, CO3**
4	Pollution Control in Pulp & Paper Industries, Tanning Industries, Sugar Industries, Alcohol Industries, Electroplating & Metal Finishing Industries, Radioactive Wastes, Pollution Control methods used in Power Plants.	**8**	**CO1, CO4, CO5**

REFERENCE BOOKS:

1. Air Pollution by H V Rao, McGraw Hill
2. Pollution Control in Process Industries by S P Mahayar, McGraw Hill
3. Encyclopedia of Environmental Pollution & Control, Vol. 1 & 2, Enviro Media, Karad, India.
4. Environmental Water Pollution & its control by G R Chhatwal, M.C. Mehra& Others, Anmol Publication, Delhi.
5. Environmental Air Pollution & its control by G.R. Chhatwal& Others, Anmol Publication, Delhi.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-101	**Course Name: Program Elective-I POWER PLANT ENGINEERING (iv)**	**L**	**T**	**P**	**C**
		3	**-**	**-**	**3**
Year and Semester	**1st Yr. 1st Semester**	**Contact hours per week: (3Hrs)** Exam: (3 Hrs)			
Pre-requisite of course	**Basic Science**	**Evaluation**			
		CIE: 40		**SEE: 60**	

Course Objectives:	
1. To study the concept of steam power plant.	
2. To study the concept of Hydro-electric power plants and Nuclear power plants	
3. To study the concept of gas turbine and diesel power plants.	
4. To study the combined operation of different power plants.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	To understand the operation of steam power plant.
CO2	To understand the operation of Hydro-electric power plants and Nuclear power plants
CO3	To understand the operation of gas turbine and diesel power plants.
CO4	To understand the combined operation of different power plants.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**

1	Steam generators, condensers and turbines: Classification of steam generators, selection, operation of locomotive, Babcock Wilcox, Cochran boilers, Types of condensers, effect of air in condensers, Dalton's law of partial pressure, cooling water calculations, steam nozzles, types of steam turbine efficiencies, compounding, governing and control. Steam power plant: Classification, Operation, Description of Rankin cycle, Regenerative cycle, Reheat-Regenerative Cycle, Binary Vapour Cycle, Selection of plant site and its layout, coal handling system, combustion system, Fluidised bed combustion, Ash handling, Feed pumps, Heat exchangers, Economizers, Super heaters, Reheaters, Air preheaters, Feed water heaters, Evaporators.	**8**	**CO1**
2	Hydro-electric power plants: Hydrological Cycle, Hydrograph, Flow duration curve, Selection of site, Essential features, Classification of hydro plants, Selection of water turbines for hydro power plant, Automatic and remote control of hydro-station, layout of hydro power plant. Nuclear power plants: Nuclear physics, Binding energy, Radioactive decay. Fertile material, Mass defect, Nuclear reactions type and application, Generation of nuclear energy by fission, Nuclear reactors. Site selections, safety measures, plant layout, Fusion reaction, Future of nuclear power.	**8**	**CO2**
3	Gas turbine: Elements of gas turbines, Open and closed cycles for gas turbines, Performance terms, Thermal refinement to gas turbines cycle, Plant layout, applications, gas turbines Cycle calculations. Diesel power plants: Classifications of IC Engines and their performance, Four stroke and two stroke diesel engines, combustion phenomenon; Essential components, Celane number, knocking, super charging, operation and layout of diesel power plant.	**8**	**CO3**
4	Combined operation of different power plants: Advantages of combined operation of plants, load division between power stations, coordination of different types of Power Plants. Pollution control: Pollution from thermal & nuclear plants, Particulate emission and control, electrostatic precipitator, solid waste disposal.	**8**	**CO4**

TEXT BOOKS/REFERENCE BOOKS:

1. Chakrabarti A., Soni, M.L. Gupta P.V. and Bhatanagar U.S., A Textbook on Power System Engineering, Dhanpat Rai & Co.
2. EI-Wakit M.M., Power Plant Engineering, McGraw Hill, USA
3. Rajput R.K., Power Plant Engineering, Luxmi Publications
4. Sharma P.C., Power Plant Engineering, Kataria& Sons
5. Skrotzki B.G.A. and Vapot W.A., Power Station Engineering and Economy, Tata McGraw-Hill

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code:	**Course Name: Program Elective-I**		**L**	**T**	**P**	**C**
EI-PE-101	ENERGY AUDITING AND METHODOLOGY (v)		**3**	**-**	**-**	**3**
Year and Semester	**1st Yr.** **1st Semester**	**Contact hours per week: (3Hrs)** Exam: (3 Hrs)				
Pre-requisite of course	**Electrical Measurements and Instruments**	**Evaluation**				
		CIE: 40	**SEE: 60**			

Course Objectives:	
1. To introduce the concept of Energy Management and Audit.	
2. To study the concepts of financial management.	
3. To study and analysis various type of appliance in electrical system.	
4. To study the conceptual theory and working of refrigeration system.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	To understand the concept of Energy Management and Audit.
CO2	To understand the concepts of financial management.
CO3	To familiarize with various type of appliance in electrical system.
CO4	To understand conceptual theory and working of refrigeration system.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	Energy Scenario: Energy needs of growing economy, Long term energy scenario, Energy pricing, Energy sector reforms, Energy and environment: Air pollution, Climate change, Energy security, Energy conservation and its importance, Energy strategy for the future, Energy conservation Act- 2001 and its features. Energy Management and Audit: Definition, Energy audit-need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments.	**8**	**CO1**
2	Material and Energy balance: Facility as an energy system, Methods for preparing process flow, Material and energy balance diagrams. Financial Management: Investment-need, Appraisal and criteria, Financial analysis techniques- Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis, Financing options, Energy performance contracts and role of energy savings companies (ESCOs).	**8**	**CO2**

3	Electrical system: Electricity tariff, Load management and maximum demand control, Power factor improvement, Distribution and transformer losses. Losses in induction motors, Motor efficiency, Factors affecting motor performance, Rewinding and motor replacement issues, energy efficient motors. Light source, Choice of lighting, Luminance requirements, and Energy conservation avenues Compressed air system: Types of air compressors, Compressor efficiency, efficient compressor operation, Compressed air system components, Capacity assessment, Leakage test Factors affecting the performance and efficiency.	**8**	**CO3**
4	High Voltage Alternating Current and Refrigeration System: Vapor compression refrigeration cycle, Refrigerants, Coefficient of performance, Capacity, Factors affecting refrigeration and air conditioning system performance and savings opportunities, Vapor absorption refrigeration system: Working principle, Types and comparison with vapor compression system, Saving potential, Fans, Blowers and pumps- Types, Performance evaluation, Efficient system operation, Flow control strategies and energy conservation opportunities.	**8**	**CO4**

TEXT BOOKS/REFERENCE BOOKS:

1. Abbi, Y.P. and Jain, S., Handbook on Energy Audit and Environment Management, Teri Bookstore
2. Diwan, P., Energy Conservation, Pentagon Press (2008).
3. Younger, W., Handbook of Energy Audits, CRC Press (2008)
4. Sawhney and Maheshwari, Solar Energy and Energy Conservation, Prentice Hall (India)
5. Rao S. and B. B. Parulkar, Energy Technology, Khanna Publishers
6. Sukhatme S. P., Solar Energy, Tata McGraw Hill
7. David S., Hand Book of Industrial Energy Conservation, Van Nostrand Reinhold Publishing Company.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-101	**Course Name: Program Elective-I** ENERGY EFFICIENT MACHENES (vi)	**L**	**T**	**P**	**C**
		3	**-**	**-**	**3**
Year and Semester	**1st Yr. 1st Semester**	**Contact hours per week: (3Hrs)** Exam: (3 Hrs)			
Pre-requisite of course	**Electrical Machines**	**Evaluation**			
		CIE: 40	**SEE: 60**		

Course Objectives:

1. To introduce the concept of energy management and energy audit system.
2. To introduce the concept and Economics of Power factor improvements.
3. To study the concept of Energy efficient machines Energy efficient and Economics of Energy power generation.
4. To study the concept of economics of electrical energy distribution and electrical drives.

Course Outcomes: On completion of the course, student would be able to:

CO1	To Familiarize withthe concept of the concept of energy management and energy audit system
CO2	To understand the concept of Energy efficient machines and Economics of Power factor improvements.
CO3	To Familiarize with the concept of Energy efficient machines and Economics of Energy power generation.
CO4	To understand the concept of economics of electrical energy distribution and electrical drives.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	INTRODUCTION: Need for energy efficient machines, energy cost and two part tariff, energy conservation in industries and farms -a necessity, introduction to energy management and energy audit system. Review of induction motor characteristics.	**7**	**CO1**
2	POWER FACTOR: The power factor in sinusoidal systems, power factor improvement, power factor with nonlinear loads, Harmonics and the power factor.	**7**	**CO2**
3	ENERGY EFFICIENT MOTORS: Standard motor efficiency, why more efficient motors? An energy efficient motor, efficiency determination methods, Direct Measurement method, Loss segregation method, Comparison, motor efficiency labelling, energy efficient motor standards. Motor life cycle.	**8**	**CO3**
4	INDUCTION MOTORS AND ADJUSTABLE DRIVE SYSTEMS: Energy Conservation, adjustable speed systems, Application of adjustable speed systems to fans, pumps and constant torque loads.	**8**	**CO4**

TEXT /REFERENCE BOOKS:

1. Andreas John C., Energy efficient electric motors, Marcel Dekker Inc. 1992.
2. Thuman Albert, Introduction to Efficient Electric System Design, The Fairmount Press Prentice Hall.
3. Tripathi S.C. , Electric Energy Utilization and Conservation, Tata McGraw-Hill 1991.

4. Belove Charles, Handbook of Modem Electronics and Electrical Engineering, John Wiley & Sons.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PC-103	**Course Name: BIO-MEDICAL INSTRUMENTATION**	**L**	**T**	**P**	**C**
		3	**-**	**-**	**3**
Year and Semester	**1st Yr. 1stSemester**	**Contact hours per week: (3Hrs)** Exam: (3 Hrs)			
Pre-requisite of course	Physics, Basic Electrical Engineering.	**Evaluation**			
		CIE: 40	**SEE: 60**		

Course Objectives:	
1. To introduce the concept of Bio Instrumentation like Medical Bio Potential Electrodes and Biomedical Recorders.	
2. To study cardiac and Respiratory measurements system	
3. To study Instrumentation for Measuring Nervous Function.	
4. To study Recent Trends in Biomedical Engineering.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	To Familiarize with Bio Medical Instrumentation.
CO2	To understand cardiac and Respiratory measurements system.
CO3	To understand Instrumentation for Measuring Nervous Function.
CO4	To understand the Recent Biomedical devices instrumentation.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	Characteristics of Transducers and Electrodes for Biological Measurement: Introduction to human body; block diagram, classification, characteristics, various physiological events and suitable transducer for their recording, bioelectric potentials	**5**	**CO1**
2	Cardiac & System: Cardiac musculature, Electro cardiography, ECG recording, Phonocardiography, holter recoding ECG lead system, Heart rate meter, vector cardiography, Pacemakers, Defibrillators. Blood Pressure and Blood Flow Measurement: Invasive and non-invasive methods of Blood	**7**	**CO1, CO2**

	pressure, Characteristics of blood flow and heart sound, Cardiac output measurement, Plethysmography. Respiratatory System: Mechanics of breathing, Parameters of respiration, Respiratory system measurements, Respiratory therapy instruments		
3	Instrumentation for Measuring Nervous Function: EEG signal, frequency band classification, Lead systems, EEG recording, Clinical applications of EEG signal, X-ray CT scan, MRI, PET. Muscoskeletal systems: EMG, Clinical applications, and Muscles stimulator. Clinical Laboratory Instrumentation: Test on blood cell, Blood cell counter, Blood glucose monitors, auto analyzer, Pulse-oximeter.	**7**	**CO3**
4	Recent Trends in Biomedical Engg.: Patient care and monitoring, Non-invasive diagnostic instrumentation, Biotelemetry, Telemedicine, Prosthetic devices, Lie detector test, Application of lasers and ultrasonic in biomedical field. Troubleshooting & Electrical Safety of Biomedical Instruments: Physiological effect of current and safety measurement.	**7**	**CO4**

TEXT/REFERENCE BOOKS:

1. Medical instrumentation application & design, John G Webster, John wiley, 1998.
2. Review of medical physiology, W.F. Ganong, Medical publisher, 1977
3. Biomedical instrument and measurement, Cromwell, PHI, 2000
4. Handbook of biomedical instrument, R S Khandpur, TMH

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PC-105	**Course Name: ADVACED ELECTRIC DRIVE**	**L**	**T**	**P**	**C**
		3	**-**	**-**	**3**
Year and Semester	**1st Yr. 1stSemester**	**Contact hours per week:** (3Hrs) Exam: (3 Hrs)			
Pre-requisite of course	**Electrical Machines, Power Electronics**	**Evaluation**			
		CIE: 40	**SEE: 60**		
Course Objectives:					
1. To introduce the concept of types of Electric Drives.					

2. To introduce the DC Motor Drives.			
3. To introduce the AC Motor Drives.			
4. To study the Motor power rating.			
5. To implement Traction Drives.			
Course Outcomes: On completion of the course, student would be able to:			
CO1	To Familiarize with Dynamics and Control of Electric Drives.		
CO2	To understand efficient speed control techniques in DC Motor Drives.		
CO3	To understand efficient speed control techniques in AC Motor Drives.		
CO4	To understand the significance and selection of power rating.		
CO5	To familiarization of Load and choice of traction for suitable load.		
Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	Electric Drive: Concept, classification, parts and advantages of electrical dives. Types of Loads, Components of load toques, Fundamental torque equations, Equivalent value of drive parameters for loads with rotational and translational motion. Determination of moment of inertia, Steady state stability, Transient stability. Multiquadrant operation of drives. Load equalization.	**8**	**CO1**
2	Motor power rating: Thermal model of motor for heating and cooling, classes of motor duty, determination ofmotor rating for continuous, short time and intermittent duty, equivalent current, torque and power methods of determination of rating for fluctuating and intermittent loads. Effect of load inertia & environmental factors. Starting of Electric Drives: Effect of starting on Power supply, motor and load. Methods of stating of electric motors. Acceleration time Energy relation during stating, methods to reduce the Energy loss during starting. Braking of Electric Drives: Types of braking, braking of DC motor, Induction motor and Synchronous motor, Energy loss during braking.	**8**	**CO1, CO2,**
3	DC motor drives: Modeling of DC motors, State space modeling, block diagram & Transfer function, Single phase, three phases fully controlled and half controlled DC drives. Dual converter control of DC drives. Power factor, supply harmonics and ripple in motor current chopper controlled DC motor drives. Induction motor drives: Stator voltage variation by three phase controllers, Speed control using chopper resistance in the rotor circuit, slip power recovery scheme. Pulse width modulated inverter fed and current source inverter fed induction motor drive. Volts/Hertz Control, Vector or Field oriented control.	**8**	**CO2, CO3**
4	Synchronous motor drives: Variable frequency control, Self-Control, Voltage source inverter fed synchronous motor drive, Vector control. Introduction to Solar and Battery Powered Drive, Stepper motor, Switched Reluctance motor drive. Industrial application: Drive consideration for Textile mills, Steel rolling mills, Cement mills, Paper mills, Machine tools. Cranes & hoist drives.	**8**	**CO4, CO5**

TEXT/REFERENCE BOOKS:

1. Fundamental of Electrical Drives, G.K. Dubey, New Age International Publication.

2. Electric Drives, Vedam Subrahmanyam, TMH
3. A first course on Electrical Drives, S.K. Pillai, , New Age International Publication.
4. Electric motor drives, R. Krishnan, PHI
5. Modern Power Electronics & Ac drives, B.K. Bose, Pearson Education.
6. Electric Motor & Drives. Austin Hughes, Newnes.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PC-107	**Course Name: ADVANCE PROCESS CONTROL**	**L**	**T**	**P**	**C**
		3	**-**	**-**	**3**
Year and Semester	**1st Yr. 1st Semester**	**Contact hours per week: (3Hrs) Exam: (3 Hrs)**			
Pre-requisite of course	**Control System**	**Evaluation**			
		CIE: 40		**SEE: 60**	

Course Objectives:	
1. Study the techniques used for PID controller tuning	
2. Development and synthesis the feedback controllers for specified close loop response	
3. Concept and Study of FC and FO type control valve and their applications with examples, Gain of valve and concept of control valve sizing for liquid, Gas, vapour and steam. (Special reference to Masoneillian & Fisher Equation) and study control valve cavitation and flashing phenomenon	
4. Study and development of advance control techniques for process control and automation	
5. Development of control techniques for safe design of process control and automation	
6. Study and development of Predictive control, Statistical control, Adaptive and Inferential control system	
Course Outcomes: On completion of the course, student would be able to:	
CO1	Able to Analyze the effect of P, PI, PD and PID controllers on a control system and design suitable controller for a typical process
CO2	Able to understand FC and FO type control valve and Able to learn and analyze the various principles & concepts involved in valve sizing for liquid, Gas, vapor and steam and control valve cavitation and flashing phenomenon
CO3	Ability to understand analysis and development of advance control techniques for process control and automation

CO4	Ability to understand analysis and development of Predictive control, Statistical control, Adaptive and Inferential control system techniques for process control and automation

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	PID controller tuning procedures: Close loop oscillation based tuning, Ziegler-Nichol close-loop method. Tuning rules for first order + dead time processes: step testing quarter decay ratio response, Ziegler-Nichol open loop method, Cohen-Coon parameters. Synthesis of feedback controllers: Development of the controller synthesis formula, specifications of close loop response, direct synthesis for minimum and non-minimum phase processes, controller modes and tuning parameters derivative mode for dead time process. Dead Time Compensation (Algorithms for Smith Predictor), & effect of process modeling error.	**10**	**CO1**
2	Control Valve Design: Control valve flow characteristics, Valve & process characteristics, range availability of control valve, control valve sizing for gas, liquid, vapors and steam, Control valve cavitation and flashing, flow control cavitation index, vibration curve cavitation index, calculation of flash fraction, Control valve gain, sequencing of control valve . Valve application, selection, valve capacity testing.	**8**	**CO2**
3	Additional control techniques: Cascade control,. Selective control & Split range control, Cascade control for various processes , dynamic characteristics of Cascade control system and its tuning. Override and Auctioneering control system for various processes, Feedforward control system, Feedforward control of various processes. Design of Feedforward controllers, Feedforward –Feedback control & their relative advantages & disadvantages.	**10**	**CO3**
4	Ratio control system, Predictive control, Statistical control Adaptive and Inferential control system: Programmed Adaptive control, gain scheduling Adaptive control, Self tuning regulator (STR), MRAC, Multivariable Process Control.	**9**	**CO4**

TEXT BOOKS/REFERENCE BOOKS:

1. Principles and Practice of Automatic Process Control by Carlos A Smith, John wiley& sons
2. Computer Aided Process control by S.K. Singh PHI
3. Process Control Modeling, Design, and Simulation by B.WayaneBequette PHI
4. Chemical Process control by Stephanopolous PHI

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-RM-109	**Course Name: Research Methodology and IPR**	**L**	**T**	**P**	**C**
		2	**-**	**-**	**2**
Year and Semester	**1st Yr. 1stSemester**	**Contact hours per week: (2Hrs)** Exam: (3 Hrs)			
Pre-requisite of course	**Nil**	**Evaluation**			
		CIE: 20		**SEE: 30**	

Course Objectives	
1. To study the ideas of research methods.	
2. To study about statistical analysis and sampling.	
3. To study about regression and correlation analysis.	
4. To study about edition, tabulation and testing of hypotheses.	
Course Outcomes	
CO1	To formulate a route map for a particular problem or topic of research
CO2	How to test and validate the data through statistical techniques
CO3	To implement the suitable methods of sampling for individual problems
CO4	To compare and evaluate the results with others
CO5	To present the results with more informative details

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	Nature and objective of the research: Methods of Research: Historical, descriptive and experimental. Alternative approaches to the study of the research problem and problem formulation. Formulation of hypotheses: Feasibility, preparation and presentation of proposal.	**8**	**CO1, CO5**
2	Introduction to statistical analysis: Probability and probability distributions, binomial, Poisson, exponential and normal distributions, and their applications. Sampling: Primary and secondary data, their collection and validation, methods of sampling, stratified random sampling, and systematic sampling.	**8**	**CO2 CO3**
3	Regression and correlation analysis: Tests of significance based on normal, t and chi square distributions, analysis of variance. Basic Principles of design of experiments, completely randomized and randomized block designs.	**8**	**CO2 CO3 CO4**
4	Edition, tabulation, & testing of hypotheses, Interpolation of results, presentation, styles for figures, tables, text, quoting of reference and bibliography. Use of software for statistical analysis like SPSS, Mini tab or MAT lab, Report writing, preparation of thesis.	**8**	**CO4 CO5**

TEXT BOOKS/REFERENCE BOOKS:

1. Research Methodology by C.R Kothari, Vishwa Prakashan
2. Research Methodology by P.G . Tripathi
3. Research Methodology in Social Science by Sadhu Singh, Himalya Publishers
4. Business Research Methods, Donald cooper, Tata McGraw Hill
5. Statistical analysis for Engineers & Scientists, J. W. Barnes, McGraw Hill

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PRPC-101	**Course Name:** Process Control Lab		**L**	**T**	**P**	**C**
			0	**0**	**3**	**1.5**
Year and Semester	**1st Year** **1st Semester**	**Contact hours per week:** (3Hrs) Exam**:** (3hrs.)				
Pre-requisite of course	**Control Engineering Lab.**	**Evaluation**				
		CIE: 20	**SEE: 30**			

Course Objectives:
1. To Familiarization of PLC Ladder Programming Instructions Set
2. To compile and execute programs in Ladder Programming
3. To study the PC and PLC based control systems
4. To study and write PLC program for the multiple process control systems
5. To study and write PLC program for different strategies of control system such as feedback, feed forward, cascade, ratio control etc.
6. To write PLC programs to solve the different control problems

Course Outcomes: On completion of the course, student would be able to:	
CO1	Ability to understand PC and PLC based control system and their implementation
CO2	Ability to develop PLC Ladder Programming skill
CO3	Analyse and implement PLC Ladder Programming for different type of process control system.
CO4	Ability to design and develop PLC program for different strategies of control system such as feedback, feed forward, cascade, ratio control for control of process variables

Expt. No	**COURSE SYLLABUS CONTENTS OF MODULE**	**COs**
1	Familiarization of PLC Ladder Programming Instructions Set	**CO1,**

2	**To Study** PC Based Traffic Light Control :- • Basic Traffic Light Sequence	**CO2, CO3, CO4**
3	PLC Based Traffic Light Control: • PLC Connection Details • Dual Traffic Light Sequence • Traffic Counting • Green Time Alteration According to Traffic Flow • The Pedestrian Crossing • Complete System Control	
4	To Study Process Control – Ratio, feedback control flow & level	
5	To Study Rotary Transfer Unit :- • Movement of Rotary Table • Initialization • Station Counting • Dispensing • A Production Line System • Follow a Set Routine	
6	To Study Industrial Control Trainer	
7	To Study Multi-process Control Trainer : Feedback, feedforward cascade and ration Control system for flow , temperature and level control	
8	To study of Pressure Control Unit :-Proportional Control : Run a loop experiments using 'proportional only control' with the following sets of SP and PG values. Record the eventual 'steady state' rate values in the table below, once the initial oscillations have decayed. • Proportional and Integral Control	
9	To design, Level Control PC :- • Proportional Control • Proportional and Integral Control	
10	To Study .Flow control PC & PLC :- • Proportional Control • Proportional and Integral Control • Saturation and Integral Windup • Three Term or PID Control • Zeigler / Nichols Tuning	
11	To Study The System Rig :- • Proportional Control • Proportional and Integral Control • Saturation and Integral Windup • Three Term or PID Control • Ziegler / Nichols Tuning • Temperature Control • Batch Volume Control • Fluid Level Control	

	• Open Loop Control • Bode Plots • Flow Loop Model using Caldwell's Method • Flo Loop Model using Sundaresan's Method • Design of Controller for PCU Flow Loop • PRT Signal Conditioning • Flowmeter Signal Conditioning	
12	Process Control Experiment :- • Proportional Control • Proportional and Integral Control • Saturation and Integral Windup • Three Term or PID Control • Ziegler / Nichols Tuning • Temperature Control • Batch Volume Control • Fluid Level Control • Open Loop Control • Bode Plots	

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-102	**Course Name: Program Elective-II Renewable & Non-Conventional Energy (i)**	**L**	**T**	**P**	**C**
		3	**0**	**-**	**3**
Year and Semester	**1st year** **2nd Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)			
Pre-requisite of course	**Basic Electrical Engineering and Engineering Science**	**Evaluation**			
		CIE: 40	**SEE: 60**		

Course Objectives:	
1. To familiarize the energy scenario and the consequent growth of the power generation from renewable energy and non-conventional energy sources.	
2. To study the basic engineering science of renewable and non-conventional energies sources.	
3. To study the wind and solar energy conversion systems for electrical system.	
4. To study the energy conversion techniques for nonconventional sources and applications.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	Understand the energy scenario and the consequent growth of the power generation from renewable energy and non-conventional energy sources.
CO2	Understand the basic engineering science of renewable and non-conventional energies sources.
CO3	Understand the wind and solar energy conversion systems for electrical power system.
CO4	To understand the energy conversion techniques for nonconventional sources and applications.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**

1	**Introduction to Energy sources:** Renewable and non-renewable energy sources, energy consumption as a measure of Nation's development; strategy for meeting the future energy requirements Global and National scenarios, Prospects of renewable energy sources. Impact of renewable energy generation on environment, Kyoto Protocol.	**7**	**CO1**
2	**Solar Energy:** Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solar radiation, local solar time, derived solar angles, sunrise, sunset and day length. flat plate collectors, concentrating collectors, Solar air heaters-types, solar driers, storage of solar energy-thermal storage, solar pond , solar water heaters, solar distillation, solar still, solar cooker, solar heating & cooling of buildings, photo voltaic - solar cells, different types of PV Cells, Mono-poly Crystalline and amorphous Silicon solar cells. Design of PV array. Efficiency and cost of PV systems & its applications. PV hybrid systems.	**8**	**CO2, CO3**
3	**Wind Energy:** Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations.	**7**	**CO2, CO3**
4	**Energy from Biomass:** Biomass conversion technologies, Biogas generation plants, classification, advantages and disadvantages, constructional details, site selection, digester design consideration, filling a digester for starting, maintaining biogas production, Fuel properties of bio gas, utilization of biogas. **Hydrogen Energy and Fuel cell:** Introduction, Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles. Introduction, Design principle and operation of fuel cell, Types of fuel cells, conversion efficiency of fuel cell, and application of fuel cells.	**9**	**CO2, CO4**

Reference Books:

1. G.D. Rai, "Non-conventional Energy sources", Khanna Publishers.
2. Bansal Keemann and Meliss, "Renewable energy sources and conversion technology", Tata Mc-Graw Hill.
3. Ashok V. Desai, "Non conventional Energy", New Age International Publishers Ltd.
4. D.P. Kothari, "Renewable energy resources and emerging technologies", Prentice Hall of India Pvt. Ltd.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-102	**Course Name: Program Elective-II THEORY AND DESIGN OF NEURO – FUZZY CONTROLLERS (ii)**	**L**	**T**	**P**	**C**
		3	**0**	**-**	**3**
Year and Semester	**1st Year 2nd Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)			
Pre-requisite of course	**Basic Engineering Mathematics**	**Evaluation**			
		CIE: 40	**SEE: 60**		

Course Objectives:
1. To study and acquire the basic knowledge of neural network and fuzzy logic.
2. To study the basic architecture and modeling of neural network control and Fuzzy logic control.
3. To study various types of fuzzy logic and neural network controllers.
4. To identify, formulate and solve the neuro fuzzy logic based problems.

Course Outcomes: On completion of the course, student would be able to:	
CO1	To understand basic concept and working of neural network and fuzzy logic system.
CO2	To understand the basic architecture and modeling of neural network control and Fuzzy logic control.
CO3	Able to neural network and fuzzy logic techniques in different field, which involve perception, reasoning and learning.
CO4	Analyze and design a real world problem for implementation and understand the dynamic behavior of a system.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	**NEURAL NETWORK THEORY:** Introduction, Biological neurons and their artificial models, Learning, adaptation and neural networks learning rules types of neural networks, Single layer, multiplayer, Feed forward, feedback networks; back propagation, Learning and training, Hop field network.	**8**	**CO1, CO2**
2	**NEURAL NETWORKS BASED CONTROL:** Neural network for non-linear systems, Schemes of neuro control, System identification forward model and inverse model, Indirect learning neural network control applications, Case studies.	**8**	**CO2, CO3, CO4**
3	**FUZZY LOGIC THEORY :** Fuzzy sets ,Fuzzy operation , Fuzzy arithmetic, Fuzzy relations ,Fuzzy relational equations, Fuzzy measure, Fuzzy functions , Approximate reasoning ,Fuzzy propositions ,Fuzzy quantifiers , If–then rules.	**8**	**CO1**

4	**FUZZY LOGICBASED CONTROL:** Structure of fuzzy logic controller, Fuzzification models, Database, Rule base Inference engine, defuzzification, Module ,Non-linear fuzzy control, PID like FLC, Sliding mode FLC, Sugeno FLC, Adaptive fuzzy control , Fuzzy control applications case studies.	**8**	**CO2, CO3, CO4**

REFERENCE BOOKS

1. Jacek. M. Zurada, "Introduction to Artificial Neural Systems", Jaico Publishing House, 1999.
2. Kosko, B. "Neural Networks and Fuzzy Systems", Prentice Hall of India Pvt. Ltd., 1994.
3. Klir G.J. & Folger T.A. "Fuzzy sets, uncertainty and information", Prentice Hall of India Pvt. Ltd., 1993.
4. Zimmerman H.J., "Fuzzy set theory and its application" Kluwer Academic Publishers, 1994. 5. Driankov, Hellendroon, "Introduction to Fuzzy Control", Narosa Publishers.
5. FarinWah S.S., Filev, D. Langari, R. "Fuzzy control synthesis and analysis", John Wiley and Sons, 2000.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-102	**Course Name: Program Elective-II DIGITAL CONTROL SYSTEM (iii)**	**L**	**T**	**P**	**C**
		3	**-**	**-**	**3**
Year and Semester	**1st Yr. 2nd Semester**	**Contact hours per week: (3Hrs)** Exam: (3 Hrs)			
Pre-requisite of course	**Control System**	**Evaluation**			
		CIE: 40		**SEE: 60**	

Course Objectives:

1. Study the digital control system details: Signal flow graph, Time domain analysis, correlation between time response & root location in S & Z transform and stability in Z-plane
2. Study the digital control system design by various methods in Z-plane
3. Study of techniques for analysis of nonlinear system, concept of local, global, asymptotic and total stability of nonlinear system, Liapunov's stability criterion.
4. Study of Tuning procedure for PID controllers and Design considerations for Robust control.
5. Study the concept, analysis and design of Adaptive and Learning system.

Course Outcomes: On completion of the course, student would be able to:

CO1	Ability to understand the concept, analyze the Digital control system and their stability
CO2	Ability to understand the digital control system design by various methods in Z-plane
CO3	Ability to understand the techniques for analysis of nonlinear system and their stability criterion
CO4	Ability to understand and skill of the Tuning procedure for PID controllers and Designing of Robust control.
CO5	Ability to understand the concept, analysis and design of Adaptive and Learning system

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	DIGITAL CONTROL: Introduction to digital control, sampling, Data reconstruction principles, Pulse transfer functions, Block diagram & signal flow graph, Digital Control Techniques-PID, Deadbeat. Time domain analysis, correlation between time response & root location in S & Z transform, effect of pole-zero configuration in Z-plane on maximum overshoot & peak time transient response, Stability in Z-plane using modified Rouths criteria, Jury's criteria.	**10**	**CO1**
2	Digital control system design : Design by Emulation, Direct design by root locus in z-plane, Frequency response method, Direct design method by Ragazzini. NON LINEAR CONTROL SYSTEM: Introduction to nonlinear feedback control system, special features of linear system; limit cycle, jump response, sub harmonics etc., describing function and phase plane techniques for analysis of nonlinear system, concept of local, global, asymptotic and total stability of nonlinear system, Liapunov's stability criterion.	**11**	**CO2 CO3**
3	PID CONTROL AND ROBUST CONTROL: Tuning procedure for PID controllers, modification of PID control schemes, two degrees of freedom control. Design considerations for Robust control.	**8**	**CO4**
4	ADAPTIVE AND LEARNING CONTROL SYSTEMS: Basic Principles of Adaptive and Learning Control Systems, Model Reference Adaptive Control, Types of Learning-Supervised and Unsupervised Learning Control Systems, On-line and Off-line Learning Control Systems.	**8**	**CO5**

TEXT BOOKS/ REFERENCE BOOKS:

1. Digital control system By B. C. Kuo (PHI)
2. Modern control engineering By Ogata (PHI)
3. Control System Engineering By Nagrath& Gopal (Wiley Eastern)
4. Control System Engineering By Phillips and Nagle (PHI Publications)
5. Control System Engineering by Norman S Nise, Wile
6. Modern Control System by R C Dorf, R H Bishop, Addision Wesley
7. Systems, Modeling & Analysis by I J Nagrath, M Gopal, TMH
8. Digital Control & State Variable Methods by M Gopal, TMH

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-102	**Course Name: Program Elective-II HVDC TRANSMISSION SYSTEM (iv)**	**L**	**T**	**P**	**C**
		3	**0**	**-**	**3**
Year and Semester	**1st year 2nd Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)			
Pre-requisite of course	**Power Electronics and Power System Engineering**	**Evaluation**			
		CIE: 40	**SEE: 60**		

Course Objectives:	
1. To study the basic concept, working theory and constructional detail of Direct Current (DC) power transmission line.	
2. To study the power converter interface and analysis in HVDC transmission line.	
3. To study the power converter controller in HVDC transmission line	
4. To study the effect of reactor and protection of DC line.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	To understand the basic concept, working theory and constructional detail of Direct Current (DC) power transmission line.
CO2	To impart technical knowledge of power converter interface and analysis in HVDC transmission line.
CO3	To apprise with power converter control system in HVDC transmission line
CO4	To understand the effect of reactor and protection of DC line.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	**Direct Current (DC) power transmission technology:** Introduction, comparison of Alternating Current (AC) and Direct Current (DC) transmission, application of DC transmission, application of DC transmission, description of DC transmission system, Configurations, planning for High Voltage Direct Current (HVDC) transmission, modern trends in DC transmission. Introduction to Device: Thyristor valve, valve tests, recent trends.	**6**	**CO1**
2	**Analysis of High Voltage Direct Current (HVDC) converters:** Pulse number, choice of converter configuration, simplified analysis of Graetz	**8**	**CO1, CO2**

	circuit, converter bridge characteristics, and characteristics of a twelve-pulse converter, detailed analysis of converters with and without overlap.		
3	**Converter and HVDC system control:** General, principles of DC link control, converter control characteristics, system control hierarchy, firing angle control, current and extinction angle control, starting and stopping of DC link, power control, higher level controllers, telecommunication requirements. **Converter faults and protection:** Introduction, converter faults, protection against over-currents, over-voltages in a converter station, surge arresters, protection against over-voltages.	**8**	**CO2, CO3**
4	**Smoothing reactor and DC line:** Introduction, smoothing reactors, DC line, transient over voltages in DC line, protection of DC line, DC breakers, Mono-polar operation, effects of proximity of AC and DC transmission lines.	**6**	**CO4**

RECOMMENDED BOOKS:

1. E.W. Kimbark, "High Voltage DC Transmission", Wiley-Interscience.
2. V. Kamaraju and M.S. Naidu, "High Voltage Engineering", Tata McGraw-Hill Education.
3. R.S.Jha,"High Voltage Engineering", Dhanpat Rai sons.
4. E. Kuffel and M. Abdullah, "High Voltage Engineering", Pergamon Press.
5. C. L. Wadhwa, "High Voltage Engineering", New Age Publications.
6. K.R. Padiyar, "HVDC Power Transmission Systems: Technology and System Interactions", New Age International Publications.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-102	**Course Name: Program Elective-II ENERGY MANAGEMENT (v)**	**L**	**T**	**P**	**C**
		3	**-**	**-**	**3**
Year and Semester	**1st Yr. 2ndSemester**	**Contact hours per week: (3Hrs)** Exam: (3 Hrs)			
Pre-requisite of course	**Electrical Machine, Electrical Measurements and Instruments**	**Evaluation**			
		CIE: 40	**SEE: 60**		
Course Objectives:					
1. To introduce the various energy systems.					
2. To study the basics theory, and operation of renewable system.					
3. To study the concept ofenergy conservation and management.					

4. To study various techniques for energy conservationand its management.			
Course Outcomes: On completion of the course, student would be able to:			
CO1	To familiarize with the various energy systems.		
CO2	To understand the basics theory, operation renewable system.		
CO3	To impart basic technical knowledge theenergy conservation system and management.		
CO4	To learn the role of various techniques used for energy conservationsystem and its management.		
Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	INTRODUCTION: Various Sources of Energy, Conventional and non-Conventional energy, Concept and Classification of Renewable energy, Concept of Energy Conservation and Energy Management, Present Energy Scenario in India (Conventional and non- Conventional energy).	**7**	**CO1**
2	RENEWABLE ENERGY SOURCES: Potential and Utilization status of Renewable Energy in India, Solar Energy: Solar Water Heater Systems, Solar Air dryer Systems, Solar Photo-voltaic Systems, Solar Cookers and Solar ponds, Wind Energy: Selection Criteria for Wind farms, Wind Mills, Bio Gas Plants-Construction and Operation, Bio Mass Gasification, Bio Mass Briquetting; Mini and Micro Hydel Power Plants, Geo-Thermal Energy, Ocean Energy.	**8**	**CO2**
3	ENERGY CONSERVATION AND MANAGEMENT: Actual energy requirement assessment techniques of any industry and energy consumption status, possibility of reduction of energy consumption by using various energy conservation techniques or equipments e.g. variable speed drives, constant voltage transformers, electronic chokes, CFLs etc.	**7**	**CO3**
4	ENERGY CONSERVATION INSTRUMENTATION:Importance of instrumentation and control techniques in the energy conservation and management, SCADA systems, Instruments required to carry out energy audit exercise, optimal mixing of renewable energy sources and load rationalization for reducing load on conventional energy sources.	**7**	**CO4**

TEXT/REFERENCE BOOKS:

1. Hand Book of Industrial Energy Conservation by S David; Van Nostrand Reinhold Publishing Company.
2. Energy Technology by S Rao & B. B. Parulkar; Khanna Publishers
3. Solar Energy by S. P. Sukhatme; TMH publications
4. Solar Energy & Energy Conservation by Sawhney&Maheshwari; PHI publication.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-102	**Course Name: Program Elective-II PROCESS MODELLING AND CONTROL (vi)**	**L**	**T**	**P**	**C**
		3	**-**	**-**	**3**
Year and Semester	**1st Yr. 2nd Semester**	**Contact hours per week: (3 Hrs)** Exam: (3 Hrs)			
Pre-requisite of course	**Mathematics, Control System**	**Evaluation**			
		CIE: 40	**SEE: 60**		

Course Objectives:	
1. Study the Mathematical Modelling, Process dynamic of various type of processes.	
2. Simulation and Modelling of different process control system	
3. Study of various control system Models and Design of cross controllers and selection of loop using RGA.	
4. Study the concept, analysis and design of Adaptive and Learning system.	
5. Study the concept, analysis and design of Real time control system	
6. Study of Distributed computing systems, Software Process models	
Course Outcomes: On completion of the course, student would be able to:	
CO1	Ability to understand and to derive Modelling, Process dynamic of various type of processes.
CO2	Ability to understand the various control system Models and Design of cross controllers and selection of loop using RGA.
CO3	Ability to understand concept, analysis and design of Adaptive and Learning system.
CO4	Ability to understand concept, analysis and design of Real time control system
CO5	Ability to implement new and emerging technologies to analyze, design, maintain reliable, safe, and cost effective solution for industry problems.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	Simulation and Modelling: Importance of Simulation, Mathematical Modelling, Process dynamic of fluid flow and heat transfer system, Mass transfer dynamics and distillation column, Reaction kinetics of chemical processes. Process control aim and objectives classification of process control system, techniques for process control. Modelling and simulation for plant Automation-case studies.	**8**	**CO1**
2	Predictive control system: Model based control system (Internal mode control, Model Predictive control and Process Model based control), Plant wide Control, Inferential control, Multiple-loop (Multivariable) control system. Interaction and Decoupling of control loops. Design of cross controllers and selection of loop using RGA. Prosperities and application of RGA.	**10**	**CO2**
3	ADAPTIVE AND LEARNING CONTROL SYSTEM: Basic principles of Adaptive and learning systems, MRAC & STAC, Adaptive control	**10**	**CO3 CO5**

	techniques, Types of Learning- Supervised and Unsupervised Learning control system, On-line and Off-line Learning control system.		
4	Real time control system: Characteristics and classes of real time systems, program classification: Sequential, multitasking real time, concurrency and synchronization. Design strategies, Reability, fault detection, fault tolerance real time operating system, Distributed computing systems, Software Process models (Build and mix model, waterfall, rapid prototyping, Incremental and Spiral model) Design techniques and tools	**10**	**CO4 CO5**

TEXT BOOKS:

REFERENCE BOOKS:

1. Techniques of Process Modelling, Simulation and Control for Engineer by Astrom, Luyben, McGraw Hill.
2. Computer Controlled System by Astrom, K.J and B. Wittenmark PHI
3. Chemical Process Control by Stephanopolous PHI
4. Process Control Modeling ,Design and Simulation by B.WayaneBequette, PHI

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M.Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PC-104	**Course Name: Power Quality Monitoring and Conditioning**	**L**	**T**	**P**	**C**
		3	**-**	**-**	**3**
Year and Semester	**1st Year. 2nd Semester**	**Contact hours per week:** (3Hrs) Exam: (3 Hrs)			
Pre-requisite of course	**Power System, Electrical Machines**	**Evaluation**			
		CIE: 40	**SEE: 60**		
Course Objectives:					
1. To familiarize the students about different power quality issues to be resolved.					
2. To understand the convention codes /guidelines issues by bodies like IEEE, IEC etc related to voltage, frequency and harmonics.					
3. To mentor the students about methods of power quality assessment.					
4. To monitor the power quality in the power system.					
5. To model a system for power quality enhancement.					
Course Outcomes: On completion of the course, student would be able to:					

CO1	Have the knowledge of various power quality issues in power system.
CO2	Work with international standards/guidelines related to power quality issues.
CO3	Quantitative analysis of power quality in system.
CO4	Monitor the power quality through measurement of various system parameters.
CO5	Decide the compensators and filters to keep the power quality indices within the standards.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**Cos**
1	UNIT I - POWER QUALITY - AN OVERVIEW: Power Quality definition, PQ characterization: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation–Power acceptability curves: CBEMA, ITIC – Sources for Electric Power Quality problem in power system: poor load power factor, Nonlinear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards and Guidelines.	**6**	**CO1**
2	VOLTAGE VARIATIONS: Voltage Sags - Magnitude & duration-Types-Sources of sags - Estimation of Voltage sag performance: Transmission system and Utility distribution system, Effect of sag on AC Motor Drives, Single-Phase Domestic and Office Loads, Monitoring and mitigation of voltage sag. Origin of Long & Short interruption -influence on various equipment.	**7**	**CO2**
3	POWER QUALITY ANALYSIS: Measurements of Voltage, Current, Power, Energy, power factor- Time domain methods and Frequency domain methods: Laplace's, Fourier and Hartley transform – The Walsh Transform – Wavelet Transform. Harmonic Distortion, Voltage versus Current Distortion, Harmonics versus Transients, Harmonic Indexes, Harmonic Sources from Commercial Loads, Harmonic Sources from Industrial Loads.	**7**	**CO3**
4	POWER QUALITY MONITORING: Monitoring considerations: Power line disturbance analyser, power quality measurement equipment, harmonic / spectrum analyser, flicker meters, disturbance analyser. Analysis of power outages, Analysis of unbalance: Symmetrical components of phasor quantities, Instantaneous symmetrical components, Instantaneous real and reactive powers, Analysis of distortion: On–line extraction of fundamental sequence components from measured samples	**8**	**CO4**
5	POWER QUALITY ENHANCEMENT: Harmonic filters: passive, Active and hybrid filters – Custom power devices: Load compensation using DSTATCOM, Voltage regulation using DSTATCOM, protecting sensitive loads using DVR, UPQC –control strategies: P-Q theory, Synchronous detection method – Custom power park.	**8**	**CO5**

Text Books:

1. Understanding Power Quality Problems-Voltage sag & Interruptions, Math Bollen H.J., IEEE Press, 2000.
2. Power Quality Enhancement Using Custom Power Devices, Arindam Ghosh , G. Ledwick, Kluwer Academic Publishers, 2002.

3. Electrical Power Systems Roger.C.Dugan, Mark.F.McGranagham, Surya Santoso, H.WayneBeaty, Quality", McGraw Hill, 2003.
4. HVDC and FACTS Controllers: Applications of Static Converters in Power Systems, Vijay K Sood, Springer
5. Facts Controllers in Power Transmission and Distribution, K R Padiyar, Tunbridge Wells : Anshan, ©2009.

Reference Books:

1. Electric Power Quality, Heydt G.T., Stars in a Circle Publications, 1994(2nd edition).
2. Handbook of Power Quality, Angelo Baggini '– Wiley

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PC-106	**Course Name: PLC & DCS**	**L**	**T**	**P**	**C**
		3	**-**	**-**	**3**
Year and Semester	**1st Yr. 2nd Semester**	**Contact hours per week: (3 Hrs)** Exam: (3 Hrs)			
Pre-requisite of course	**Control System**	**Evaluation**			
		CIE: 40		**SEE: 60**	
Course Objectives:					
1. Study the concept of Direct Digital Control					
2. Study and development of position and velocity control algorithm and their applications in 3. different control schemes					
4. Study the characteristic function of PLC, its Architecture and various PLC programming languages and Demonstrate various PLC programming skill for industrial applications.					
5. Detail study and applications of Distributed process control system and Understanding of various automotive standards and Protocols used in PLC network and DCS					
6. Study DCS supervisory control techniques & considerations(Algorithms), Concept of field buses and their applications					
7. Detail study and applications of Supervisory control and Data Acquisition system(SCADA)					
Course Outcomes: On completion of the course, student would be able to:					
CO1	Ability to understand the concept of Direct digital control and able to development position and velocity control algorithm and their applications in different control schemes				

CO2	Able to learn the various PLC programming languages and Demonstrate various PLC programming skill for industrial applications.
CO3	Able to learn and analyze the various principles & concepts of Distributed process control system and Understanding of various automotive standards and Protocols used in PLC network and DCS
CO4	Acquire the knowledge of DCS supervisory control techniques, the concept of field buses and their Industrial applications.
CO5	To implement new and emerging technologies to analyze, design, maintain reliable, safe, and cost effective solution for industry problems.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	Direct Digital Control – Structure and Software: The position algorithm (simplifying PID control equation, deriving position algorithm); the velocity algorithm (velocity algorithm, deriving the velocity algorithm); Multi variable control (Cascade control using velocity algorithm, radio control using velocity algorithm).	**8**	**CO1**
2	Discrete State Process Control System: Development and analysis of ladder diagram, logic diagram from ladder diagram, Function description of PLC, Programming fundamentals , hardware and system sizing and selection, PLC peripherals, programming, PLC networking, PLC programmable languages, ladder diagrams language, Boolean mnemonics language, functional block language, PLCs.	**10**	**CO2 CO3**
3	Distributed Process Control System: Functional requirement of DPCS, DCS configurations/ architecture, data highway cables, field buses, protocols used in DCS, Software configuration: controller function configuration, multiplexer and party line system.	**10**	**CO3 CO4 CO5**
4	Supervisory control and Data Acquisition system (Functions of SCADA, channel scanning, conversion to engineering units, data processing, distributed SCADA system, Remote terminal unit). DCS supervisory computer and configurations: supervisory computer function, supervisory control techniques and consideration, Supervisory control algorithm, DCS system integration with PLC and computer. Fiber optic local area networks – map and top. Popular Distributed Control Systems: CP 80 system.	**9**	**CO3 CO4 CO5**

TEXT BOOKS/REFERENCE BOOKS:

1. Computer Aided Process control by S.K. Singh PHI
2. Computer Based Industrial Control by Krishna Kant PHI
3. Instrument Engineers Handbook- Process Control by Bela G. Liiptak
4. Microprocessor in Process control by C.D. Johnson
5. Principles and Practice of Automatic Process Control by Carlos& A Smith

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.

3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PC-108	**Course Name:** Embedded System Design	**L**	**T**	**P**	**C**
		3	**-**	**-**	**3**
Year and Semester	**1st Yr.** **2nd Semester**	**Contact hours per week:** (3 Hrs) Exam: (3 Hrs)			
Pre-requisite of course	Microprocessor and Microcontrollers	**Evaluation**			
		CIE: 40	**SEE: 60**		

Course Objectives:	
1. To provide an overview of Design Principles of Embedded System.	
2. To provide clear understanding about the role of firmware, operating systems in correlation with hardware systems.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	Expected to understand the selection procedure of Processors in the Embedded domain.
CO2	Design Procedure for Embedded Firmware.
CO3	Expected to visualize the role of Real time Operating Systems in Embedded Systems
CO4	Expected to evaluate the Correlation between task synchronization and latency issues

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	**Introduction to Embedded Systems**: Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems.	**7**	**CO1**
2	**Typical Embedded System:** Core of the Embedded System: General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS), Memory: ROM, RAM, Memory according to the type of Interface, Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators, Communication Interface: Onboard and External Communication Interfaces.	**8**	**CO1 CO2**
3	**Embedded Firmware**: Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer, Embedded Firmware Design Approaches and Development Languages.	**7**	**CO2 CO3**
4	**RTOS Based Embedded System Design:** Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling.	**6**	**CO3**
5	**Task Communication:** Shared Memory, Message Passing, Remote Procedure Call and Sockets, Task Synchronization: Task Communication/	**8**	**CO3 CO4**

	Synchronization Issues, Task Synchronization Techniques, Device Drivers, How to Choose an RTOS.		

TEXT BOOKS:

1. Introduction to Embedded Systems - Shibu K.V, Mc Graw Hill.

REFERENCE BOOKS:

1. Embedded Systems - Raj Kamal, TMH.
2. Embedded System Design - Frank Vahid, Tony Givargis, John Wiley.
3. Embedded Systems – Lyla, Pearson, 2013
4. An Embedded Software Primer - David E. Simon, Pearson Education.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PC-110	**Course Name: ADVACED POWER SYSTEM**	**L**	**T**	**P**	**C**
		3	**0**	**-**	**3**
Year and Semester	**1st year** **2nd Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)			
Pre-requisite of course	**Basics of Power System**	**Evaluation**			
		CIE: 40		**SEE: 60**	

Course Objectives:
1. To study basics PU theory and modelling of electrical networks.
2. To study working of theory of load flow parameters and its methods.
3. To study the transient phenomena and type of faults in power system.
4. To introduce the concept of transient stability theory and its method.

Course Outcomes: On completion of the course, student would be able to:	
CO1	To understand the basic concept of PU system for electrical circuits and its modellings.
CO2	To impart basic technical knowledge of load flow studies and its iteration solution methods.
CO3	To understand and analyze various types of faults for different electrical equipments.
CO4	To impart a technical knowledge of transient stability in electrical system and solution of its stability equations.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	**SYSTEM MODELLING:** System modelling of synchronous machines, transformers, loads etc, per unit system, single line diagram of electrical	**8**	**CO1**

	networks, single phase impedance diagrams. Formulation of impedance and admittance matrices for the electrical networks.		
2	**LOAD FLOW STUDIES:** Data for the load flow studies, Swing Bus, Formulation of simultaneous equations, Iterative solutions by the Gauss-Seidal method and Newton Raphson Method.	**8**	**CO2**
3	**FAULT ANALYSIS:** Transients on transmission line, short circuit of synchronous machine, selection of circuit breakers, Algorithm for short circuit studies, Symmetrical Component transformation, and construction of sequence networks of power systems. Symmetrical Analysis of Unsymmetrical Line-to-ground (LG), Line-to line (LL), double line to ground (LLG) faults using symmetrical components.	**8**	**CO3**
4	**POWER SYSTEM STABILITY:** Steady state stability, Dynamics of a synchronous machine, Power angle equations, Transient stability, equal area criterion, Numerical solution of swing equation , factors effecting transient stability.	**8**	**CO4**

REFRENCE BOOKS RECOMMENDED:

1. O.I.Elgerd, "Electric Energy Systems Theory",Tata McGraw Hill
2. I.J Nagrath, D.P. Kolthari, "Modern Power System Analysis", Tata McGraw Hill
3. W.D.Stevenson, "Elements of Power System Analysis", McGraw Hill
4. I.J. Nagrath and D.P, Kothari, "Power System Engineering", Tata McGraw Hill
5. J. Arrillaga and C.P. Arnold, "Computer Analysis of Power Systems", John Wiley & Sons
6. W. Stagg Glenn and H. Ei-Abiad Ahmed "Computer Methods in Power System Analysis", Tata McGraw Hill
7. G.L. Kusic, "Computer Aided Power System analysis", Prentice Hall, India

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PRPC -102	**Course Name: Advanced Power System Lab**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**
Year and Semester	**1st Year** **2nd Semester**	**Contact hours per week:** (3 Hrs) **Exam:** (3hrs.)			
	Basic of Power System	**Evaluation**			

Pre-requisite of course		CIE: 20	SEE:30
Course Objectives:			
1. To study the various parameters of power system like ABCD, Y-Bus, Z-Bus.			
2. To learn different methods for load flow analysis.			
3. To learn fault analysis methods			
4. To learn transient stability methods			
Course Outcomes: On completion of the course, student would be able to:			
CO1	To apprise with the various parameters of power system like ABCD, Y-Bus, Z-Bus.		
CO2	To develop a technical skill to analyze the load flow in power system		
CO3	To develop a technical skill to analyze the transient stability of electrical system.		
CO4	To analyze the performance of the transmission line system.		

Expt. No	COURSE SYLLABUS CONTENTS OF MODULE	COs
1	To compute ABCD parameters and Regulation of a 3-Φ transmission line model.	**CO1 CO2 CO3 CO4**
2	To study Formation of Admittance Matrices (Y-BUS).	
3	To study Formation of Impedance Matrices (Z-BUS).	
4	To study Load Flow Analysis using GAUSS SEIDAL Method.	
5	To study Load Flow Analysis using NEWTON-RAPHSON Method.	
6	To perform Short circuit analysis of 3-Φ synchronous machine.	
7	To study Power circle diagrams of a 3-Φ transmission line model.	
8	To perform Transient Stability Analysis for Single Machine connected to Infinite Bus by Point by Point method.	
9	To study Load – Frequency Dynamics of Single Area Power Systems.	
10	To study Load – Frequency Dynamics of Two Area Power Systems.	

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PRPC-104	Course Name: Embedded Systems Lab	L	T	P	C
		-	-	3	1.5
Year and Semester	**1st Yr.** **2nd Semester**	**Contact hours per week:** (3 Hrs) Exam: (3 Hrs)			
Pre-requisite of course	Microprocessor and Microcontrollers	**Evaluation**			
		CIE: 20	**SEE: 30**		
Course Objectives:					
1. To provide an overview of Design Principles of Embedded System.					
2. To provide clear understanding about the role of firmware, operating systems in correlation with hardware systems.					
Course Outcomes: On completion of the course, student would be able to:					
CO1	Expected to understand the selection procedure of Processors in the Embedded domain.				
CO2	Design Procedure for Embedded Firmware.				
CO3	Expected to visualize the role of Real time Operating Systems in Embedded Systems				
CO4	Expected to evaluate the Correlation between task synchronization and latency issues				

Expt. No	COURSE SYLLABUS CONTENTS OF MODULE	COs
1	**Functional Testing Of Devices:** Flashing the OS on to the device into a stable functional state by porting desktop environment with necessary packages.	**CO1** **CO2** **CO3** **CO4**
2	**Exporting Display On To Other Systems:** Making use of available laptop/desktop displays as a display for the device using SSH client & X11 display server.	
3	**GPIO Programming:** Programming of available GPIO pins of the corresponding device using native programming language. Interfacing of I/O devices like LED/Switch etc., and testing the functionality.	
4	**Interfacing Chronos eZ430:** Chronos device is a programmable texas instruments watch which can be used for multiple purposes like PPT control, Mouse operations etc., Exploit the features of the device by interfacing with devices.	
5	**ON/OFF Control Based On Light Intensity:** Using the light sensors, monitor the surrounding light intensity & automatically turn ON/OFF the high intensity LED's by taking some pre-defined threshold light intensity value.	
6	**Battery Voltage Range Indicator:** Monitor the voltage level of the battery and indicating the same using multiple LED's (for ex: for 3V battery and 3 LED's, turn on 3 LED's for 2-3V, 2 LED's for 1-2V, 1 led for 0.1-1V & turn off all for 0V)	
7	**Dice Game Simulation:** Instead of using the conventional dice, generate a random value similar to dice value and display the same using a 16X2 LCD. A possible extension could be to provide the user with option of selecting single or double dice game.	
8	**Displaying RSS News Feed On Display Interface:** Displaying the RSS news feed headlines on a LCD display connected to device. This can be adapted to other websites like twitter or other information websites. Python can be used to acquire data from the internet.	
9	**Porting Openwrt To the Device:** Attempt to use the device while connecting to a wifi network using a USB dongle and at the same time providing a wireless access point to the dongle.	
10	**Hosting a website on Board:** Building and hosting a simple website (static/dynamic) on the device and make it accessible online. There is a need to install server (eg: Apache) and thereby host the website.	
11	**Webcam Server:** Interfacing the regular usb webcam with the device and turn it into fully functional IP webcam & test the functionality.	
12	**FM Transmission:** Transforming the device into a regular fm transmitter capable of transmitting audio at desired frequency (generally 88-108 Mhz)	
	Note: Devices mentioned in the above lists include Arduino, Raspbery Pi, Beaglebone	
	Cycle 1: Programming in 8051	
1	Study of 8051 Evaluation Board Trainer kit and Keil IDE Software Tool.	
2	Serial Data Transmission	
3	Interface switches and LEDs	
4	Interface LCD	
5	Interface 4*4 matrix keyboard	
6	Interface stepper motor	
7	Interface 7 Segment Display using I2C	
8	ADC, DAC Interface	

	Cycle 2: Programming in PIC Processor	
9	Configure and Control General Purpose I/O Pins	
10	Interfacing LED & Switch Interface	
11	2*16 LCD Display	
12	Serial Communication	
13	I2C Interface & EEPROM Interface	
14	Buzzer Interface	
15	SD-MMC Card Interface	
Note: all the experiments are to be carried out independently by each student with different specifications. At least 12 experiments are to be carried out.		

Text Books:

1. Use the IDE tool effectively for developing and executing the programs using 8051.
2. Comprehend the usage of on-chip timers and serial communication of 8051 and their interrupts using programs
3. Interface devices like ADC, DAC, LCD, and Stepper Motor to 8051 and develop real time projects.
4. Use the keil software for the development of logic, proteus software for hardware simulation and flash magic for downloading the code on to the target system.
5. Develop the logic to interface devices like temp sensor, stepper motor, Buzzer to ARM microcontroller and analyse the working of GPIO, on-chip peripherals of ARM

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PC-201	**Course Name:** Smart & Micro Sensor Design	**L**	**T**	**P**	**C**
		3	**-**	**-**	**3**
Year and Semester	**2nd Yr.** **3rd Semester**	**Contact hours per week:** (3 Hrs) Exam: (3 Hrs)			
Pre-requisite of course	**VLSI Design**	**Evaluation**			
		CIE: 40		**SEE: 60**	
Course Objectives:					
3. It aims to equip the students with MEMS fabrication					
4. To provide adequate knowledge about tools at an intermediate to advanced level.					
5. To provide exposure to students towards advanced level of sensors					
Course Outcomes: On completion of the course, student would be able to:					
CO1	Understand of MEMS fabrication				
CO2	Apply various fabrication procedures				
CO3	Analyze the design of sensors				
CO4	Design and develop smart and intelligent systems				

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	MEMS: Introduction, principle of MEMS, Example of Mems, small and large scaling, fabrication technology, micromachining: photolithography, thin film deposition and doping, wet chemical etching, waferbonding, plasma etching, surface micromachining.	**8**	**CO1, CO2**

2	Mechanics of Membrane and beams: dynamics, string, beams, diaphragms and membrane Transduction of Deformation: Metal strain gauges, Semiconductor Strain Gauges, Capacitive Transducers, Force and Pressure sensors: Force Sensors, Pressure sensors, Thermocouples Semi conducting Thermo resistors, Fiber Optical sensors, concept of smart and intelligent sensor, bio sensors.	**8**	**CO3, CO4**
3	Acceleration Sensors: introduction, Bulk Michromachined Accelerometers, surface Michromachined accelerometers, force feedback, angular rate sensors, Flow Sensors: The laminar boundary layer, Heat Transport in the limit of very small Reynolds Numbers, Thermal Flow Sensors, Skin Friction Sensors, Dry fluid Flow Sensors, wet fluid flow sensors, Resonant Sensors: Basic principle and physics.	**8**	**CO3**
4	Definition of intelligence and of intelligent instrumentation system: Features characterizing intelligence and Features intelligent instrumentation, component of intelligent instrumentation. Design of intelligent instrumentation systems. Smart and Intelligent transmitters, smart features standard for smart sensing, setting standards for smart sensors and system, IEEE 1451.1, IEEE 1451.2, STIM, IEEE P1451.3, IEEEP 1451.4, Field buses systems.	**8**	**CO4**

Text Books:

1. E.O. Doeblin Measurement System Application and Design, McGraw Hill
2. Beeweth and Buck- Mechanical Measurement, Nares Puti
3. Nortan- Hand Book of transducers, PHI
4. Conside-Process and industrial instrumentation, McGraw Hill
5. Mechanical Microsensors, M.Elwenspoek, R. Wiegerink, Springer

Note for Examiner(s): Question paper will comprise three sections,

4. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.

5. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.

6. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

3. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.

4. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code:	**Course Name: Program Elective-III**	**L**	**T**	**P**	**C**
EI-PE-203	**DIGITAL SIGNAL PROCESSING (i)**	**3**	**0**	**-**	**3**

Year and Semester	**2nd year** **3rd Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)	
Pre-requisite of course	**Basic Engineering Mathematics**	**Evaluation**	
		CIE: 40	**SEE: 60**

Course Objectives:

1. To study the discrete linear Time Invariant systems in Z domain and in frequency domain.
2. To study the basic of Discrete-Fourier Transform (DFT), Fast Fourier Transform (FFT) algorithms and its application.
3. To study different structure realization of Finite Impulse Response systems and Finite Impulse Response systems.
4. To study the digital filters for filtering applications.
5. To study the Multi-rate digital Signal Processing techniques and its applications

Course Outcomes: On completion of the course, student would be able to:

CO1	To analyze the Discrete linear Time Invariant systems in Z domain and in frequency domain.
CO2	To understand the different structure realization of Finite Impulse Response systems and Finite Impulse Response systems.
CO3	To learn the basic of Discrete-Fourier Transform (DFT), Fast Fourier Transform (FFT) algorithms and its applications.
CO4	To Design digital filters for filtering applications.
CO5	To apprise with Multi-rate Signal Processing techniques.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	**Introduction of Discrete Time Signals and Systems:** Discrete time systems, Analysis of discrete time linear time-invariant systems, Discrete time systems described by difference equations, Implementation of discrete system, Correlation of discrete time signals, Z-transform and properties of Z-transform, Rational Z-transformation, Inverse Z-transform, Analysis of linear time invariant systems in Z-domain. **Frequency Analysis of Signals and Systems:** Frequency analysis of continuous time signals, Frequency analysis of discrete time signals, Properties of Fourier Transform for discrete time signals, Frequency domain characteristics of linear time invariant systems, linear invariant systems as frequency selective filters.	**8**	**CO1**
2	**The Discrete Fourier Transform:** Frequency domain sampling, Properties of Discrete Fourier Transform (DFT), discrete Frequency analysis of signals using the DFT.FFT algorithm : Decimation-in-time (DIT) algorithm and Decimation-in-frequency(DIF) algorithm, Linear filtering methods based on DFT. **Realization of digital systems**: Structure realizations methods of FIR and IIR system.	**8**	**CO2, CO3**
3	**Design of Digital Filters:** Generalized characteristics of discrete filters, Design of Finite Impulse Response (FIR) filters, FIR digital filter design using Fourier series method, window design techniques. Optimal equi-ripple design techniques, frequency sampling design techniques. Design of Infinite Impulse Response (IIR) filters from analog filters, Comparison of IIR and FIR filters.	**8**	**CO4**

4	**Multirate Digital Signal Processing:** Introduction, decimation by a factor D, Interpolation by a factor I, sampling rate conversion by a rational factor I/D, implementation of sampling rate conversion, multistage implementation of sampling rate conversion, sampling rate conversion of Band pass signals, sampling rate conversion by an arbitrary factor, applications of multi rate signal processing.	**8**	**CO5**

Suggested Text / Reference Books:

1. John G. Proakisand Dimitris G. Manolakis,"Digital Signal Processing", PHI Pub.
2. Allan Y. Oppenhein& Ronald W. Schater , "Digital Signal Processing", PHI, 2004.
3. J. R. Jhohnson, "Intorduction to Digital Signal Processing", PHI, 2000.
4. B. Somanthan Nair, "Digital Signal Processing: Theory, Analysis & Digital Filter Design", PHI, 2004
5. Sanjit K. Mitra, "DSP a Computer based approach", TMH, 2nd Ed., 2001.
6. S. Salivahanan, C. Gnanapriya, "Digital Signal Processing", McGraw Hill.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-203	**Course Name: Program Elective-III Reliability Engineering (iii)**	**L**	**T**	**P**	**C**
		3	**0**	**-**	**3**
Year and Semester	**2nd Year 3rd Semester**	**Contact hours per week: (3 Hrs) Exam: (3 hrs.)**			
Pre-requisite of course	**Basic Engineering Mathematics**	**Evaluation**			
		CIE: 40	**SEE: 60**		

Course Objectives:	
1. To study the basic concept of reliability, maintainability and availability engineering.	
2. To study the evaluation techniques of engineering models and reliability improvement methods.	
3. To study the concept of fault tree analysis and optimization techniques.	
4. To study evaluation model for reliability, maintainability, availability testing.	
5. To study the applications of fuzzy theory and neural networks to reliability engineering,	
Course Outcomes: On completion of the course, student would be able to:	
CO1	To understand the basic concept of reliability, maintainability and availability engineering.

CO2	To understand the evaluation techniques of engineering models and reliability improvement methods.
CO3	To learn the fault tree analysis and optimization techniques.
CO4	Ability to do testing and evaluate the reliability, maintainability, availability of engineering models.
CO5	To study the applications of fuzzy theory and neural networks to reliability engineering,

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	Review of basic concepts in reliability engineering, reliability function, different reliability models etc., and reliability evaluation techniques for complex system: Non path set and cutest approaches, path set and cut set approaches, different reliability measures and performance indices, modeling and reliability evaluation of system subjected to common cause failures.	7	CO1
2	Reliability improvement, Reliability allocation/apportionment and redundancy optimization techniques, Fault tree analysis.	7	CO2, CO3
3	Maintainability Analysis: measure of system performance, types of maintenance, reliability centered maintenance, reliability and availability evaluation of engineering systems using Markov models. Reliability testing,Design for reliability and maintainability.	7	CO1, CO4
4	Applications of fuzzy theory and neural networks to reliability engineering,Typical reliability case studies.	7	CO5

Suggested Text / Reference Books:

1. M.L Shooman, "Probabilistic reliability- an engineering approach" RE Krieger Pub, 1990.
2. K.K Aggarwal, "Reliability Engineering" Springer Pub, 1993.
3. E. Balaguruswamy, "Reliability Engineering" McGraw hill, 2002.
4. R. Ramakumar, "Engineering Reliability" Prentice, NJ, 1993.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code:	**Course Name: Program Elective-III**,	**L**	**T**	**P**	**C**
EI-PE-203	Electrical Vehicle Engineering (iv)	**3**	**0**	**-**	**3**
Year and Semester	**2nd Year** **3rd Semester**	**Contact hours per week:** (3Hrs) **Exam:** (3hrs.)			

Pre-requisite of course	Electrical Machines, Power Electronics, Basic Science Engineering	Evaluation	
		CIE: 40	SEE: 60

Course Objectives:

1. To introduce the upcoming technology of electric and hybrid system
2. To study the basics theory, operation and modeling of electric Hybrid system.
3. To study different topologies of electric Hybrid system
4. To study electric propulsion system in electric hybrid system

Course Outcomes: On completion of the course, student would be able to:

CO1	To familiarize with upcoming technology of electric and hybrid system
CO2	To understand the basics theory, operation and modeling of electric Hybrid system.
CO3	To understand and analyze different drive train topologies electric of Hybrid system.
CO4	To learn the role of electric propulsion system in electric hybrid system andits application.
CO5	To impart basic technical knowledge of electric hybrid vehicle system and apply it to technological fields.

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	**Introduction:** Introduction to hybrid electric vehicles: history of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Conventional vehicles: basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance.	7	CO1, CO2
2	**Hybrid Electric Drive:** Hybrid electric drive-trains: basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.	7	CO3
3	**Electric Propulsion Unit:** Introduction to electric components used in hybrid and electric vehicles, configuration and control of DC motor drives, configuration and control of induction motor drives, configuration and control of permanent magnet motor drives, configuration and control of switch reluctance motor drives, drive system efficiency.	7	CO4
4	**Case Studies:** Design of a hybrid electric vehicle (HEV), design of a battery electric vehicle (BEV).	5	CO5

Suggested Text / Reference Books:

1. Iqbal Hussein, "*Electric and Hybrid Vehicles, Design Fundamentals"*, CRC Press, 2003.
2. MehrdadEhsani, YimiGao, E Sebastian Gay, Ali Emadi, "*Modern Electric, Hybrid Electric and Fuel Cell VehiclesFundamentals", Theory and Design*, CRC Press, 2004.
3. James Larminie, John Lowry, "*Electric Vehicle Technology Explained"*, Wiley, 2003.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-203	**Course Name:** Program Elective III System Theory (v)	**L**	**T**	**P**	**C**
		3	**-**	**-**	**3**
Year and Semester	**2nd Yr.** **3rd Semester**	**Contact hours per week:** (3 Hrs) Exam: (3 Hrs)			
Pre-requisite of course	**Control Systems**	**Evaluation**			
		CIE: 40	**SEE: 60**		

Course Objectives:	
1. It aims to equip the students with advanced concepts of control	
2. To provide adequate knowledge about tools at an intermediate to advanced level.	
3. To provide students to serve them well towards tackling more advanced level of control systems problems.	
4. To provide knowledge about different aspects like stability, controllability and observability.	
Course Outcomes: On completion of the course, student would be able to:	
CO1	Develop various models of control systems
CO2	Evaluate controllability of the systems
CO3	Evaluate observabilty of the systems
CO4	Evaluate stability of the systems
CO5	Develop state models of the systems

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	Controllability & Observability: Introduction, general concept of controllability, general concept of observability, controllability tests for continuous time systems, observability tests for continuous time systems, controllability & observability for discrete time systems, controllability & observability of state model in Jordan canonical form, loss of controllability & observability due to sampling, controllability & observability canonical forms of state model.	**8**	**CO1, CO2, CO3**
2	State variables and input output descriptions: introduction, input output maps from state models, LTI continuous time systems, LTI discrete time systems, linear time varying systems, output controllability, reducibility, state model from input output maps realization of scalar transfer functions, phase variable canonical forms, realization of transfer function matrices, realization of pulse transfer functions.	**8**	**CO1, CO5**
3	Stability: Introduction, equilibrium points, stability concepts and definitions, stability of linear time invariant systems, equilibrium stability of non-linear continuous time autonomous systems, direct method of Lyapunov and the linear continuous time autonomous systems, aids to find Lyapunov functions for non-linear continuous time autonomous systems, use of Lyapunov	**8**	**CO1, CO4**

	functions to estimate transients, the direct method of Lyapunov and discrete time autonomous systems.		
4	Model control: Introduction, controllable and observable companion forms for single input/single output systems & multi-input/multi-output systems, the effect of state feedback on controllability & observability, pole placement by state feedback, full order observers, the separation principle, reduced order observers, deadbeat control by state feedback, deadbeat observers.	**8**	**CO1, CO5**

Text Books:

1. Modern control system theory by M. Gopal (New age international)
2. Modern control systems – a manual of design methods by John A Borrie (Prentice hall international)
3. Digital control and state variable methods by M. Gopal (Tata McGraw Hill)

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PC-203	**Course Name: Program Elective-III Intelligent Instrumentation (vi)**	**L**	**T**	**P**	**C**
		3	**-**	**-**	**3**
Year and Semester	**2nd Year. 3rd Semester**	**Contact hours per week: (3Hrs)** Exam: (3 Hrs)			
Pre-requisite of course	**Measurements and Instrumentations**	**Evaluation**			
		CIE: 40	**SEE: 60**		

Course Objectives:	
1. Study the concept of intelligent instrumentation system	
2. Study of intelligent instrumentation components	
3. Study the characteristic function of **Smart Sensors**	
4. Detail study of Standards for smart sensors	
5. Study and development of data acquisition system for smart sensor system	
6. Detail study and applications of Microelectro-mechanical systems	
Course Outcomes: On completion of the course, student would be able to:	
CO1	Ability to understand the concept of intelligent instrumentation system
CO2	Able to learn characteristic function of **Smart Sensors**

CO3	Acquire the knowledge of Standards for smart sensors and their Industrial applications.
CO4	Able to learn and analyze the various principles & concepts of data acquisition system for smart sensor system.
CO5	To implement new and emerging technologies to analyze, design, maintain reliable, safe, and cost effective solution Smart sensors development including Microelectro-mechanical systems

Module No	COURSE SYLLABUS CONTENTS OF MODULE	Hrs	COs
1	Definition of intelligence and of an intelligent instrumentation system; features characterizing intelligence and features of intelligent instrumentation; components of intelligent instrumentation; Block diagram of an intelligent instrumentation system.	**8**	**CO1 CO2**
2	**Smart Sensors:** Primary sensors**;** Excitation**;** Amplification; Filters**;** Converters; Compensation (Nonlinearty**:** look up table method**,** polygon interpolation, polynomial interpolation**,** cubic spline interpolation, Approximation & regression; Noise & interference**;** Response time**;** Drift; Cross-sensitivity)**;** Information Coding/ Processing**;** Data Communication**;** Standards for smart sensor interface**;** The automation.	**10**	**CO2 CO3**
3	**Interfacing Instruments & Computers:** Basic issues of interfacing; Address decoding; Data transfer control; A/D converter; D/A converter; Other interface considerations.	**10**	**CO4**
4	**Software Filters (Digital Filters)** : Description of Spike Filter**,** Low pass filter, High pass filter etc. **Recent Trends in Sensor Technologies:** Introduction**;** Film sensors (Thick film sensors, Thin film sensors)**;** Semiconductor IC technology –standard methods; Microelectro-mechanical systems (Micro-machining, some application examples)**;** Nano-sensors**.**	**9**	**CO4 CO5**

TEXT BOOKS:

REFERENCE BOOKS:

1. Alan S. Morris, 'Principles of measurement & Instrumentation', PHI.
2. Wai-Kai Chen, 'Passive and Active Filters: Theory and Implementations', John Willey & Sons (Asia) Ptr. Ltd., New Delhi.
3. D. Patranabis, 'Sensors & Transducers', PHI, 2003.
4. Roman Kuc, 'Introduction to Digital Signal Processing', Mc Graw Hill Introduction Edition N.York.

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.

Program Name: M. Tech.-Electrical and Instrumentation Engineering

Course Code: EI-PE-203	**Course Name: Program Elective-III, INDUSTRIAL POWER ELECTRONICS (vii)**	**L**	**T**	**P**	**C**
		3	**-**	**-**	**3**
Year and Semester	**2nd Yr. 3rdSemester**	**Contact hours per week: (3 Hrs)** Exam: (3 Hrs)			
Pre-requisite of course	**Power Electronics**	**Evaluation**			
		CIE: 40	**SEE: 60**		

Course Objectives:
1. To study the basic working theory of different power electrons devices.
2. To study the control of DC drive with the help of power electrons devices.
3. To study different industrial application of power electronic devices.
4. To study the control of AC electric drive with the help of power electrons devices.

Course Outcomes: On completion of the course, student would be able to:	
CO1	To apprise with the basic working theory of different power electrons devices.
CO2	To understand the control of DC drive with the help of power electrons devices.
CO3	To understand different industrial application of power electronic devices.
CO4	To understand the control of AC electric drive with the help of power electrons devices.

Module No	**COURSE SYLLABUS CONTENTS OF MODULE**	**Hrs**	**COs**
1	INTRODUCTION: Review of semiconductor power devices (Power diodes, Power Transistors, MOSFETS, IGBT, SCR, GTO, MCT, DIAC, TRAIC, PUT, SUS, SCS), Review of choppers, converters, inverters, cyclo-converters. CLOSED LOOP CONTROL OF DC DRIVES: Single Quadrant variable speed drives; Four Quadrant variable speed drives, Armature voltage control at constant field, field weakening, details of various blocks of closed loop drives; drive employing armature reversal by a contractor, drive employing a dual converter with non- simultaneous and simultaneous control.	**8**	**CO1, CO2**
2	INDUSTRIAL APPLICATION OF POWER ELECTRONIC DEVICES: Control of electric drives used in manufacturing and process industries, protection of electric drives using solid state devices and controllers, analysis of drive systems. Testing for drive controllers: Design and testing if microprocessor based drive controllers, analysis of solid state control of industrial drives, design and testing of thyristor based controllers for electric drives.	**8**	**CO2, CO3**
3	FREQUENCY CONTROLLED INDUCTION MOTOR DRIVES: Control of IM by VSI-3 phase VSI, six step inverter voltage control, PWM inverter, breaking and multi-quadrant control, VSI variable frequency drives; control of IM by CSI- 3 phase CSI, current sources, Braking, PWM in a thyristor CSI, PWM GTO CSI, CSI variable frequency drives.	**8**	**CO4**

4	SELF -CONTROLLED SYNCHRONOUS MOTOR DRIVES: Self-control, brushless &commutator less, DC & AC motors synchronous motor control-operation of a wound field and permanent magnet synchronous motor from a variable frequency current source; source, permanent magnet, operation of a permanent magnet motor at the maximum torque to armature current ratio and at the maximum torque to flux ratio; operation of self-controlled synchronous motor drives- CSI drives, VSI drives, cyclo-converters drives, brush-less and commutator-less AC & DC motor drives and their applications.	**8**	**CO4**

TEXT BOOKS:

REFERENCE BOOKS:

1. Industrial Electronics by Frank D. Petruzella (Mc Graw- Hill)
2. Industrial Electronics by Morris (McGraw-Hill)
3. Power semiconductor drives by G.K.Dubey, Prentice Hall Inc, New Jersey

Note for Examiner(s): Question paper will comprise three sections,

1. Section-A will be compulsory and comprise 4-short answer type questions uniformly spread to the entire syllabus.
2. Section-B will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on concepts, definitions, derivations, principles, construction and working etc.
3. Section-C will comprise 4-questions uniformly spread to the entire syllabus and questions will be based on derivations, numerical and applications of the various topics covered therein.

Note for Students:

1. Section – A is compulsory and attempt/answer all the four questions carrying 12 marks in total.
2. Attempt/answer two questions each out of the Section – B and Section – C. All questions will carry 12 marks.