GOVERNMENT COLLEGE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University)

Coimbatore – 641 013

Curriculum and Syllabi For

B.E. ELECTRONICS AND INSTRUMENTATION ENGINEERING

(Full Time)

2018

Regulations

OFFICE OF THE CONTROLLER OF EXAMINATIONS

GOVERNMENT COLLEGE OF TECHNOLOGY,

THADAGAM ROAD, COIMBATORE-641 013

VISION AND MISSION OF THE INSTITUTION

VISION

To emerge as a centre of excellence and eminence by imparting futuristic technical education in keeping with global standards, making our students technologically competent and ethically strong so that they can readily contribute to the rapid advancement of society and mankind.

MISSION

- To achieve academic excellence through innovative teaching and learning practices.
- To enhance employability and entrepreneurship.
- To improve the research competence to address societal needs.
- To inculcate a culture that supports and reinforces ethical, professional behaviours for a harmonious and prosperous society.

VISION AND MISSION OF THE DEPARTMENT

VISION

To be a premier value based department, committed to excellence in preparing students for success in Electronics and Instrumentation Engineering and Technology professions through research and Experience based Instruction with the help of highly qualified and fully supportive faculty.

MISSION

The department is committed to provide the students with strong theoretical foundations blended with practical Engineering skills with an emphasis on team work, critical and creative thinking and professional ethics, to enable them to become successful Electronics and Instrumentation Engineers and be of service to the society at a large.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

The following Programme Educational Objectives are designed based on the department mission.

PEO1: To provide students with strong foundation in Mathematical, Scientific and Engineering fundamentals necessary to formulate, solve and analyse Engineering Problems related to Industry and Research.

PEO2: To impart the state of art technology to the students in the field of Electronics and Instrumentation.

PEO3: To foster innovation, invention and entrepreneurship by enabling the students to transform their ideas to proof of concepts for High Tech Applications.

PEO4: To provide opportunity for the students to work as part of teams on multidisciplinary projects.

PEO5: To inculcate in the students professional and ethical attitude, communication skills and the lifelong learning skills needed for the successful professional career.

PROGRAMME OUTCOMES (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSO)

PSO1: To integrate fundamental and recent approaches from engineering sciences and practices to accomplish professional development in a responsive and innovative manner.

PSO2: To apply appropriate techniques and modern engineering hardware and software tools to design, implement and evaluate the process, instrumentation system measurement, and control to work effectively as an individual and in a multidisciplinary team.

PSO3: To continually be responsive to new technological and cultural challenges through lifelong learning leading to advanced degrees, publications, presentations, awards and exhibit good citizenship with elegant mannerism.

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B.E.ELECTRONICS AND INSTRUMENTATION ENGINEERING

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FIRST SEMESTER

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks
		Induction Programme	MC	0	0	0

Details of the Programme:

Number of Days: 21 Days

Day0: College Admission

Day1: Orientation Programme

Day2: Registration.

Day3 to Day 23 : Induction Programme

Activities:
Physical activity,
Playground Events,
Yoga Practices,
Literary, Proficiency modules,
Team Building,
Lectures by Eminent people,
Familiarization to department,
Branch oriented information,
Motivational speakers,
Talent exposure,
Quiz completion,
Visit to local areas….etc.

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FIRST SEMESTER

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
		THEORY								
1	18NHS101	Communicative English	HS	50	50	100	2	1	0	3
2	18NBS102	Calculus and Differential Equations	BS	50	50	100	3	1	0	4
3	18NBS103	Waves, Optics and Introduction to Quantum Mechanics	BS	50	50	100	3	1	0	4
4	18NES104	Programming in C	ES	50	50	100	3	0	0	3
		PRACTICAL								
5	18NBS105	Physics Laboratory	BS	50	50	100	0	0	3	1.5
6	18NES106	Workshop Practice	ES	50	50	100	1	0	4	3
7	18NES107	Programming in C Laboratory	ES	50	50	100	0	0	3	1.5
		TOTAL		**350**	**350**	**700**	**12**	**3**	**10**	**20**

SECOND SEMESTER

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
		THEORY								
1	18NBS201	Applied Chemistry	BS	50	50	100	3	1	0	4
2	18NBS202	Linear Algebra, Numerical Methods and Transform Calculus	BS	50	50	100	3	1	0	4
3	18NES203	Electrical Circuits and Networks	ES	50	50	100	3	0	0	3
		PRACTICAL								
4	18NBS204	Chemistry Laboratory	BS	50	50	100	0	0	3	1.5
5	18NES205	Electrical Circuits and Networks Laboratory	ES	50	50	100	0	0	3	1.5
6	18NES206	Engineering Graphics	ES	50	50	100	2	0	4	4
		TOTAL		**300**	**300**	**600**	**11**	**2**	**10**	**18**

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THIRD SEMESTER

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
		THEORY								
1	18NHS301	Business Communication Skills	HS	50	50	100	3	0	0	3
2	18NBS302	Biology for Engineers	BS	50	50	100	3	0	0	3
3	18NES303	Principles of Electrical Machines	ES	50	50	100	3	0	0	3
4	18NPC304	Electronic circuits	PC	50	50	100	3	0	0	3
5	18NPC305	Sensors and Transducers	PC	50	50	100	3	0	0	3
6	18NPC306	Measurements and Instrumentation	PC	50	50	100	3	0	0	3
7	18NMC3Z7	Environmental Sciences and Engineering	MC	50	50	100	3	0	0	0
		PRACTICAL								
8	18NPC308	Sensors and Measurements Laboratory	PC	50	50	100	0	0	3	1.5
9	18NPC309	Electronic Devices and Circuits Laboratory	PC	50	50	100	0	0	3	1.5
		TOTAL		**450**	**450**	**900**	**21**	**0**	**6**	**21**

FOURTH SEMESTER

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
		THEORY								
1	18NHS401	Professional Ethics	HS	50	50	100	3	0	0	3
2	18NBS402	Probability and Applied Statistics	BS	50	50	100	3	1	0	4
3	18NES403	Engineering Mechanics	ES	50	50	100	3	1	0	4
4	18NPC404	Electronics for Analog Signal Processing	PC	50	50	100	3	0	0	3
5	18NPC405	Digital Electronics	PC	50	50	100	3	0	0	3
6	18NPC406	Fundamentals of Microprocessors and Microcontrollers	PC	50	50	100	3	0	0	3
7	18NMC4Z7	Constitution of India	MC	50	50	100	3	0	0	0
		PRACTICAL								
8	18NPC408	Microprocessors and Microcontrollers Laboratory	PC	50	50	100	0	0	3	1.5
9	18NPC409	Linear and Digital Circuits Laboratory	PC	50	50	100	0	0	3	1.5
		TOTAL		**450**	**450**	**900**	**21**	**2**	**6**	**23**

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FIFTH SEMESTER

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
		THEORY								
1	18NHS501	Technology Management	HS	50	50	100	3	0	0	3
2	18NES502	Industrial Hydraulics and Pneumatics	ES	50	50	100	3	0	0	3
3	18NPC503	Control System Design	PC	50	50	100	3	0	0	3
4	18NPC504	Basics of Signals and Systems	PC	50	50	100	3	0	0	3
5	18NPE5XX	Professional Elective - I	PE	50	50	100	3	0	0	3
6	18#OE5XX	Open Elective -I	OE	50	50	100	3	0	0	3
		PRACTICAL								
7	18NPC507	Control Systems Laboratory	PC	50	50	100	0	0	3	1.5
8	18NEE508	Virtual Instrumentation Laboratory	EEC	50	50	100	0	0	3	1.5
		TOTAL		**400**	**400**	**800**	**18**	**0**	**6**	**21**

SIXTH SEMESTER

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
		THEORY								
1	18NPC601	Principles of Communication	PC	50	50	100	3	0	0	3
2	18NPC602	Process Control	PC	50	50	100	3	0	0	3
3	18NPC603	Industrial Instrumentation	PC	50	50	100	3	0	0	3
4	18NPE6XX	Professional Elective II	PE	50	50	100	3	0	0	3
5	18#OE6XX	Open Elective -II	OE	50	50	100	3	0	0	3
6	18#OE6XX	Open Elective -III	OE	50	50	100	3	0	0	3
		PRACTICAL								
7	18NPC607	Process Control Laboratory	PC	50	50	100	0	0	4	2
8	18NEE608	Industrial Instrumentation Laboratory	EEC	50	50	100	0	0	3	1.5
		TOTAL		**400**	**400**	**800**	**18**	**0**	**7**	**21.5**

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SEVENTH SEMESTER

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
		THEORY								
1	18NPC701	Soft Computing Techniques	PC	50	50	100	3	0	0	3
2	18NPC702	Analytical Instrumentation	PC	50	50	100	3	0	0	3
3	18NPC703	Industrial Automation Systems	PC	50	50	100	3	0	0	3
4	18NPE7XX	Professional Elective - III	PE	50	50	100	3	0	0	3
5	18NPE7XX	Professional Elective - IV	PE	50	50	100	3	0	0	3
6	18#OE7XX	Open Elective -IV	OE	50	50	100	3	0	0	3
		PRACTICAL								
7	18NPC707	Industrial Automation Laboratory	PC	50	50	100	0	0	3	1.5
8	18NEE708	Mini Project	EEC	50	50	100	0	0	8	4
		TOTAL		**400**	**400**	**800**	**18**	**0**	**11**	**23.5**

EIGHTH SEMESTER

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
		THEORY								
1	18NPE8XX	Professional Elective - V	PE	50	50	100	3	0	0	3
2	18NPE8XX	Professional Elective - VI	PE	50	50	100	3	0	0	3
		PRACTICAL								
3	18NEE803	Project work	EEC	100	100	200	0	0	16	8
		TOTAL		**200**	**200**	**400**	**6**	**0**	**16**	**14**

CATEGORY-WISE CREDIT DISTRIBUTION

HUMANITIES AND SOCIAL SCIENCES INCLUDING MANAGEMENT (HS)

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem marks	Total Marks	Hours/Week			
							L	T	P	C
1	18NHS101	Communicative English	HS	50	50	100	2	1	0	3
2	18NHS301	Business Communication Skills	HS	50	50	100	3	0	0	3
3	18NHS401	Professional Ethics	HS	50	50	100	3	0	0	3
4	18NHS501	Technology Management	HS	50	50	100	3	0	0	3

BASIC SCIENCES (BS)

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	18NBS102	Calculus and Differential Equations	BS	50	50	100	3	1	0	4
2	18NBS103	Waves, Optics and Introduction to Quantum Mechanics	BS	50	50	100	3	1	0	4
3	18NBS105	Physics Laboratory	BS	50	50	100	0	0	3	1.5
4	18NBS201	Applied Chemistry	BS	50	50	100	3	1	0	4
5	18NBS202	Linear Algebra, Numerical Methods and Transform calculus	BS	50	50	100	3	1	0	4
6	18NBS204	Chemistry Laboratory	BS	50	50	100	0	0	3	1.5
7	18NBS302	Biology for Engineers	BS	50	50	100	3	0	0	3
8	18NBS402	Probability and Applied Statistics	BS	50	50	100	3	1	0	4

ENGINEERING SCIENCES (ES)

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	18NES104	Programming in C	ES	50	50	100	3	0	0	3
2	18NES106	Workshop Practice	ES	50	50	100	1	0	4	3
3	18NES107	Programming in C Laboratory	ES	50	50	100	0	0	3	1.5
4	18NES203	Electrical Circuits and Networks	ES	50	50	100	3	0	0	3
5	18NES205	Electrical Circuits and Networks Laboratory	ES	50	50	100	0	0	3	1.5
6	18NES206	Engineering Graphics	ES	50	50	100	2	0	4	4
7	18NES303	Principles of Electrical Machines	ES	50	50	100	3	0	0	3
8	18NES403	Engineering Mechanics	ES	50	50	100	3	1	0	4
9	18NES502	Industrial Hydraulics and Pneumatics	ES	50	50	100	3	0	0	3

PROFESSIONAL CORE (PC)

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1.	18NPC304	Electronic Circuits	PC	50	50	100	3	0	0	3
2.	18NPC305	Sensors and Transducers	PC	50	50	100	3	0	0	3
3.	18NPC306	Measurements and Instrumentation	PC	50	50	100	3	0	0	3
4.	18NPC308	Sensors and Measurements Laboratory	PC	50	50	100	0	0	3	1.5
5.	18NPC309	Electronic Devices and Circuits Laboratory	PC	50	50	100	0	0	3	1.5
6	18NPC404	Electronics for Analog Signal Processing	PC	50	50	100	3	0	0	3
7	18NPC405	Digital Electronics	PC	50	50	100	3	0	0	3
8	18NPC406	Fundamentals of Microprocessors and Microcontrollers	PC	50	50	100	3	0	0	3
9	18NPC408	Microprocessors and Microcontrollers Laboratory	PC	50	50	100	0	0	3	1.5
10	18NPC409	Linear and Digital Circuits Laboratory	PC	50	50	100	0	0	3	1.5
11	18NPC503	Control System Design	PC	50	50	100	3	0	0	3
12	18NPC504	Basics of Signals Systems	PC	50	50	100	3	0	0	3
13	18NPC507	Control Systems Laboratory	PC	50	50	100	0	0	3	1.5
14	18NPC601	Principles of Communication	PC	50	50	100	3	0	0	3
15	18NPC602	Process Control	PC	50	50	100	3	0	0	3
16	18NPC603	Industrial Instrumentation	PC	50	50	100	3	0	0	3
17	18NPC607	Process Control Laboratory	PC	50	50	100	0	0	4	2
18	18NPC701	Soft Computing Techniques	PC	50	50	100	3	0	0	3
19	18NPC702	Analytical Instrumentation	PC	50	50	100	3	0	0	3
20	18NPC703	Industrial Automation Systems	PC	50	50	100	3	0	0	3
21	18NPC707	Industrial Automation Laboratory	PC	50	50	100	0	0	3	1.5

PROFESSIONAL ELECTIVES (PE)

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	18NPE$01	Advanced Control Theory	PE	50	50	100	3	0	0	3
2	18NPE$02	Digital Control System	PE	50	50	100	3	0	0	3
3	18NPE$03	Computer Control of Process	PE	50	50	100	3	0	0	3
4	18NPE$04	Advanced Process Control	PE	50	50	100	3	0	0	3
5	18NPE$05	System Identification and Adaptive Control	PE	50	50	100	3	0	0	3
6	18NPE$06	Optimal Control	PE	50	50	100	3	0	0	3
7	18NPE$07	Machine Learning Techniques	PE	50	50	100	3	0	0	3
8	18NPE$08	Fault Diagnosis and Tolerances	PE	50	50	100	3	0	0	3
9	18NPE$09	Instrument Standards	PE	50	50	100	3	0	0	3
10	18NPE$10	MEMS and Nano Technology	PE	50	50	100	3	0	0	3
11	18NPE$11	Safety Instrument Systems	PE	50	50	100	3	0	0	3
12	18NPE$12	Energy Harvesting	PE	50	50	100	3	0	0	3
13	18NPE$13	Power Electronics and Drives	PE	50	50	100	3	0	0	3
14	18NPE$14	Industrial Data Networks	PE	50	50	100	3	0	0	3
15	18NPE$15	Industrial Internet of Things	PE	50	50	100	3	0	0	3
16	18NPE$16	Wireless Sensor Network	PE	50	50	100	3	0	0	3
17	18NPE$17	Fiber Optics and Laser Instrumentation	PE	50	50	100	3	0	0	3
18	18NPE$18	Aircraft Instrumentation	PE	50	50	100	3	0	0	3
19	18NPE$19	Smart and Wireless Instrumentation	PE	50	50	100	3	0	0	3
20	18NPE$20	Power Plant Instrumentation	PE	50	50	100	3	0	0	3
21	18NPE$21	Biomedical Instrumentation	PE	50	50	100	3	0	0	3
22	18NPE$22	Instrumentation and Control in Petro Chemical Industries	PE	50	50	100	3	0	0	3
23	18NPE$23	Instrumentation and Control in Iron and Steel Industries	PE	50	50	100	3	0	0	3
24	18NPE$24	Robotics and its Applications	PE	50	50	100	3	0	0	3
25	18NPE$25	Real Time Embedded Systems	PE	50	50	100	3	0	0	3
26	18NPE$26	Automotive Instrumentation	PE	50	50	100	3	0	0	3
27	18NPE$27	Discrete Time Signal Processing	PE	50	50	100	3	0	0	3
28	18NPE$28	Basics of VLSI Technology	PE	50	50	100	3	0	0	3
29	18NPE$29	VHDL Based Digital System Design	PE	50	50	100	3	0	0	3

OPEN ELECTIVES (O.E)

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem. Marks	Total Marks	Hours/Week			
							L	T	P	C
1.	18COE$01	Climate Change and Adaptation	OE	50	50	100	3	0	0	3
2.	18COE$02	Disaster Management and Mitigation	OE	50	50	100	3	0	0	3
3.	18COE$03	Energy Efficient Buildings	OE	50	50	100	3	0	0	3
4.	18MOE$04	Nanotechnology and Surface Engineering	OE	50	50	100	3	0	0	3
5.	18MOE$05	Mechatronics	OE	50	50	100	3	0	0	3
6.	18MOE$06	Renewable Energy Sources	OE	50	50	100	3	0	0	3
7.	18EOE$07	Renewable Power Generation Systems	OE	50	50	100	3	0	0	3
8.	18EOE$08	Electric Vehicles	OE	50	50	100	3	0	0	3
9.	18EOE$09	Smart Grid Systems	OE	50	50	100	3	0	0	3
10.	18LOE$10	Mobile Communication	OE	50	50	100	3	0	0	3
11.	18LOE$11	Introduction to VLSI System Design	OE	50	50	100	3	0	0	3
12.	18LOE$12	Microcontroller and Applications	OE	50	50	100	3	0	0	3
13.	18POE$13	Rapid Prototyping	OE	50	50	100	3	0	0	3
14.	18POE$14	Managerial Economics	OE	50	50	100	3	0	0	3
15.	18POE$15	Hydraulics and Pneumatics	OE	50	50	100	3	0	0	3
16.	18NOE$16	Measurement and Control	OE	50	50	100	3	0	0	3
17.	18NOE$17	Industrial Automation	OE	50	50	100	3	0	0	3
18.	18NOE$18	Virtual Instrumentation	OE	50	50	100	3	0	0	3
19.	18SOE$19	Programming in Java	OE	50	50	100	3	0	0	3
20.	18SOE$20	Cyber Security	OE	50	50	100	3	0	0	3
21.	18SOE$21	Network Essentials	OE	50	50	100	3	0	0	3
22.	18IOE$22	Programming in Python	OE	50	50	100	3	0	0	3
23.	18IOE$23	Big Data Science	OE	50	50	100	3	0	0	3
24.	18IOE$24	Object Oriented Programming Using C++	OE	50	50	100	3	0	0	3
25.	18BOE$25	Computational Biology	OE	50	50	100	3	0	0	3
26.	18BOE$26	Biology for Engineers	OE	50	50	100	3	0	0	3
27	18BOE$27	Fundamentals of Bioengineering	OE	50	50	100	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC) – PRACTICAL COURSES AND PROJECT WORK

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	18NEE508	Virtual Instrumentation Laboratory	EEC	50	50	100	0	0	3	1.5
2	18NEE608	Industrial Instrumentation Laboratory	EEC	50	50	100	0	0	3	1.5
3	18NEE708	Mini Project	EEC	50	50	100	0	0	8	4
4	18NEE803	Project Work	EEC	50	50	100	0	0	16	8

MANDATORY COURSE (MC) (NO - CREDIT)

Sl. No.	Course Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	18NMC3Z7	Environmental Sciences and Engineering	MC	50	50	100	3	0	0	0
2	18NMC4Z7	Constitution of India	MC	50	50	100	3	0	0	0

VALUE ADDED COURSES (VA) (ONE – CREDIT)

Sl. No.	Subject Code	Course Title	CAT	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	18NVA$01	MATLAB Programming	VA	50	50	100	1	0	0	1
2	18NVA$02	PCB Design and Fabrication	VA	50	50	100	1	0	0	1
3	18NVA$03	Calibration of Instrument	VA	50	50	100	1	0	0	1
4	18NVA$04	Safety Practices and Management in Process Industries	VA	50	50	100	1	0	0	1

SUMMARY OF CREDIT DISTRIBUTION

Sl. No.	Course Work Subject Area	Credits Per Semester								Total Credits	% of credits	AICTE
		I	II	III	IV	V	VI	VII	VIII			
1	HS	3	0	3	3	3	-	-	-	12	7.41	12
2	BS	9.5	9.5	3	4	-	-	-	-	26	16.05	25
3	ES	7.5	8.5	3	4	3	-	-	-	26	16.05	24
4	PC	-	-	12	12	7.5	11	10.5	-	53	32.72	48
5	PE	-	-	-	-	3	3	6	6	18	11.11	18
6	OE	-	-	-	-	3	6	3	-	12	7.41	18
7	EEC	-	-	-	-	1.5	1.5	4	8	15	9.26	15
8	MC	0	-	0	0	-	-	-	-	0	0	0
	Total	**20**	**18**	**21**	**23**	**21**	**21.5**	**23.5**	**14**	**162**	**100**	**160**

HS	Humanities and Social Science
BS	Basic Science
ES	Engineering Science
PC	Professional Core
PE	Professional Elective
OE	Open Elective
EEC	Employability Enhancement Courses
MC	Mandatory Course
VA	Value Added Course

18NHS101	COMMUNICATIVE ENGLISH *(Common to All Branches)*	SEMESTER I

Category : HS

PRE-REQUISITES: NIL

L	T	P	C
2	1	0	3

COURSE OBJECTIVES:

The course is intended to

- Make learners listen to audio files and replicate in speaking contexts
- Make learners read widely and practice it in writing
- Make learners develop vocabulary and strengthen grammatical understanding

UNIT-I : LISTENING	**(6+3 Periods)**
Listening Comprehension, Pronunciation, Intonation, Stress, Pause, Rhythm, Listening to Short & Long Conversations/Monologues - Note-Taking.	
UNIT-II : SPEAKING	**(6+3 Periods)**
Self Introduction, Making Oral & Formal Presentation, Communication at Work Place, Mock Interviews, Role Play Activities, Group Discussions, Debates, Delivering Welcome Address, Proposing Vote of Thanks, Introducing the Chief Guest at a function.	
UNIT-III : READING	**(6+3 Periods)**
Reading Comprehension, Speed Reading, Interpreting Visual Materials (Signs, Post Cards Pictures, Labels Etc.), Reading for Specific Information-Reading to identify Stylistic Features (Syntax, Lexis, Sentence Structures)-Cloze Test.	
UNIT-IV : WRITING	**(6+3 Periods)**
Phrase, Clause And Sentence Structures, Punctuation, Discourse Markers, Coherence, Precision in Writing, Graph & Process Description-Definition, Writing Email-Paraphrasing, Note making, Job Application With Resume, Writing Review of a Book / Movie, Creative Writing.	
UNIT-V : GRAMMAR AND VOCABULARY	**(6+3 Periods)**
Word Formation with Prefix and Suffix, Synonyms and Antonyms, Tenses, Parts of Speech, Common Errors in English (Subject –Verb Agreement, Noun-Pronoun Agreement, Prepositions, Articles, Conditional statements, Redundancies, Clichés etc), Voices.	
Contact periods:	

Lecture: 30 Periods	**Tutorial:15 Periods**	**Practical: 0 Periods**	**Total: 45 Periods**

TEXT BOOKS:

1. ***"Board of Editors, Using English"****, Orient Black Swan, 2015.*

REFERENCE BOOKS:

1. ***"Practical English Usage"****, Michael Swan. OUP 1995.*
2. ***"Cambridge BEC Vantage"*** *- Practice Tests, Self-study Edition, CUP, 2002*
3. ***"Exercises in Spoken English Parts. I –III"****. EFLU,Hyderabad, OUP, 2014*
4. ***"Indlish"*** *Jyothi Sanyal, Viva Books,2006*
5. ***"Communicative English"*** *J.Anbazhagan Vijay, Global Publishers, Chennai. 2018*

WEB REFERENCES

1. *www.cambridgeenglish.org/exams/business.../business-preliminary/*
2. *http://www.examenglish.com/BEC/BEC_Vantage.html*
3. *www.splendid-speaking.com/exams/**bec**_speaking.htmlhtml*

COURSE OUTCOMES:

At the end of the course, the learners will be able to

CO1: Listen and speak better in formal / semi formal situations
CO2: Read and write well for a context appropriately
CO3: Strengthen Vocabulary and Grammar

18NBS102	CALCULUS AND DIFFERENTIAL EQUATIONS *(Common to EEE, ECE & EIE Branches)*	SEMESTER I

Category : BS

PRE-REQUISITES: NIL

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

- To be familiarize with differentiation of single variable and its applications.
- To obtain the knowledge of integration and its applications.
- To acquire knowledge of differentiation for more than one variable and vector differentiation.
- To gain the knowledge of multiple integration and related applications and vector integration including theorems.
- To gain methods to solve second order differential equations with constant and variable coefficients.

UNIT-I: DIFFERENTIAL CALCULUS	**(9+3 Periods)**
Rolle's theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; indeterminate forms and L'Hospital's rule; Maxima and minima, Evolute of a curve.	
UNIT-II: INTEGRAL CALCULUS	**(9+3 Periods)**
Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volume of revolution.	
UNIT-III: MULTIVARIABLE CALCULUS (DIFFERENTIATION)	**(9+3 Periods)**
Limit, continuity and partial derivatives, total derivative, Jacobians, Maxima, minima and saddle points, Method of Lagrange multipliers, Gradient, curl and divergence.	
UNIT-IV: MULTIVARIABLE CALCULUS (INTEGRATION)	**(9+3 Periods)**
Multiple integration - Double integrals, change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Triple integrals (Cartesian), Change of variables (Cartesian to spherical polar). Theorems of Green, Gauss and Stokes, Simple applications involving cubes, sphere and rectangular parallelepipeds.	
UNIT-V : ORDINARY DIFFERENTIAL EQUATIONS OF HIGHER ORDER	**(9+3 Periods)**
Second order linear differential equations with constant and variable coefficients: Cauchy-Euler equation, Cauchy-Legendre equation. Method of variation of parameters, Power series solutions of Bessel and Legendre equations.	
Contact periods:	

Lecture: 45 Periods	**Tutorial:15 Periods**	**Practical: 0 Periods**	**Total: 60 Periods**

TEXT BOOKS:

1. *Veerarajan T., **"Engineering Mathematics (for first year)"**, Tata McGraw-Hill, New Delhi,2008.*
2. *Srimanta Pal and suboth.C.Bhunia, **"Engineering Mathematics"**, Oxford university publications, New Delhi, 2015.*

REFERENCE BOOKS:

1. *B.S.Grewal **"Higher Engineering Mathematics"**, Khanna Publishers, 43rdEdition,2015.*
2. *Erwinkreyszig, **"Advanced Engineering Mathematics"**,9thEdition, John Wiley&Sons, 2006.*
3. *James Stewart, **"Essential Calculus"**, Cengage Learning, Delhi, 2ndEdition, 2013.*
4. *E. A. Coddington, **"An Introduction to Ordinary Differential Equations"**, Prentice Hall India, 1995.*
5. *G.F. Simmons and S.G. Krantz, **"Differential Equations"**, Tata McGraw Hill, 2007.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the standard theorems and applications like maxima and minima, evolute of a curve using principles of differentiation.

CO2: Acquire fluency in integration of one variable for definite and improper integrals like beta and gamma functions and also applications of area and volumes.

CO3: Understand the techniques of partial differentiation and vector differentiation.

CO4: Understand multiple integration for finding area, surface and volume and applications to Green's, Stoke's and Gauss theorems under Vector Calculus.

CO5: Understand the general solutions to higher order differential equations and power series solutions to second order differential equations leading to Bessel and Legendre functions.

18NBS103	WAVES, OPTICS AND INTRODUCTION TO QUANTUM MECHANICS *(Common to EEE, ECE & EIE Branches)*	SEMESTER I

Category : BS

PRE-REQUISITES: NIL

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

To improve the basic knowledge in Physics and its applications relevant to various streams of Engineering and Technology. Upon completion of this course the students will be familiar with:

- Wave optics phenomenon, Huygens' principle, Interference of light
- Basic principles in lasers, characteristics, types of lasers and its applications
- Origin of quantum physics, Schrödinger's equation and its applications.
- Free electron theory, density of states in metals, Intrinsic and Extrinsic properties.
- Fiber optic principles and its applications.

UNIT-I : WAVE OPTICS	**(9+3 Periods)**
Huygens' Principle-superposition of waves and interference of light - Air wedge- Theory - Applications- Testing of flat surfaces –Thickness of a thin sheet of paper- Michelson interferometer-Theory-Applications-Determination of wavelength of monochromatic light.	
UNIT-II : LASER OPTICS	**(9+3 Periods)**
Einstein's theory of matter radiation interaction and A and B coefficients-amplification of light by population inversion-different types of lasers-gas laser-CO_2- solid state laser-Neodymium Nd-YAG laser-dye laser-properties of laser beams-monochromaticity-coherence-directionality and brightness-Applications of lasers in cutting , welding and materials processing.	
UNIT-III : INTRODUCTION TO QUANTUM MECHANICS	**(9+3 Periods)**
Limitations of classical Physics - Introduction to Quantum theory - Dual nature of matter and radiation-Properties of matter waves-de-Broglie wavelength in terms of voltage, energy, and temperature – Heisenberg's Uncertainty principle – verification – physical significance of a wave function-Schrödinger's Time independent and Time dependent wave equations –- Particle in a one dimensional potential well .	
UNIT-IV : INTRODUCTION TO SOLIDS AND SEMICONDUCTORS	**(9+3 Periods)**
Quantum theory - Fermi distribution function - effect of temperature – density of energy states in metals-Semiconductors – Properties – elemental and compound semiconductors - Intrinsic and extrinsic semiconductors – properties - Carrier concentration in intrinsic Semiconductor - variation of Fermi level with temperature - extrinsic semiconductors - Carrier concentration in P- type and N-type semiconductors variation of Fermi level with temperature and impurity concentration.	
UNIT-V : FIBER OPTICS	**(9+3 Periods)**
Introduction – Basic Principles involved in fiber optics- Total internal reflection – Structure of optical fiber –Propagation of light through optical fiber –Derivation for Numerical Aperture and acceptance angle - fractional index change - Classification of optical fiber based on materials, refractive index profile and Modes - Fiber optical communication links-Fiber optic sensors- Temperature and displacement.	

Contact periods:			
Lecture: 45 Periods	**Tutorial:15 Periods**	**Practical: 0 Periods**	**Total: 60 Periods**

TEXT BOOKS:

1. *Arumugam M-* **"*Engineering* Physics"**, *Anuradha Publishers, 2010. (Unit II, Unit III & Unit V)*
2. *P.K.Palanisamy-**"Engineering physics-II"** Scitech publications (India) pvt. Ltd 2015 (Unit IV)*

REFERENCE BOOKS:

1. *Avadhanulu M N and Kshirsagar P G,* **"*A Textbook of Engineering Physics*",** *S.Chand and Company Ltd, New Delhi, 2010. (Unit I)*
2. *E.Hecht,* **"*Optics"**, McGraw Hill Education, 2012.*
3. *D.J.Griffiths,* **"*Quantum mechanics"**, Pearson Education, 2014.*
4. *D.A.Neamen,* **"*Semiconductor Physics and Devices",** Times Mirror High Education Group, Chicago, 1997.*
5. *H.J.Pain,* **"*The physics of vibrations and waves",** Wiley, 2006.*
6. *O.Svelto,* **"*Principles of Lasers"**, Springer Science & Business Media, 2010.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Study the waves and optics phenomena- applications [Familiarity& Assessment]

CO2: Analyze the construction and working of gas lasers and solid state lasers. [Familiarity & Applications]

CO3: Analyze the dual nature of matter using de-Broglie matter waves, Heisenberg's Uncertainty principle, Schrodinger's time independent and dependent wave equations. [Familiarity & Application]

CO4: List and analyze the properties of conducting and Semiconducting materials and devices. [Familiarity & Application]

CO5: Explain fiber optics and classify fibers based on index profiles and modes[Familiarity & Application]

18NES104	PROGRAMMING IN C *(Common to All Branches Expect MECH & PRODN Branches)*	SEMESTER I

Category :ES

PRE-REQUISITES: NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

Upon completion of this course, the students will be familiar with,

- The Computer and Programming fundamentals
- Data types in C and Flow control statements
- Functions, Arrays, Pointers And Strings
- Bitwise Operators, Preprocessor Directives, Structures and Unions
- Structures, List Processing, Input And Output

UNIT-I : COMPUTER AND PROGRAMMING FUNDAMENTALS	**(9 Periods)**
Computer fundamentals – Evolution, classification, Anatomy of a computer: CPU, Memory, I/O – Introduction to software – Generation and classification of programming languages – Compiling – Linking and loading a program – Translator – loader – linker – develop a program – software development – Introduction to OS –Types of OS – Algorithms – Structured programming concept.	
UNIT-II : DATA TYPES AND FLOW OF CONTROL	**(9 Periods)**
An overview of C – Programming and Preparation – Program Output – Variables – Expressions, and Assignment, The use of #include, printf(), scanf() – Lexical elements, operators and the C systems – The fundamental data types – Flow of control	
UNIT-III : FUNCTIONS, ARRAYS, POINTERS AND STRINGS	**(9 Periods)**
Functions and storage classes - 1D Arrays – Pointers – Call by reference – Relationship between Arrays and Pointers – Pointer arithmetic and element size – Arrays as function argument – Dynamic memory allocation – Strings – String handing functions – Multidimensional Arrays.	
UNIT-IV : ARRAY OF POINTERS, BITWISE OPERATORS, PREPROCESSOR DIRECTIVES	**(9 Periods)**
Arrays of Pointers – Arguments to main () - Ragged Arrays – Functions as Arguments – Arrays of Pointers to Functions - Type qualifiers.-Bitwise operators and expressions – Masks – Software tools – Packing and unpacking – Enumeration types – The preprocessor directives.	
UNIT-V : STRUCTURES AND UNIONS, I/O AND FILE OPERATIONS	**(9 Periods)**
Structures and Unions – Operator precedence and associativity – Bit fields – Accessing bits and bytes - Input and Output functions – File Processing Functions – Environment variables – Use of make and touch.	
Contact periods:	

Lecture: 45 Periods	**Tutorial:0 Periods**	**Practical: 0 Periods**	**Total: 45 Periods**

TEXT BOOKS:

1. *Pradip Dey, Manas Ghosh,* ***"Computer Fundamentals and Programming in C"****, Second Edition, Oxford University Press, 2013.*
2. *Al Kelley, Ira Pohl,* ***"A Book on C-Programming in C",*** *Fourth Edition, Addison Wesley, 2001.*

REFERENCE BOOKS:

1. *Stephen G. Kochan,* ***"Programming in C-A complete introduction to the C programming language"****, Third Edition, Sams Publication, 2004.*
2. *Yashavant P. Kanetkar,* ***"Let Us C"****, 13th edition, BPB Publications, 2013.*
3. *Brian W. Kernighan and Dennis Ritchie,* ***"The C Programming Language"****, Second Edition, Prentice Hall Software Series, 1988.*
4. *Stephen Prata,* ***"C Primer Plus"****, Fifth Edition, Sams Publishing, 2005.*

COURSE OUTCOMES:

Upon completion of this course, the students will be able to

CO1:Articulate the programming environment [Familiarity]

CO2:Write algorithm for solving the given problem statement [Usage]

CO3:Use right data types and flow control statements [Assessment]

CO4:Write programs using functions, arrays, pointers and strings [Usage]

CO5:Use right storage classes, preprocessor directives, bitwise operators in programs [Assessment]

CO6:Use structures, unions and files [Usage]

18NBS105	PHYSICS LABORATORY *(Common to All Branches)*	SEMESTER I

Category : BS

PRE-REQUISITES: NIL

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVES:

To improve the basic knowledge in Physics and its applications relevant to various streams of Engineering and Technology. Upon completion of this course the students will be familiar with:

* To have a practical knowledge about the concepts of physics and its applications in the emerging fields of engineering and technology

LABORATORY EXPERIMENTS			
1.	Spectrometer - Diffraction Grating Normal Incidence Method		
2	Air Wedge –Determination thickness of a paper		
3.	Young's Modulus – Cantilever Bending Koenig's Method		
4.	a) Laser - Particle size Determination b) Optical fiber - Determination of NA & Acceptance angle		
5.	Ammeter and Voltmeter Calibration – Low Range		
6.	Determination of Bandgap Energy of Semiconductor		
7.	Ultrasonic Interferometer - Velocity of sound & Compressibility of liquids.		
8.	Torsional pendulum –Determination of Rigidity Modulus & Moment of Inertia		
Contact periods:			
Lecture: 0Periods	**Tutorial: 0Periods**	**Practical: 45 Periods**	**Total: 45 Periods**

COURSE OUTCOMES:

Upon the completion of the course, the student will be able to

CO1: Determine all physical properties of any matter,

CO2: Calibrate electrical measuring instruments and thereby effectively using it for particular application

CO3: Understand principle of Laser diffraction and its application in particle size determination

CO4: Understand the concept of light propagation through optical fibers and determination of its parameters

CO5: Determine the Intrinsic characteristic features of electronic devices for electrical and electronic applications.

CO6: Understand the ultrasonic wave propagation in liquids and the determination of compressibility of liquids for engineering applications.

18NES106	WORKSHOP PRACTICE *(Common to All Branches)*	SEMESTER I

Category : ES

PRE-REQUISITES: NIL

L	T	P	C
1	0	4	3

COURSE OBJECTIVES:

- To make various basic prototypes in the carpentry trade such as Lap joint, Lap Tee joint, Dove tail joint, Mortise & Tenon joint and Cross-Lap joint.
- To make various welding joints such as Lap joint, Lap Tee joint, Edge joint, Butt joint and Corner joint.

LIST OF EXPERIMENTS

1. Introduction to use of tools and equipments in Carpentry, Welding, Foundry and Sheet metal
2. Safety aspects in Welding, Carpentry and Foundry
3. Half lap Joint and Dovetail Joint in Carpentry
4. Welding of Lap joint, Butt joint and T-joint
5. Preparation of Sand mould for cube, conical bush, pipes and V pulley
6. Fabrication of parts like tray, frustum of cone and square box in sheet metal
7. Electrical wiring – simple house wiring
8. Plumbing
9. CNC Machines demonstration and lecture on working principle.
10. Additive manufacturing demonstration and lecture on working principle.

Contact periods:

Lecture: 15 Periods	Tutorial:0 Periods	Practical: 60 Periods	Total: 75 Periods

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Use tools and equipment used in Carpentry, Welding, Foundry and Sheet metal.
CO 2: Make half lap joint and dovetail joint in carpentry.
CO 3: Make welded lap joint, butt joint and T-joint.
CO 4: Prepare sand mould for cube, conical bush, pipes and V pulley.
CO 5: Fabricate parts like tray, frustum of cone and square box in sheet metal
CO 6: Carry out minor works/repair related to electrical wiring and plumbing

18NES107	**PROGRAMMING IN C LABORATORY** *(Common to All Branches Expect MECH & PRODN Branches)*	**SEMESTER I**

Category : ES

PRE-REQUISITES: NIL

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVES:

Upon completion of this course, the students will be familiar with,

- Data types in C and Flow control statements
- Functions, Arrays, Pointers And Strings
- Dynamic memory allocation and command line arguments
- Bitwise Operators, Preprocessor Directives, Structures and Unions
- Structures, List Processing, Input and Output

PRACTICALS EXERCISES ILLUSTRATING THE FOLLOWING CONCEPTS:			
1	Operators , Expressions and IO formatting		
2	Decision Making and Looping		
3	Arrays and Strings		
4	Functions and Recursion		
5	Pointers		
6	Dynamic Memory Allocation		
7	Structures		
8	Unions		
9	Files		
10	Command line arguments		
11	Mini Project		
Contact periods:			
Lecture: 0Periods	**Tutorial: 0Periods**	**Practical: 45 Periods**	**Total: 45 Periods**

COURSE OUTCOMES:

Upon completion of this course, the students will be able to

CO1: Use appropriate data types and flow control statements [Usage]
CO2: Write programs using functions, arrays, pointers and strings [Usage]
CO3: Write programs using dynamic memory allocation [Usage]
CO4: Implement programs using right storage classes, preprocessor directives, bitwise operators [Usage]
CO5: Work with command line arguments, structures, unions and files [Usage]
CO6: Develop applications using C [Usage]

18NBS201	APPLIED CHEMISTRY *(Common to EEE, ECE, EIE, CSE & IT Branches)*	SEMESTER II

PRE-REQUISITES: NIL

Category : BS

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

- The course is aimed at inculcating knowledge of applied chemistry topics which would be useful for students to understand Chemistry relevant to circuitry Engineering subjects.

UNIT-I : ELECTROCHEMICAL CELLS	**(9+3 Periods)**
Galvanic cells – redox reactions- electrodes - metal and metal ion, hydrogen electrode and calomel electrode – electrode potentials – standard oxidation and reduction potentials - Nernst equation and problems - EMF series and significance – Application of EMF measurements - pH measurement using glass electrode and fluoride measurement by ISE.	
UNIT-II : BATTERIES	**(9+3 Periods)**
Batteries - components , characteristics - voltage, current, current capacity, power density, energy density, cycle life, shelf life and self-discharge. Types of batteries- Primary - Zn/MnO_2 , Zn/HgO, Zn/Ag_2O, $Li/SOCl_2$ - construction, function and performance comparison – Secondary- Pb/ acid, Ni/Cd, and Lithium ion battery- construction, function and performance comparison.	
UNIT-III : CORROSION	**(9+3 Periods)**
Corrosion- Spontaneity - Chemical corrosion- mechanism, nature of oxides – Pilliing Bedworth rule- electrochemical corrosion- mechanism-Galvanic series and importance – Prevention methods - design of materials, cathodic protection techniques(sacrificial anode and impressed current cathode), Inhibitors - Protective coatings-Inorganic coating- electroplating – surface preparation and plating method applied to Cr and Ni and galvanizing – Organic coating- paints - constituents and functions.	
UNIT-IV : SPECTROSCOPIC TECHNIQUES AND APPLICATIONS	**(9+3 Periods)**
Beer Lambert's law -UV visible spectroscopy and IR spectroscopy – principles – instrumentation (block diagram only)- Flame photometry- principle – instrumentation (block diagram only)- estimation of sodium by flame photometry- Atomic absorption spectroscopy – principles – instrumentation(block diagram only) – estimation of nickel by atomic absorption spectroscopy.	
UNIT-V : SILICON WAFER TECHNOLOGY	**(9+3 Periods)**
Silicon for IC chips - single crystal – preparation by Czechralsky and float zone processes- wafer preparation, P-N junction formation – Ion implantation , Diffusion and epitaxial growth techniques - Insulator layer by oxidation- Printing of circuits by photolithography – masking and electron beam methods- etching by chemical and electrochemical methods.	
Contact periods:	

Lecture: 45 Periods	**Tutorial:15 Periods**	**Practical: 0 Periods**	**Total: 60 Periods**

TEXT BOOKS:

1. *Jain. P.C. and Monica Jain,* ***"Engineering Chemistry",*** *Dhanpat Rai Publications Pvt. Ltd, New Delhi, 16th Edition, 2017.*
2. *Vairam. S, Subha Ramesh,* ***"Engineering Chemistry",*** *Wiley India, 2015.*

REFERENCE BOOKS:

1. *Dara. S.S, Umarae,* **"*Text book of Engineering Chemistry",*** *S. Chand Publications, 2013.*
2. *M.S.Tyagi,* ***"Introduction to semiconductor materials and devices",*** *Wiley India, 2012.*
3. *Y R Sharma ,* ***"Elementary Organic Spectroscopy",*** *S. Chand Publications, 2013.*
4. *B.R. Puri, L.R. Sharma & M. S. Pathania,* **"*Principles of Physical Chemistry*"**, *S. Nagin Chand and Co., 2017*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the principles of electrochemical principles such as EMF measurements, electrode potentials and apply them in experimental techniques useful for electrochemical instrumentation.

CO2: Know the knowledge about different types of batteries with the functions which find use in their society including engineering fields.

CO3: Be familiar with corrosion of the instruments and equipment they use in their field and also to learn the mechanisms and the preventive measures by various techniques.

CO4: Know about the different types of spectroscopic techniques and applications.

CO5: Gain the knowledge about the silicon chips and their fabrication methods and to apply in preparation of in electrical and electronic instruments.

18NBS202	LINEAR ALGEBRA, NUMERICAL METHODS AND TRANSFORM CALCULUS *(Common to EEE, ECE, EIE & IBT Branches)*	SEMESTER II

Category : BS

PRE-REQUISITES: NIL

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

- To know about matrix theory to solve linear system and diagonalise a matrix by orthogonal transformation.
- To be familiar with numerical solutions of equation with one variable and the knowledge of numerical interpolation, numerical differentiation and numerical integration.
- To acquire knowledge of numerical solution to first order ordinary differential equations using single and multi step techniques.
- To gain the knowledge of numerical solution to second order partial differential equations using explicit and implicit methods.
- To be familiar with techniques of Laplace and Inverse Laplace transformation.

UNIT-I: MATRICES	**(9+3 Periods)**
Inverse and rank of a matrix, System of linear equations, Eigenvalues and eigenvectors, Diagonalization of matrices, Cayley-Hamilton Theorem, Orthogonal transformation and quadratic to canonical forms.	
UNIT-II: INTERPOLATION, NUMERICAL DIFFERENTIATION AND INTEGRATION	**(9+3 Periods)**
Solution of polynomial and transcendental equations: Newton-Raphson method. Finite differences, Relation between operators, Interpolation using Newton's forward and backward difference formulae. Interpolation with unequal intervals: Newton's divided difference and Lagrange's formulae. Numerical Differentiation and integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules.	
UNIT-III: NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS	**(9+3 Periods)**
Ordinary differential equations: Taylor's series, Euler and modified Euler's methods. Runge - Kutta method of fourth order for solving first and second order equations. Milne's and Adam's predicator-corrector methods.	
UNIT-IV: NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS	**(9+3 Periods)**
Partial differential equations: Finite difference solution two dimensional Laplace equation and Poission equation, Implicit and explicit methods for one dimensional heat equation (Bender-Schmidt and Crank-Nicholson methods), Finite difference explicit method for wave equation.	
UNIT-V : TRANSFORM CALCULUS	**(9+3 Periods)**
Laplace Transform, Properties of Laplace Transform, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Evaluation of integrals by Laplace transform, solving ordinary differential equations by Laplace Transform method.	

Contact periods:			
Lecture: 45 Periods	**Tutorial:15 Periods**	**Practical: 0 Periods**	**Total: 60 Periods**

TEXT BOOKS:

1. *B.S.Grewal,* ***"Higher Engineering Mathematics",*** *Khanna Publishers,New Delhi, 43rd Edition, 2015.*
2. *Srimanta Pal,* ***"Numerical Methods Principles, Analyses and Algorithms",*** *Oxford University Press, New Delhi, I st Edition 2009.*

REFERENCE BOOKS:

1. *Erwinkreyszig, **"Advanced Engineering Mathematics"**, 9th Edition, John Wiley&Sons, 2006.*
2. *N.P. Bali and Manish Goyal, **"A text book of Engineering Mathematics"**, Laxmi Publications, Reprint, 2008.*
3. *D.Poole, **"Linear Algebra: A Modern Introduction"**, 2nd Edition, Brooks/Cole, 2005.*
4. *P. Kandasamy, K. Thilagavathy, K. Gunavathi, **"Numerical Methods"**, S. Chand & Company, 3rd Edition, Reprint 2013.*
5. *S.S. Sastry, **"Introductory methods of numerical analysis"**, PHI, New Delhi, 5th Edition, 2015.*
6. *Ward Cheney, David Kincaid, **"Numerical Methods and Computing",** Cengage Learning**,** Delhi, 7th Edition 2013.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Solve the linear system of equations by rank of a matrix and matrix inversion and understand the process of diagonalisation by orthogonal transformation.

CO2: Acquire fluency in numerical solution to equation by Newton Raphson method, numerical interpolation techniques with equal and unequal intervals, numerical differentiation and integration.

CO3: Understand numerical solution to first order ordinary differential equations by single step and multistep methods.

CO4: Understand numerical solution to second order partial differential equations using finite differences.

CO5: Understand how to find Laplace and Inverse Laplace transforms with applications.

18NES203	ELECTRICAL CIRCUITS AND NETWORKS	SEMESTER II

Category : ES

PRE-REQUISITES: NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To learn the analysis of circuits and network reduction using mesh current and nodal voltage methods.
- To solve the Electrical circuits using network theorems.
- To understand the sinusoidal circuit reduction, types of power and power factors.
- To understand the concept of resonant and coupled circuits, complex frequency and free forced responses of RL, RC & RLC circuits.
- To get an insight into two-port networks.

UNIT-I : DC CIRCUITS ANALYSIS	**(9 Periods)**
Voltage, Current, Power and Energy – Ohm's law – Circuit Elements (R,L,C) – Independent and Dependent Sources – Kirchhoff's Laws – Series and Parallel Combinations of Elements – Voltage Division and Current Division – Node Analysis – Mesh Analysis with voltage and current sources – Three Phase Networks – Star/Delta Connection-Linearity – Superposition Theorem – Source Transformations – Thevenin's Theorem – Norton's Theorem – Maximum Power Transfer Theorem – Compensation Theorem – Reciprocity Theorem – Millman's Theorem – Telegen's Theorem.	
UNIT-II : DC CIRCUITS STEADY-STATE ANALYSIS	**(9 Periods)**
Singularity Functions – RC and RL Source – Free Circuits – Constant and Non-Constant Forcing Functions – Initial and Final Values – RLC Circuits – Time Domain Analysis.	
UNIT-III : STEADY-STATE ANALYSIS OF AC CIRCUITS	**(9 Periods)**
Sinusoids – Complex Numbers – Complex, Exponential Representations of Sinusoids – Impedance and Admittance – Analysis and Network Theorems for Sinusoidal Steady-State – Frequency Response – Resonance – Power Analysis – Instantaneous and Average Power – Power Factor and Power Factor Correction – Complex Power.	
UNIT-IV: INTRODUCTION TO RESONANCE & COUPLED CIRCUITS AND TRANSIENTS	**(9 Periods)**
Series resonant circuits-Q factor-Bandwidth-Parallel Resonance–Coupled circuits-Self and Mutual inductance-Inductance in series and parallel – Mutual and leakage flux – Coefficient of coupling–Step response of RC, RL and RLC circuits-series and parallel RLC circuit responses-responses to sinusoidal excitation.	
UNIT-V : TWO PORT NETWORKS	**(9 Periods)**
Introduction – T-to-n Transformation-Introduction to Three Terminal Networks – Equations of Two-Port Networks – Z and Y Parameters – Hybrid and Transmission Parameters – Relationships Between Two-Port Parameters – Inter-connection of Two-Port Networks – lattice Networks.	
Contact periods:	

Lecture: 45 Periods	**Tutorial:0 Periods**	**Practical: 0 Periods**	**Total: 45 Periods**

TEXT BOOKS:

1. *M.E.VanValkenburg, **"Network Analysis",** Prentice-Hall, Third Edition, 1974.*
2. *Vasudev. K, Aatre, **"Network Theory and Filter Design",** John Wiley&Sons, Second Edition, 1987.*
3. *Sudhakar, A. and Shyammohan S.Palli, **"Circuits and Networks Analysis and Synthesis",** Tata McGraw-Hill Publishing Company Limited, Third Edition, 2008.*

REFERENCE BOOKS

1. *Boylsted, R.L., **"Essentials of Circuit Analysis",** Prentice Hall, 2003.*
2. *William Hayt, Jack.E.Kemmerley and Steven. M.Durbin, **"Engineering circuit Analysis",** Tata McGraw-Hill, Sixth Edition, Reprint, 2008.*
3. *Alexander, C.K., Matthew, N.O., and Sadiku, **"Fundamentals of Electric Circuits",** Tata McGraw-Hill, 2003.*
4. *Joseph. A., Edminister, **"Theory and Problems of Electric Circuits",** Schaum's Outline Series, McGraw-Hill Book Company, Fourth Edition, 2003.*
5. *Richard, C., Dorf & James, A., Svoboda, **"Introduction to Eclectic Circuits",** John Wiley & Sons, Eighth Edition, 2010.*
6. *Decarlo, R.A. and Lin, P.M., **"Linear Circuit Analysis",** Oxford University Press, 2001.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Analyze simple DC and AC Circuits.

CO2: Apply and examine network theorems for basic electrical circuits.

CO3: Understand the concept of resonant and coupled circuits, complex frequency, free and forced responses of RL, RC, RLC circuits and two-port networks.

18NBS204	CHEMISTRY LABORATORY *(Common to All Branches)*	SEMESTER II

Category: BS

PRE-REQUISITES: NIL

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVES:

- To inculcate practical applications of chemistry to students and make him apply in the fields of engineering and technology.

LIST OF EXPERIMENTS			
1.	Estimation of hardness by EDTA method.		
2	Estimation of chloride by Argentometric method.		
3.	Conductometric titration of mixture of strong acid and weak acid using strong base.		
4.	Potentiometric titration of ferrous iron by dichromate.		
5.	Determination of Saponification value of an oil.		
6.	Estimation of Iron by Spectrophotometry.		
7.	Estimation of HCl by pH titration.		
8.	Determination of the rate constant of reaction.		
9.	Estimation of Dissolved Oxygen.		
Contact periods:			
Lecture: 0 Periods	**Tutorial: 0 Periods**	**Practical: 45 Periods**	**Total: 45 Periods**

REFERENCE BOOKS:

1. *A.O. Thomas,* ***"Practical Chemistry",*** *Scientific Book Centre, Cannanore, 2003.*
2. *Vogel's* ***"Text book of Quantitative Analysis"****, Jeffery G H, Basset J. Menthom J, Denney R.C., 6th Edition, EBS, 2009.*

COURSE OUTCOMES:

Upon the completion of the course, the student will be able to

CO1: Understand the nature of hardness, chloride level, pollution level using dissolved oxygen content, iron present in water and analyse them in water.

CO2: Apply the EMF and conductometric measurements in quantitative analysis of substances.

18NES205	ELECTRICAL CIRCUITS AND NETWORKS LABORATORY	SEMESTER II

Category : ES

PRE-REQUISITES: NIL

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVES:

- To study and simulate Ohm's and Kirchoff's law.
- To verify and analyze network theorems used in circuit analysis.
- To analyze transient response of circuits and to learn the parameters of coupled circuits.

LIST OF EXPERIMENTS			
1.	Verification of Ohm's law and Kirchhoff's law.		
2	Circuit analysis using Mesh analysis.		
3.	Circuit analysis using Nodal analysis.		
4.	Experimental verification of Superposition theorems.		
5.	Experimental verification of Thevenin theorems.		
6.	Experimental verification of Norton's theorems.		
7.	Series resonance of RL, RC and RLC circuits.		
8.	Parallel resonance of RL, RC and RLC circuits.		
9.	Estimation of parameter of two port DC network		
10.	Estimation of parameter of two port AC network		
11.	Transient analysis of series RLC circuits using Standard inputs		
12.	Study of Coupled Circuits.		
Contact periods:			
Lecture: 0 Periods	**Tutorial: 0 Periods**	**Practical: 45 Periods**	**Total: 45 Periods**

COURSE OUTCOMES:

CO1: Verify simple laws and theorems using electrical circuits.
CO2: Understand and verify the concept of resonance and transient analysis in electrical network.
CO3: Familiarize with two port network parameters.

18NES206	ENGINEERING GRAPHICS *(Common to All Branches)*	SEMESTER II

Category : ES

PRE-REQUISITES: NIL

L	T	P	C
2	0	4	4

COURSE OBJECTIVES:

- Geometrical constructions
- Orthographic projections.
- Performing section of solids and development of the same.
- Pictorial view of solids
- Familiarization of CAD packages.

UNIT-I : GEOMETRICAL CONSTRUCTIONS	**(6+12 Periods)**
Dimensioning-Lettering-Types of Lines-Scaling conventions-Dividing a given straight line in to any number of equal parts- Bisecting a given angle- Drawing a regular polygon given one side-Special methods of constructing a pentagon and hexagon.	
UNIT-II : ORTHOGRAPHIC PROJECTIONS	**(6+12 Periods)**
Introduction to Orthographic Projection-Projection of points-Projection of straight lines with traces - Conversion of pictorial views to orthographic views-Projection of solids	
UNIT-III : SECTION OF SOLIDS AND DEVELOPMENT	**(6+12 Periods)**
Section of solids- Development of surfaces	
UNIT-IV : PICTORIAL VIEWS	**(6+12 Periods)**
Isometric projections - Conversion of orthographic views to pictorial views (simple objects).	
UNIT-V : COMPUTER AIDED DRAFTING	**(6+12 Periods)**
Introduction to computer aided drafting package to make 2-D Drawings. OBJECT CONSTRUCTION – page layout – Layers and Line type – Creating, Editing and selecting the Geometric Objects MECHANICS – Viewing, Annotating, Hatching and Dimensioning the drawing – Creating Blocks and Attributes, DRAFTING – Create 2D drawing. A number of chosen problems will be solved to illustrate the concepts clearly. (Demonstration purpose only, not be included in examinations)	
Contact periods:	

Lecture: 30 Periods	**Tutorial: 0 Periods**	**Practical: 60 Periods**	**Total: 90 Periods**

TEXT BOOKS:

1. *K.Venugopal, **"Engineering Graphics"**, New Age International (P) Limited, 2015.*
2. *K.L.Narayana and P.Kannaiah, **"Text book on Engineering Drawing,"** 2nd Edition, SciTech Publications (India) Pvt. Ltd, Chennai, 2009.*

REFERENCE BOOKS:

1. *Dhananjay.A.Jolhe, **"Engineering Drawing"**, Tata McGraw Hill Publishing Co., 2007.*
2. *K.V.Nataraajan, **"A text book of Engineering Graphics"**, Dhanalakashmi Publishers, Chennai, 2006.*
3. *M.B.Shah and B.C. Rana, **"Engineering Drawing"**, Pearson Education, 2005.*
4. *Luzadder and Duff, **"Fundamentals of Engineering Drawing"**, Prentice Hall of India Pvt Ltd, XIth Edition, 2001.*
5. *Alan Kalameja, **"AutoCAD 2008: A tutor for Engineering Graphics",** Auto Desk Press 2007*
6. *CAD Software manuals of latest version.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Represent solids as per international standards.

CO2: Generate and interpret multiple views through development, interpretation and sectional views.

CO3: Generate and interrupt orthographic views.

CO4: Generate and interrupt pictorial views.

CO5: Towards the end of the course it is expected that the students would be matured to visualize the engineering components.

18NHS301	**BUSINESS COMMUNICATION SKILLS** *(Common to Mech, EEE, Production & EIE branches)*	**SEMESTER - III**

PRE-REQUISITES: NIL

Category : HS

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To impart knowledge on effective Business Communication Skills

UNIT I : **ACQUISITION OF GOOD ENGLISH**	**(9 Periods)**
Parts of speech, Tenses, Vocabulary, Choice of words, Synonyms, Antonyms, Homonyms, Homophones, Prefixes, Suffixes, One word substitutes, Idioms, Phrasal verbs, Abbreviations, Acronyms.	
UNIT II : BUSINESS WRITING	**(9 Periods)**
Sentence structure & patterns, SV Agreement, Punctuation, Email, Letter writing: Application, Interview, Appointment, Confirmation, Reference, Good will, Congratulatory, and thanking letters, Report writing, Precise writing: Summarizing matters reported in dailies & journals, decisions taken in meetings & conferences.	
UNIT III : **BUSINESS CORRESPONDENCE**	**(9 Periods)**
Enquiry: Types, Purpose, Notice inviting Tenders, Placing order, Making, Handling & Rejecting complaints, Sales letters, Market surveys, Status reports, Advertisements, Classifieds, Memo reports, Office circulars, Memorandums, and Report writing.	
UNIT IV : **BUSINESS COMMUNICATION**	**(9 Periods)**
Verbal & Non-Verbal communication, Body language, Soft skills, Pronunciation, Stress & Intonation, Inviting people, Accepting or Declining offers, Conveying or leaving messages over phone, Presentation, Negotiation, Speaking at a meeting.	
UNIT V : **INTERPERSONAL COMMUNICATION IN ORGANIZATIONS**	**(9 Periods)**
Skills needed to develop effective teams, Group Communication, Professional etiquettes, Interpersonal communication, Team roles, Effective listening and speaking, Critical thinking, Technology and communication.	
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**	

TEXT BOOKS

1. *Bisen, Vikram & Priya.* ***"Business Communication"****, New Age International Publishers, New Delhi, 2009*
2. *Thomas.L.Means.* ***"Business Communication"****. South-Western Cengage Learning, USA, 2010.*
3. *Adhikari, Bhavana & Sethi, Anjanee.* ***"Business Communication"****, Tata McGraw Hill Education Private Ltd., New Delhi, 2010*

REFERENCE BOOKS

1. *Simon Sweeney. "**English for Business Communication"**, Cambridge University Press, Cambridge, 2007.*
2. *Hartley, Peter & Bruckmann G. Clive. **"Business Communication"**, Routledge, New York, 2007*
3 *Locker O. Kitty. '**Business Communication'** McGrill, New York, 2009*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Acquire English language skills.

CO2: Familiarize English language usage for business contexts.

CO3: Develop business correspondence.

CO4: Execute effective business communication.

CO5: Practice good interpersonal communication.

COURSE ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	L									M	L	M		M	L
CO2	L									M	L	M		M	L
CO3	L									M	L	M		M	L
CO4	L									M	L	M		M	L
CO5	-									M	L	M		M	L
18NHS 301	L									M	L	M		M	L

L-Low, M-Moderate (medium), H-High

18NBS302	BIOLOGY FOR ENGINEERS	SEMESTER - III

PRE-REQUISITES: NIL

Category : BS

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To get familiarized with human anatomy and physiology

UNIT I : **BASICS OF CELL BIOLOGY**	**(9 Periods)**
An Overview of cells – Origin and evolution of cells. Cell theory, Classification of cells – prokaryotic cells and eukaryotic cells. Structure of prokaryotic and eukaryotic cells and their organelles. Comparison of prokaryotic and eukaryotic cells, Transport across membranes – diffusion - active and passive diffusion.	
UNIT II : BASICS OF MICROBIOLOGY	**(9 Periods)**
Classification of microorganism, Microscopic examination of microorganisms, Structural organization and multiplication of bacteria, viruses, algae and fungi, Microorganism used for the production of penicillin, alcohol and vitamin B-12.	
UNIT III : **HUMAN ANATOMY AND PHYSIOLOGY**	**(9 Periods)**
Basics of human anatomy, tissues of the human body: epithelial, connective, nervous and muscular, Nervous system, Respiratory System, Circulatory system and Digestive system.	
UNIT IV : **BIO MOLECULES AND IMMUNE SYSTEM**	**(9 Periods)**
Introduction to Biochemistry, Classification, structure and properties of carbohydrates, proteins, lipids and nucleic acids. Innate and acquired immunity, Types of immune responses.	
UNIT V : **APPLIED BIOLOGY FOR ENGINEERS**	**(9 Periods)**
Overview of biosensors - glucometer applications - medicine, Microarray analysis to diagnose cancer, Microbial production of biofuels, Applications of stem cells	
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**	

TEXT BOOKS

1. *Darnell J, Lodish H, Baltimore D, **"Molecular Cell Biology"**, W.H.Freeman; 8th edition,2016*
2. *Pelczar MJ, Chan ECS and KreinNR, **"Microbiology"**, Tata McGraw Hill, 5th edition, New Delhi.2001*
3. *WulfCruger and AnnelieseCruger, **"A Textbook of Industrial Microbiology"**, Panima Publishing Corporation, 2nd Edition, 2000.*

REFERENCE BOOKS

1. *David L. Nelson and Michael M Cox, **"Lehninger's Principles of Biochemistry"**, Macmillan Worth Publisher, 4th edition, 2004.*
2. *Brain R.Eggins ,**"Chemical Sensors and Biosensors"**, John Wiley & Sons, 2002*
3. *Anton Moser, **"Bioprocess Technology, Kinetics and Reactors"**, Springer, Berlin (Verlag),1st edition, 1998*
4. *Kuby J, **"Immunology"**, WH Freeman & Co., 2013.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1 Recognize the functions of cell and their structural organization

CO 2 Describe the mechanisms and role of cell in immune system

CO 3 Get familiarized biomolecules and human anatomy system

CO 4 Illustrate the applications of microbes in industrial process

CO 5 Apply the engineering concepts in biology

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	L	L	L	-	-	-	-	-	-	-	-	-	L	L	L
CO2	L	M	-	L	-	-	L	M	-	-	-	-	L	M	M
CO3	L	M	L	L	-	-	-	L	M	-	-	L	L	M	M
CO4	L	L	L	L	M	-	-	-	L	-	-	-	L	L	L
CO5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18NBS 302	L	M	L	L	M	-	L	M	M	-	-	L	L	M	M

L-Low, M-Moderate(medium), H-High

18NES303	PRINCIPLES OF ELECTRICAL MACHINES (Qualitative Treatment Only)	SEMESTER III

Category : ES

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

* To impart the knowledge on energy conversion and generation of DC and AC power and Testing of electrical machines and identify their suitability for real time application.

UNIT I : **DC MACHINES**	**(9 Periods)**
Principle of operation - construction – EMF and torque equation – Characteristics of different types of DC generators and motors – starting, and speed control characteristics of DC motors.	
UNIT II : TRANSFORMERS	**(9 Periods)**
Principle of operation – Types and constructional features of single phase and three phase transformers – EMF equation- Phasor diagrams – Equivalent circuit – Regulation and efficiency – Autotransformers.	
UNIT III : INDUCTION MACHINES	**(9 Periods)**
Constructional features of three phase Induction motors – Principle of Operation – torque-slip characteristics – starting, and speed control methods – solid state control– Principle of operation and types of single phase Induction motors.	
UNIT IV : **SYNCHRONOUS MACHINES**	**(9 Periods)**
Types and general constructional features – EMF equation – regulation – power angle curve – phasor diagram of synchronous motor – starting methods.	
UNIT V : **SPECIAL MOTORS AND INTRODUCTION TO DRIVES**	**(9 Periods)**
Principle of operation of Universal motor – Reluctance and Hysteresis motor – Stepper motors –Switched reluctance motor- Linear Induction motor – BLDC. Introduction to drives - Types of electrical drives – factors influencing the choice of electrical drives- loading conditions and classes of duty- determination of power rating.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS:

1. *Kothari D.P. and Nagrath I.J **"Electric Machines"** Tata McGraw Hill, Fourth Edition, 2011*
2. *Theraja B.L. and Theraja A.K **"A Text Book of Electrical Technology- Vol. II",** S.Chand and Co. Ltd., New Delhi, 2007*
3. *Pillai S.K **" A First Course on Electrical Drives"** New Age International Publishers, New Delhi,2010*

REFERENCE BOOKS:

1. *Fitzgerald A.E.,Kingsly C. and Kusko A.* ***"Electric Machinery"*** *Tata McGraw Hill, 2007*
2. *Irving.L.Kosow,* ***"Electrical Machinery and Transformers"*** *Prentice Hall, 2nd Edition, 2007.*
3. *Stephen J Chapman* ***"Electric Machinery"*** *Tata McGraw Hill, Fourth Edition 2005*
4. *Sen.S.K,* ***"Electric Drives"*** *Prentice Hall, 2009.*
5. *Vedam Subramaniam* ***" Electric Drives- Concepts and Applications"*** *Tata McGraw Hill ,2011*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Illustrate the construction, working, characteristics and applications of AC and DC machines.

CO 2: Evaluate the performance characteristics of electrical machines for the different level of utilization in industries

CO 3: Apply the concepts of static and dynamic electrical machines and the principles of electromagnetism.

CO 4: Control the parameters in electrical machines and identify their suitability for real time application

CO 5: Select the appropriate drives and special motors for industrial applications.

COURSE ARTICULATION MARTIX:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12	PSO 1	PSO 2	PSO 3
CO1	H	M	M	M	L	M	H	L	H	M	H	M	H	L	M
CO2	H	H	M	H	M	L	H	M	H	H	H	M	H	M	M
CO3	H	H	H	H	M	M	M	M	H	H	M	H	H	M	H
CO4	H	H	M	H	M	M	M	M	H	H	M	H	H	M	H
CO5	H	M	M	M	L	M	M	M	M	M	H	M	H	L	M
18NES 303	H	H	M	M	M	M	M	M	H	H	M	M	H	M	M

L- Low, M-Moderate (Medium), H-High

18NPC304	ELECTRONIC CIRCUITS	SEMESTER III

Category : PC

PRE-REQUISITES: NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge on the working of semiconductor devices and the operation of electronic circuits

UNIT I : SEMI CONDUCTOR DIODES	**(9 Periods)**
Introduction to semiconductors: chemical bonding, effect of temperature, drifts current, diffusion current, electrical properties. PN junction diode: working, characteristics, diode equations, applications as clipper, clamper, rectifier. Construction, working, applications of: Zener diode, Varactor diode, Tunnel diode, Schottky diode. Characteristics and applications of uni-junction Transistor, Silicon Controlled Rectifier, DIAC and TRIAC.	
UNIT II : BIPOLAR JUNCTION TRANSISTOR	**(9 Periods)**
Transistor: construction, operation, characteristics and parameters –Transistor as a switch, as an amplifier. Transistor biasing: Voltage divider bias, fixed bias, emitter bias, collector feedback bias – DC and AC load lines - bias stabilization. CE, CC and CB amplifiers: Small signal low frequency transistor amplifier circuits, h-parameter representation.	
UNIT III : FIELD EFFECT TRANSISTORS	**(9 Periods)**
JFET: characteristics, parameters, working in CS, CD, CG mode, Q point. JFET biasing: self bias, voltage divider bias – FET as an amplifier and a VVR. MOSFET: characteristics, parameters, working in enhancement and depletion mode – MOSFET biasing: zero bias, voltage divider bias, drain feedback bias.	
UNIT IV : MULTI STAGE AMPLIFIERS AND POWER AMPLIFIERS	**(9 Periods)**
Multistage amplifier: RC coupling, direct coupling, transformer coupling and Darlington amplifier. Differential amplifier: operation in common and difference mode, AC and DC analysis. Classification of Power amplifiers: Class A, B, AB and C Power amplifiers. Push-Pull and Complementary Symmetry Push-Pull amplifiers - Design of power output, efficiency and cross-over distortion.	
UNIT V : FEEDBACK AMPLIFIERS AND MULTIVIBRATORS	**(9 Periods)**
Negative feedback: Advantages, Voltage/Current, series/shunt feedback. Positive feedback – Barkhausen criterion for oscillation, Phase shift, Wein Bridge, Hartley, Colpitts and Crystal oscillators. Multivibrator: operation of Monostable, Astable and Bi-stable Multivibrator.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS:

1. *Robert Boylestad, Louis Nashelsky, **"Electronics Devices and Circuit Theory"**, Prentice Hall of India, Eleventh Edition, 2012.*
2. *Jacob Millman, Christos C Halkias, Satyabrata, **"Electronic Devices and Circuits",** McGraw Hill, Fourth Edition, 2015.*
3. *Allen Mottershead, **"Electronic Devices and Circuits: An Introduction"**, Prentice Hall of India, First Edition, 2011.*

REFERENCE BOOKS:

1. *Thomas L Floyd,* ***"Electronic Devices",*** *Pearson Education, Tenth Edition, 2017.*
2. *David A Bell,* ***"Fundamentals of Electronic Devices and Circuits"****, Oxford Higher Education, Fifth Edition, 2012.*
3. *Albert Malvino, David J Bates,* ***"Electronic Principles"*** *McGraw Hill. Seventh Edition, 2012.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the operation of semiconductor devices
CO2: Evaluate the parameters of Electronic devices
CO3: Analyze the operation of simple electronic circuits
CO4: Choose the devices for particular applications
CO5: Design the amplifier and multivibrator circuits using semiconductor devices

COURSE ARTICULATION MATRIX:

PO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	M	M	M					M		M	H	M		M
CO2	M	H	M	M					M		M	M	M	M	M
CO3	H	M	H	M					M		M	M	M	M	M
CO4	M	M	M	M					M		M	M	M	M	M
CO5	M	M	H	M					M		M	M	M	M	M
18NPC 304	M	M	M	M					M		M	M	M	M	M

L - Low, M - Moderate (Medium), H - High

18NPC305	SENSORS AND TRANSDUCERS	SEMESTER - III

PRE-REQUISITES: NIL

Category: PC

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To impart knowledge about the measurement, errors in measurement and their analysis, and to have adequate knowledge on the characteristics of sensors and variable resistive, capacitive, inductive transducers.

UNIT I : CHARACTERISTICS OF TRANSDUCERS	**(9 Periods)**
Measurements - Basic methodology of measurement systems – general input – output configuration – Units and standards –Errors- Classification of errors - Statistical analysis – Sensors – Transducers - classification of transducer – selection of transducer– calibration- Static and Dynamic characteristics of Transducers - Mathematical model of transducer -Zero, First and Second order transducers- Response to impulse, step, ramp and sinusoidal inputs.	
UNIT II : VARIABLE RESISTANCE TRANSDUCERS	**(9 Periods)**
Principle, Operation, Characteristics and Applications of Potentiometer – Strain gauge – Load cell - Piezo resistive sensor – Load and Torque measurement.	
UNIT III : VARIABLE INDUCTANCE AND CAPACITANCE TRANSDUCERS	**(9 Periods)**
Induction Potentiometer – LVDT – RVDT - Eddy current transducers - Proximity Sensor – Capacitive transducer – Tachogenerators – Stroboscope- Principle , Operation, Characteristics and Applications.	
UNIT IV : SEISMIC TRANSDUCERS	**(9 Periods)**
Piezoelectric transducers and their signal conditioning, Photo electric transducers, Hall effect sensors, Magnetostrictive sensor. Basics of Gyroscope, Seismic instrument and Accelerometers.	
UNIT V : OTHER TRANSDUCERS	**(9 Periods)**
Digital Transducer - Fiber optic sensor – MEMS – Nano sensors – Smart Sensors - Principle, Operation, Characteristics and Applications.	
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**	

TEXT BOOKS

1. *J. P. Bentley, **"Principles of Measurement Systems"**, Addison Wesley Longman Ltd., UK, 2010*
2. *E. O. Doeblin, **"Measurement Systems: Applications and Design"**, Tata McGraw-Hill Book Co., 2017*
3. *S. Renganathan, **"Transducer Engineering"**, Allied Publishers, 2012*

REFERENCE BOOKS

1. *D. Patranabis, **"Sensors and Transducers"**, Prentice Hall India Pvt. Ltd, 2007*
2. *D. V. S. Murthy, **"Transducers and Instrumentation"**, Prentice Hall of India Pvt. Ltd., New Delhi, 2009*
3. *H. K. P. Neubert, **"Instrument Transducers – An Introduction to their Performance and Design",** Oxford University Press, Cambridge, 2009*
4. *W.Bolton, **"Engineering Science"**, Elsevier Newnes, Fifth edition, 2006.*
5. *Ian Sinclair, **"Sensors and Transducers"**, 3rd Edition, Elsevier, 2012.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1 Choose the apt sensor/ transducer for a given application.

CO 2 Determine the static and dynamic characteristics of sensors/transducers.

CO 3 Describe the characteristics of resistive, inductive and capacitive transducers.

CO 4 Compare the zero, first, second order transducer.

CO 5 Illustrate the principle of operation of sensors/transducers.

COURSE ARTICULATION MATRIX:

PO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	L	L	M	M	M	L	L	M	M	H	H	M	L	H	M
CO2	H	H	H	M	M	L	M	L	L	L	H	L	L	H	M
CO3	L	L	L	M	M	M	L	M	L	L	H	L	L	H	H
CO4	H	H	H	H	L	L	L	L	M	M	M	L	M	M	M
CO5	L	L	L	L	L	L	M	M	M	M	H	M	M	M	H
18NPC 305	M	M	M	M	M	L	L	L	L	M	H	L	L	M	M

L - Low, M - Moderate (Medium), H – High

18NPC306	MEASUREMENTS AND INSTRUMENTATION	SEMESTER - III

PRE-REQUISITES: NIL

Category: PC

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To understand the use of instruments and techniques for practical measurements required in electrical and electronic measurements.

UNIT I : **VOLTAGE AND CURRENT MEASUREMENTS**	**(9 Periods)**
Introduction to Electrical measurements - Construction, Principle of operation and torque equation of Moving Coil, Moving Iron, Dynamometer, Thermal and Rectifier Instruments - Extension of Instruments range - Calibration – Application - AC and DC current Probes.	
UNIT II : **POWER AND ENERGY MEASUREMENTS**	**(9 Periods)**
Electro-dynamic wattmeter, Thermal wattmeter and Compensated wattmeter - Single and three phase power measurement - Low power factor watt meter - calibration of wattmeter. Induction type energy meter - Phantom loading - Calibration of energy meter - Power factor meter.	
UNIT III : **RESISTANCE AND IMPEDANCE MEASUREMENTS**	**(9 Periods)**
DC Bridges - Wheatstone bridge, Kelvin double bridge and direct deflection methods - Megger. AC Bridges - Maxwell, Wien's bridge - Hay's bridge - Anderson's bridge - Maxwell's inductance capacitance bridge - Schering bridge.	
UNIT IV : **ELECTRONIC MEASUREMENTS**	**(9 Periods)**
Digital Voltmeter - Analog and digital multimeters - Digital wattmeter --True RMS meter - Q-meter - Signal generators - Measurement of period, time, frequency and phase difference.	
UNIT V : **WAVEFORM ANALYZING INSTRUMENTS**	**(9 Periods)**
Digital Oscilloscopes - Wave analyzer - Spectrum analyzer - Distortion meter. Introduction to Virtual Instruments (VI) - Realization of Test and Measuring instruments using VI.	
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**	

TEXT BOOKS

1. *David.A.Bell,* ***"Electronic Instrumentation and Measurement Techniques"*** *Prentice Hall, 3rd Edition, 2013.*
2. *E.W. Golding and F.C. Widdis,* ***"Electrical Measurements and Measuring Instruments"*** *A.H.Wheeler and Co, 5th Edition, 2011.*

REFERENCE BOOKS

1. *Cooper, W.D. and Helfric, A.D.* ***"Electronic Instrumentation and Measurements"*** *Prentice Hall of India, 2nd Edition, 2009.*
2. *Kalsi.H.S,* ***"Electronic Instrumentation"****, Tata McGraw Hill Education Private Limited, 3rd Edition, 2012.*
3. *A.K. Sawhney, Puneet Sawhney,* ***"A Course in Electronic and Electrical Measurements and Instrumentation"****, S.K.Kataria & Sons, Delhi, 2014.*
4. *Sanjay Gupta and Joseph John* ***"Virtual Instrumentation using Lab VIEW"*** *Tata-McGraw Hill, 2nd Edition, 2010.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Explain the principle and operation of instruments used for the measurement of voltage and current, power and energy instruments, waveform analyzers and signal instruments

CO 2 : Use the concept of bridges in instrumentation application.

CO 3: Apply the knowledge of electrical measurement techniques to design circuits.

CO 4: Analyze the range, pros and cons of different instruments.

CO 5: Suggest suitable type of instruments for various measurements.

COURSE ARTICULATION MATRIX:

PO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	M	M	L	L	L	H	L	M	M	L	H	M	L
CO2	H	H	H	H	L	L	L	H	L	M	M	L	H	M	L
CO3	H	H	H	H	L	L	M	H	L	M	M	L	H	M	L
CO4	H	H	H	H	L	L	L	H	L	M	M	L	H	M	L
CO5	H	H	H	H	M	L	L	H	L	M	M	L	H	M	L
18NPC 306	H	H	H	H	L	L	L	H	L	M	M	L	H	M	L

L - Low, M - Moderate (Medium), H – High

18NMC3Z7	ENVIRONMENTAL SCIENCES AND ENGINEERING *(Common to All branches)*	SEMESTER-III

PRE-REQUISITES: NIL

Category : MC

L	T	P	C
3	0	0	0

COURSE OBJECTIVES:

- The course is aimed at creating awareness among students and also to inseminate the critical ideas of preserving environment.

UNIT I: ENVIRONMENTAL RESOURCES	**(9 Periods)**
Natural resources-Forest – benefits, over exploitation, deforestation & consequences – Water- unique features, hydrological cycle & over exploitation – Food -effect of modern agriculture, fertilizers, pesticides, eutrophication & biomagnifications- Energy resources - renewable & non-renewable resources - wind, solar and tidal-harnessing methods.	
UNIT II: ECO SYSTEM AND BIODIVERSITY	**(9 Periods)**
Ecology - ecosystem, physical and chemical components of ecosystem, biological components of ecosystem, forest ecosystem, desert ecosystem and pond ecosystem, Energy flow in ecosystem, nitrogen cycle and carbon dioxide cycle, food pyramid, Ecological succession, Biodiversity - types, values of biodiversity, hot spots of biodiversity, endangered and endemic species, conservation of biodiversity – in situ – ex situ conservation.	
UNIT III: ENVIRONMENTAL POLLUTION	**(9 Periods)**
Air pollution, classification of air pollutants – sources, effects and control of gaseous pollutants SO_2, NO_2, H_2S, CO, CO_2 and particulates, control methods - cyclone separator and electrostatic precipitator, water pollution - classification of water pollutants, organic and inorganic pollutants, sources, effects and control of water pollutants, soil pollution- sources, effects and control, noise pollution - decibel scale , sources, effects and control.	
UNIT IV: ENVIRONMENTAL THREATS	**(9 Periods)**
Acid rain, greenhouse effect, global warming and ozone depletion, disaster management - flood, drought, earthquake and tsunami, Threats to biodiversity-destruction of habitat, habit fragmentation-hunting, over exploitation and man-wildlife conflicts, The IUCN red list categories, status of threatened species.	
UNIT V: SOCIAL ISSUES AND ENVIRONMENT	**(9 Periods)**
Sustainable development- sustainable technologies, need for energy and water conservation, rain water harvesting, water shed management, waste land reclamation, Pollution control Act, Wild life protection act, Forest conservation act, population growth- exponential and logistic growth, variation in population among nations, population policy, women and child welfare programs, role of information technology in human and health, HIV/AIDS - effects and preventive measures.	

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1. *Sharma J.P., **"Environmental Studies",** 3rd Edition, University Science Press, New Delhi 2009.*
2. *Anubha Kaushik and C.P.Kaushik, **"Environmental Science and Engineering",** 3rd Edition, New age International Publishers, New Delhi, 2008.*

REFERENCE BOOKS:

1. *R.K.Trivedi,* ***"Hand book of Environmental laws, Rules, Guidelines, Compliances and Standards"****, Vol.I&II, Environ Media, 2006.*
2. *G.TylerMiller, JR,* ***"Environmental Science",*** *Tenth Edition, Thomson BROOKS / COLE Publishing, 2004.*
3. *Gilbert M.Masters,* ***"Introduction to Environmental Engineering and Science",*** *2nd Edition, Pearson Education, 2004.*

COURSE OUTCOMES:

Upon the completion of the course, Students will be able to

CO1: To know about the various environmental resources, the effective utility and problems accompanied in over exploitation.

CO2: To acquire knowledge about the interaction of biosphere with environment and conservation methods of bio diversity.

CO3: To be aware of the sources of various types of pollution, their ill effects and preventive methods.

CO4: To understand the environmental threats, Acid rain, Green house effect and Ozone depletion and natural disasters.

CO5: To create an idea about sustainable development and social issues.

COURSE ARTICULATION MATRIX:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	L	H	L	M	M	M	M	M	M	L	L	L	L	M
CO2	M	L	L	L	L	L	L	L	L	L	L	L	M	L	L
CO3	L	L	H	L	L	L	M	M	L	M	L	L	L	L	L
CO4	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L
CO5	M	L	H	L	L	L	H	H	L	M	L	L	M	L	M
18NMC 3Z7	M	L	H	L	L	L	M	M	L	M	L	L	L	L	L

L - Low, M - Moderate (Medium), H - High

18NPC308	SENSORS AND MEASUREMENT LABORATORY	SEMESTER-III

PRE-REQUISITES: NIL

Category : PC

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVE

* To impart knowledge of measuring electrical parameters and to understand the physical principles of various sensors.

LIST OF EXPERIMENTS

1. Characteristics of Photodiode and LDR
2. Characteristics of RTD, Thermistor and Thermocouple
3. Characteristics of Linear Displacement Transducer (LVDT)
4. Characteristics of Strain Gauge and Load Cell
5. Loading effect of Potentiometer
6. Digital Transducer – Shaft Angle Encoder
7. Pressure Transducer
8. Wheatstone and Kelvin's bridge for measurement of resistance.
9. Schering Bridge for capacitance measurement
10. Anderson Bridge for inductance measurement
11. Maxwell's inductance bridge
12. Wien's bridge for frequency measurement
13. Extension the range of voltmeter and ammeter

Contact Periods :
Lecture : 0 Periods **Tutorials : 0 Periods** **Practical : 45 Periods** **Total : 45 Periods**

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Obtain the characteristics of different types of transducers.
CO 2 : Create the different types of bridges for measurement of resistance, capacitance and inductance.
CO 3: Identify suitable sensors for a particular application.
CO 4: Work as a member of a team while carrying out experiments.
CO 5: Develop generic skills in project management, project documentation and reporting.

COURSE ARTICULATION MATRIX:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	M	M	M		M	M		M	M	M	M	H	M	M
CO2	M	M	L	M		M	M		M	M	M	H	M	M	M
CO3	M	M	M	M		L	M		M	M	M	M	M	M	M
CO4	M	M	M	M		M	M		M	M	M	M	M	M	M
CO5	M	M	M	M		M	M		M	M	M	M	M	M	M
18NPC 308	M	M	M	M		M	M		M	M	M	M	M	M	M

L-Low, M-Moderate(medium), H-High

18NPC309	ELECTRONIC DEVICES AND CIRCUITS LABORATORY	SEMESTER-III

PRE-REQUISITES: NIL

Category : PC

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVE

* To provide hands on experience on working with semiconductor devices

LIST OF EXPERIMENTS

1. Characteristics of Diode and application as clipper circuits
2. Characteristics of Zener diode and Zener voltage regulator
3. Characteristics of BJT
4. Application of BJT as an amplifier and switch
5. Characteristics of JFET
6. Characteristics of SCR, DIAC, TRIAC
7. Characteristics of UJT
8. Design of Oscillators
9. Design of RC coupled amplifier
10. Design of Push Pull amplifier
11. Design of Multivibrator
12. Design of Differential amplifier

Contact Periods:

Lecture: 0 Periods **Tutorials: 0 Periods** **Practical: 45 Periods** **Total: 45 Periods**

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Build the circuits using electronic devices and debug them.

CO 2 : Differentiate the devices based on their characteristics

CO 3: Design signal conditioning circuits for semiconductor devices

CO 4: Work as a member of a team while carrying out experiments.

CO 5: Develop generic skills in project management, project documentation and reporting.

COURSE ARTICULATION MATRIX:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	M	M	M		M	M		M	M	M	M	H	M	M
CO2	M	M	L	M		M	M		M	M	M	H	M	M	M
CO3	M	M	M	M		L	M		M	M	M	M	M	M	M
CO4	M	M	M	M		M	M		M	M	M	M	M	M	M
CO5	M	M	M	M		M	M		M	M	M	M	M	M	M
18NPC 309	M	M	M	M		M	M		M	M	M	M	M	M	M

L-Low, M-Moderate (medium), H-High

18NHS401	**PROFESSIONAL ETHICS** *(Common to MECH, EEE, ECE, EIE & IT Branches)*	**SEMESTER-IV**

PRE-REQUISITES: NIL

Category : HS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To possess knowledge on ethics, safety, rights, responsibilities and global issues on engineering and technology.

UNIT I : **ENGINEERING ETHICS**	**(9 Periods)**
Senses of 'Engineering Ethics' - Variety of moral issued - Types of inquiry - Moral dilemmas - Moral autonomy - Kohlberg's theory - Gilligan's theory - Consensus and controversy – Models of Professional Roles - Theories about right action - Self-interest - Customs and religion - Uses of ethical theories	
UNIT II : ENGINEERING AS SOCIAL EXPERIMENTATION	**(9 Periods)**
Engineering as experimentation - Engineers as responsible experimenters - Codes of ethics - A balanced outlook on law - The challenger case study.	
UNIT III : **SAFETY**	**(9 Periods)**
Safety and risk - Assessment of safety and risk - Risk benefit analysis and reducing risk - The three mile island and chernobyl case studies.	
UNIT IV : **RESPONSIBILITIES AND RIGHTS**	**(9 Periods)**
Collegiality and loyalty - Respect for authority - Collective bargaining - Confidentiality - Conflicts of interest - Occupational crime - Professional rights - Employee rights - Intellectual Property Rights (IPR) - Discrimination.	
UNIT V : GLOBAL ISSUES	**(9 Periods)**
Multinational corporations - Environmental ethics - Computer ethics - Weapons development - Engineers as managers - Consulting engineers - Engineers as expert witnesses and advisors - Moral leadership - Sample code of Ethics like ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management, Institution of Electronics and Telecommunication Engineers(IETE)(India).	

Contact Periods:

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS

1. *Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, **"Engineering Ethics – Concepts and Cases",** Cengage Learning, 2009*
2. *Mike Martin and Roland Schinzinger **"Ethics in Engineering"** McGraw-Hill, New York 1996*
3. *Govindarajan M, Natarajan S, Senthil Kumar V. S "**Engineering Ethics**" Prentice Hall of India, New Delhi, 2004*

REFERENCE BOOKS

1. *Charles D. Fleddermann,* ***"Engineering Ethics",*** *Pearson Education / Prentice Hall, New Jersey,2004 (Indian Reprint)*
2. *Charles E Harris, Michael S. Protchard and Michael J Rabins, "****Engineering Ethics– Concepts and Cases****", Wadsworth Thompson Learning, United States, 2000 (Indian Reprint now available).*
3. *John R Boatright, "****Ethics and the Conduct of Business****", Pearson Education, New Delhi, 2003.*
4. *Edmund G Seebauer and Robert L Barry, "****Fundamentals of Ethics for Scientists and Engineers****", Oxford University Press, Oxford, 2001*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Recognize the theories and principles of professional ethics.

CO2: Understand the basic perception of profession, professional ethics, various moral issues & uses of ethical theories..

CO3: Understand various social issues, industrial standards, code of ethics and role of professional ethics in engineering field.

CO4: Analysis of safety and risk benefit analysis.

CO5: Acquire knowledge on professional rights and responsibilities of an engineer.

CO6: Outline the global issues and codes of ethics.

COURSE ARTICULATION MATRIX:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	M	M	M	L	H	M	M	H	M	H	H	H	L	H
CO2	H	M	M	M	L	H	M	M	H	M	H	H	H	L	H
CO3	H	M	M	M	L	H	M	M	H	M	H	H	H	L	H
CO4	H	M	M	M	L	H	M	M	H	M	H	H	H	L	H
CO5	H	M	M	M	L	H	M	M	H	M	H	H	H	L	H
CO6	H	M	M	M	L	H	M	M	H	M	H	H	H	L	H
18NHS 401	H	M	M	M	L	H	M	M	H	M	H	H	H	L	H

L- Low, M-Moderate (Medium), H-High

18NBS402	PROBABILITY AND APPLIED STATISTICS *(Common to EEE & EIE branches)*	SEMESTER-IV

PRE-REQUISITES: NIL

Category : BS

L	T	P	C
3	1	0	4

COURSE OBJECTIVE

- To gain the knowledge of basic probability concepts, test of hypothesis, Random process and Markov chains

UNIT I : **PROBABILITY AND RANDOM VARIABLES**	**(9+3 Periods)**
Samplespaces – Events - Probability Axioms – Conditional Probability – Independent Events – Baye's Theorem. Random Variables**:** Distribution Functions – Expectation – Moments - Moment Generating Functions.	
UNIT II : PROBABILITY DISTRIBUTIONS	**(9+3 Periods)**
Binomial, Poisson, Geometric, Uniform, Exponential, Normal, Gamma, Weibull (Mean, Variance and Simple problems). Functions of random variables.	
UNIT III : **TWO DIMENSIONAL RANDOM VARIABLES**	**(9+3 Periods)**
Joint distributions – Marginal Distributions – Conditional distributions – Covariance – Correlation and Regression – Transformation of random variables – Central Limit Theorem.	
UNIT IV : **TESTING OF HYPOTHESIS**	**(9+3 Periods)**
Large Samples: Tests for Mean and proportions – Small samples: Tests for Mean, Variance and Attributes using t, F, Chi – Square distribution.	
UNIT V : **RANDOM PROCESSES**	**(9+3 Periods)**
Definition and Examples - First and Second order, Strict sense stationary, Wide sense stationary and ergodic processes- Markov processes – Poisson processes - Birth and Death processes - Markov chains - Transition probabilities - Limiting distributions.	
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60 Periods**	

TEXT BOOKS

1. *Veerarajan. T., **"Probability and Random Processes (with Queueing Theory and Queueing Networks)",** McGraw Hill Education (India)Pvt Ltd., New Delhi, Fourth Edition,2016.*

REFERENCE BOOKS

1. *Gupta S.C and Kapoor V.K., **"Fundamentals of Mathematical Statistics"**, Sultan CChand & ons, NNew Delhi, 2015.*
2. *Gupta S.P, **"Statistical Methods"**, Sultan Chand & Sons, New Delhi, 2015.*
3. *Trivedi K.S, **"Probability and Statistics with Reliability, Queuing and Computer Science Applications"**, Prentice Hall of India, New Delhi.*
4. *Hwei Hsu, **"Schaum's Outline series of Theory and Problems of Probability and Random Process"**, Tata McGraw Hill Publishing Co., New Delhi, 2015.*
5. *Roy D Yates, **"Probability and Stochastic Processes a Friendly introduction for Electrical and Computer Engineers"**, John Wiley & sons, third edition 2015.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Understand probability axioms and calculate expected values through moment generating functions

CO 2: Identify various probability distributions of discrete and continuous random variables.

CO 3: Understand the concept of two dimensional random variables

CO 4: Understand testing hypothesis connected to small and large samples

CO 5: Understand the first and second order stationary process and Markovian processes.

COURSE ARTICULATION MATRIX:

PO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	H	H	M	H	H	M	L	L	M	H	M	L	L
CO2	H	H	M	L	M	M	L	L	L	M	L	M	M	L	L
CO3	H	H	H	L	L	L	L	L	M	M	L	M	M	M	M
CO4	H	H	H	M	M	L	M	L	M	L	L	M	M	L	M
CO5	H	H	H	M	M	M	M	M	M	L	M	H	M	M	M
18NBS402	H	H	H	M	M	M	M	L	M	L	L	M	M	L	M

L - Low, M - Moderate (Medium), H - High

18NES403	**ENGINEERING MECHANICS** *(Common to MECH., EEE, PROD, EIE & CSE Branches)*	**SEMESTER-IV**

PRE-REQUISITES: NIL

Category : ES

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

Upon completion of this course, the students will be familiar with:

∗ To understand the force systems, geometrical properties and frictions in real life applications.

∗ To understand the dynamics behaviour of particles and impulse momentum principle.

UNIT – I : INTRODUCTION TO MECHANICS AND FORCE CONCEPTS	**(9+3 Periods)**
Principles and Concepts – Laws of Mechanics – system of forces – resultant of a force system – resolution and composition of forces – Lami's theorem – moment of a force – physical significance of moment-Varignon's theorem – resolution of a force into force and couple – forces in space – addition of concurrent forces in space – equilibrium of a particle in space.	
UNIT – II : FRICTION	**(9+3 Periods)**
Frictional resistance – classification of friction- laws of friction – coefficient of friction-angle of friction – angle of repose — cone of friction – free body diagram-advantages-equilibrium of a body on a rough inclined plane – non-concurrent force system - ladder friction – rope friction – wedge friction.	
UNIT – III : GEOMETRICAL PROPERTIES OF SECTION	**(9+3 Periods)**
Centroids – Determination by integration – centroid of an area – simple figures - composite sections – bodies with cut parts - moment of inertia – theorems of moment of inertia – moment of inertia of composite sections – principal moment of inertia of plane areas - radius of gyration.	
UNIT – IV : BASICS OF DYNAMICS	**(9+3 Periods)**
Kinematics and kinetics – displacements, velocity and acceleration - Equations of motion – Rectilinear motion of a particle with uniform velocity, uniform acceleration, varying acceleration – motion curves – motion under gravity – relative motion – curvilinear motion of particles – projectiles – angle of projection – range – time of flight and maximum height. Newton's second law of motion – linear momentum – D'Alembert's principle, Dynamics equilibrium — work energy equation of particles– law of conservation of energy – principle of work and energy	
UNIT – V : IMPULSE MOMENTUM AND IMPACT OF ELASTIC BODIES	**(9+3 Periods)**
Principle of impulse and momentum – Equations of momentum – Laws of conservation of momentum. Impact – Time of compression, restitution, collision – Co-efficient of restitution – types of impact – collision of elastic bodies by direct central impact and oblique impact – collision of small body with a massive body – Kinetic energy of a particle.	

Contact Periods:
Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60 Periods

TEXT BOOKS:

1. *S.S. Bhavikatti and K.G. Rajasekarappa **"Engineering Mechanics"** New Age International (P) Ltd. 1999.*
2. *S.C. Natesan **"Engineering Mechanics"** Umesh Publications, 5-B north market, Naisarak, Delhi , 2002.*
3. *Domkundwar V.M and Anand V. Domkundwar**, "Engineering Mechanics (Statics and Dynamics)",** Dhanpat Rai and Co. Ltd, 1 st Edition, 2006.*

REFERENCE BOOKS:

1. *F.B. Beer and E.R. Johnson, **"Vector Mechanics for Engineers"**, Tata Mc.Graw Hill Pvt. Ltd, 10th Edition,2013.*
2. *S. Timoshenko and Young, **"Engineering Mechanics",** Mc.Graw Hill, 4th Edition, 1995.*
3. *Irving Shames and Krishna Mohana Rao, **"Engineering Mechanics"**, Prentice Hall of India Ltd, Delhi, 2006.*
4. *R.C. Hibbeller, **"Engineering Mechanics"**, Prentice Hall of India Ltd,13th Edition,2013.*
5. *Vela Murali, **"Engineering Mechanics",** Oxford university Press,1st Edition,2010.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Know the concept of mechanics and system of forces.

CO2: Calculate the frictional properties at different bodies.

CO3: Identify the locations of centre of gravity and moment of inertia for different sections.

CO4: understand the basics of dynamics of particles

CO5: know the impulse and momentum principle and impact of elastic bodies.

COURSE ARTICULATION MATRIX:

PO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	H	M	L	L				L		L		L	L	L
CO2	L	H	L		L				L		L		L		L
CO3	L	H	L		L				L		L		L		L
CO4	M	H	L	M	L								L		L
CO5	L	H		M		L							L		L
18NES 403	L	H	L	M	L	L			L		L		L	L	L

L-Low, M-Moderate (medium), H-High

18NPC404	ELECTRONICS FOR ANALOG SIGNAL PROCESSING	SEMESTER- IV

PRE-REQUISITES: NIL

Category : PC

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To familiarize the working, principle, application of operational amplifier and A/D converter.

UNIT I : **OPERATIONAL AMPLIFIER CHARACTERISTICS**	**(9 Periods)**
Introduction to Fabrication of Op-amp, Functional block diagram and operation of Op-amp, Ideal Characteristics of Op-amp, DC Characteristics: Input bias current, Input offset current, Input offset voltage and Thermal drift, AC Characteristics: Frequency response, stability, frequency compensation, slew rate and methods of improving slew rate.	
UNIT II : APPLICATIONS OF OP-AMPS	**(9 Periods)**
Basic operation of Inverting and Non Inverting amplifiers, Voltage follower, Adder, Subtractor, Integrator, Differentiator, Instrumentation amplifier, Differential amplifier, Voltage to current and Current to voltage converters, Precision rectifier, Filters, Sample and hold circuits.	
UNIT III : **COMPARATORS AND WAVEFORM GENERATORS**	**(9 Periods)**
Basic operation and applications of Comparator, Schmitt trigger, Monostable, Astable and Bistable Multi-vibrators, Triangular wave generators, Log and Antilog amplifier.	
UNIT IV : **VOLTAGE REGULATORS AND TIMERS**	**(9 Periods)**
Voltage Regulators: General purpose regulator, Switching regulator. Timers: Functional block diagram, mono stable and Astable operation and applications. Voltage Controlled Oscillator, Phase Locked Loop and its applications.	
UNIT V – D-A AND A – D CONVERTERS	**(9 Periods)**
D-A converter: Weighted resistor, R-2R ladder, and inverted R-2R types. A – D converter: Flash, Counter, Servo tracking, Successive approximation, Dual slope types. DAC and ADC performance characteristics.	
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**	

TEXT BOOKS

1. *Ramkant A Gayakwad,* ***"Op-Amps and Linear Integrated Circuits"*** *Prentice Hall of India, Fourth Edition, 2009*
2. *Robert F Coughlin, Frederick F Driscoll,* ***"Operational amplifiers and Integrated Circuits"*** *Prentice Hall of India, 2009*

REFERENCE BOOKS

1. *William D Stanely,* ***"Operational Amplifiers with Linear Integrated Circuits"*** *Pearson Education, Fourth Edition, 2009.*
2. *Albert Malvino, David Bates,* ***"Electronic Principles"*** *Tata McGraw Hill, Seventh Edition, 2008*
3. *Roy D Choudhary & Shail B Jain,* ***"Linear Integrated circuits",*** *New age international publishers, 5th edition, 2018*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Acquire the knowledge in IC fabrication procedure and characteristics of operational amplifier

CO 2 : Analyze operational amplifier circuits and communicate the results effectively

CO 3: Design circuits using operational amplifier and simulate them using software tools

CO 4: Work effectively in a team and implement circuits using operational amplifier

CO 5: Recognize and acquire knowledge on the converters based on applications

COURSE ARTICULATION MARTIX:

PO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	H	H	L	L	L	L	M	L	L	H	M	M	M
CO2	H	H	H	H	M	L	M	L	M	H	L	M	M	M	M
CO3	H	M	H	M	H	M	H	M	M	M	H	H	M	M	M
CO4	H	M	M	M	M	H	H	M	H	M	H	H	M	M	M
CO5	H	M	M	H	L	H	M	H	L	M	M	M	M	M	M
18NPC 404	H	M	M	M	M	M	M	M	M	M	M	M	M	M	M

L- Low, M-Moderate (Medium), H-High

18NPC405	DIGITAL ELECTRONICS	SEMESTER-IV

PRE-REQUISITES: NIL

Category : PC

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To teach the fundamentals of digital systems and memory devices

UNIT I : NUMBER SYSTEM AND BOOLEAN ALGEBRA	**(9 Periods)**
Review of number systems: Binary, octal, decimal, hexadecimal – conversions. Binary code: BCD, Gray, Excess 3 code, parity, Hamming code, weighted and non-weighted, error detecting and correcting, sequential, self-complementary, cyclic, reflective codes. Boolean Algebra: Axioms, laws and theorems, logic gates. Switching functions: Minimization and implementation using K-map method and Quine-McCuskey method.	
UNIT II : COMBINATIONAL CIRCUITS	**(9 Periods)**
Design of combinational circuits: Binary and BCD Adders, Subtractor, Multiplier, Code Converters, Comparator, Encoder, Decoder, Multiplexer, Demultiplexer. Function realization using basic gates and multiplexers.	
UNIT III – SYNCHRONOUS SEQUENTIAL CIRCUITS	**(9 Periods)**
Flip Flops: SR, JK, D, T and their conversions. Shift Registers: SISO, SIPO, PIPO, PISO and universal shift registers. Counters: Up, Down, Up-down, mod, ring and Johnson counters. Synthesis and design of circuits using finite state model: serial adder, sequence detector, parity generator, counter.	
UNIT IV – ASYNCHRONOUS SEQUENTIAL CIRCUITS AND ALGORITHMIC STATE MACHINE	**(9 Periods)**
Counter: Up, Down, Up-down. Design and Analysis of fundamental mode circuits. Algorithmic state machine: ASM chart, design examples.	
UNIT V – MEMORY DEVICES, PROGRAMMABLE LOGIC DEVICES AND LOGIC FAMILIES	**(9 Periods)**
Memory devices: ROM, RAM, PROM, EPROM. Programmable Logic Devices: ROM, PAL, PLA, PROM. Logic Families: TTL, ECL, CMOS. Introduction to VLSI,FPGA Verilog and VHDL.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Thomas L Floyd, **"Digital Fundamentals",** Pearson Education International, Eleventh Edition, 2015.*
2. *Morris Mano M, Michael D Ciletti, "**Digital Design with an Introduction to Verilog HDL**", Pearson Education International, Fifth Edition, 2013.*

REFERENCE BOOKS

1. *Donald P Leach and Albert Paul Malvino, **"Digital Principles and Applications",** Tata McGraw Hill Education Private Limited, New Delhi, Seventh Edition, 2011.*
2. *Ronald J Tocci, Neal S Widmer, Gregory L Moss, **"Digital Systems: Principles and Applications",** Pearson Education International ,Eleventh Edition, 2010.*
3. *Anand Kumar, **"Fundamentals Of Digital Circuits",** Prentice Hall of India, Second Edition 2010.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Explain the working of simple digital circuits

CO 2: Design circuits for digital applications

CO 3: Differentiate between the various memory devices

CO 4: Discriminate the operation of synchronous and asynchronous sequential circuits

CO 5: Develop a digital logic and apply it to solve real life problems.

COURSE ARTICULATION MARTIX:

PO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	M	M	M	L			M	M	M		M	H	M	M
CO2	M	H	H	M	L			M	M	M		M	M	H	M
CO3	M	M	H	H	L			M	M	M		M	M	H	H
CO4	M	M	H	H	M			M	M	M		M	M	H	H
CO5	M	M	H	M	L			M	M	M		M	M	H	M
18NPC405	M	M	M	M	L			M	M	M		M	M	M	M

L- Low, M-Moderate (Medium), H-High

18NPC406	FUNDAMENTALS OF MICROPROCESSORS AND MICROCONTROLLERS	SEMESTER-IV

PRE-REQUISITES: NIL

Category : PC

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To learn the architecture of microprocessor and microcontroller, assembly language programming, interfacing techniques and applications of Microprocessors and Microcontrollers.

UNIT I – 8085 AND PERIPHERAL INTERFACING	**(9 Periods)**
Introduction to microprocessors - 8085 Architecture - Instruction set - Addressing Modes - Hardware and software interrupts - Memory and I/O Interfacing - Programmable Peripheral Interface (8255) - Keyboard display controller (8279) - ADC - DAC Interface. Introduction to 8086 Processor.	
UNIT II – 8051 MICRO CONTROLLER	**(9 Periods)**
8051 Microcontroller - Architecture - Instruction Set - Addressing modes - Interrupts - Assembly Language Programming - Programming 8051 Timers - Serial Port Programming - Interrupts Programming.	
UNIT III – 8051- INTERFACING	**(9 Periods)**
LCD & Keyboard Interfacing - External Memory interfacing - Sensor Interfacing - Motor Control – Relay - PWM - Stepper Motor - Design of traffic light control and Washing machine control.	
UNIT IV – PIC MICROCONTROLLER	**(9 Periods)**
PIC Architecture and Assembly language Programming - I/O Port Programming - Arithmetic ,Logic Instructions and Programs - PIC Programming in C.	
UNIT V – AVR MICROCONTROLLER	**(9 Periods)**
Microcontrollers and Embedded processors - Overview of AVR family - AVR Microcontroller architecture - AT mega 32 - Pin configuration - General Purpose Register - AVR status register- Addressing modes of AVR- Branch, Call, Time delay loop, arithmetic and Logical instructions .Introduction to ARM Processor.	
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**	

TEXT BOOKS

1. *Ramesh. S. Gaonkar,* ***"Microprocessor Architecture, Programming and Applications of 8085",*** *Penram International Pvt. Ltd., 2004*
2. *Rajkamal* ***"Microcontrollers (Architecture, programming, interfacing and system design)",*** *Dorling Kindersley Pvt Ltd, 2009*
3. *Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D.McKinlay* ***"The 8051 Microcontroller and Embedded Systems"*** *2nd Edition 2008, 5th Reprint, 2010, Pearson Education*

REFERENCE BOOKS

1. *Deshmhmukh L M,* ***"Microcontrollers (Theory and applications)",*** *Tata McGraw-Hill Publishing Co. Ltd, New Delhi, 2008*
2. *Vijayendran.V,* ***"Fundamentals of Microprocessor-8085: Architecture, Programming & Interface",*** *Vijay Nicole Pvt. Ltd, 2004*
3. *John Crisp,* ***"Introduction to Microprocessors and Microcontrollers",*** *Newnes publications (Imprint of Elsevier), 2nd Ed., 2004*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Impart the knowledge about the instruction set.

CO 2: Understand the basic idea about Interface LCD, Keyboard, Sensor, Relay, DC motor and stepper motor with microcontroller.

CO 3: Illustrate how the different peripherals (8255, 8279 etc.) are interfaced with Microprocessor.

CO 4: Use microprocessor/microcontroller knowledge in minor projects that solves real world problems.

COURSE ARTICULATION MATRIX:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	M	M	L	L			M	M	M	M	M	M	L
CO2	M	L	L	L	L				L	M	M	L	L	M	L
CO3	M	M	M	M	L	L			M	M	M	M	M	M	L
CO4	M	M	M	M	M	L			M	M	M	L	M	M	M
CO5	M	M	M	M	M	M			M	M	L	M	M	M	M
18NPC 406	M	M	M	M	M	L			M	M	M	M	M	M	M

L-Low, M-Moderate(medium), H-High

18NMC4Z7	CONSTITUTION OF INDIA *(Common to All Branches)*	SEMESTER-IV

PRE-REQUISITES: NIL

Category: MC

L	T	P	C
3	0	0	0

COURSE OBJECTIVES:

- To know about Indian constitution.
- To know about central and state government functionalities in India.
- To know about Indian society.

UNIT – I : INTRODUCTION	**(9 Periods)**
Historical Background – Constituent Assembly of India – Philosophical foundations of the Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Role of the Election Commission.	
UNIT – II : STRUCTURE AND FUNCTION OF CENTRAL AND STATE GOVERNMENT	**(9 Periods)**
Union Government – Structures of the Union Government and Functions – President – Vice President– Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review. State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts.	
UNIT – III : CONSTITUTION FUNCTIONS OF INDIA AND INDIAN SOCIETY	**(9 Periods)**
Indian Federal System – Central – State Relations – President's Rule – Constitutional Amendments – Constitutional Functionaries - Assessment of working of the Parliamentary System in India. Society : Nature, Meaning and definition; Indian Social Structure; Caste, Religion, Language in India; Constitutional Remedies for citizens – Political Parties and Pressure Groups; Right of Women, Children and Scheduled Castes and Scheduled Tribes and other Weaker Sections.	
UNIT – IV : POLICIES AND ACTS - GENERAL	**(9 Periods)**
Insurance and Bonding – Laws Governing Sale, Purchase and use of Urban and Rural Land – Land Revenue Codes – Tax Laws – Income Tax, Sales Tax , Excise and Custom duties and their Influence on Construction Cost – Legal Requirements for Planning – Property Law– Agency Law – Local Government Laws for Approval.	
UNIT – V : POLICIES AND ACTS ON INFRASTRUCTURE DEVELOPMENT	**(9 Periods)**
A Historical Review of the Government Policies on Infrastructure – Current Public Policies on Transportations – Power and telecom Sector – Plans for Infrastructure Development – Legal framework for Regulating Private Participation in Roads and Highways – Ports and Airport and Telecom.	

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1 *Durga Das Basu, **"Introduction to the Constitution of India",** Prentice Hall of India, New Delhi,2018*
2 *R.C.Agarwal **"Indian Political System",** S.Chand and Company, New Delhi,2004.*
3 *Maciver and Page, **" Society: An Introduction Analysis",** Mac Milan India Ltd., New Delhi,2007*
4 *K.L.Sharma, **"Social Stratification in India: Issues and Themes",** Jawaharlal Nehru University, New Delhi,2006*

REFERENCE BOOKS:

1 *M.Laxmikanth,* ***"Indian Polity",*** *Mcgraw Hill Education (India)Private limited,2016*

2 *Sharma, Brij Kishore,* ***"Introduction to the Constitution of India",*** *Prentice Hall of India, New Delhi, 2018*

COURSE OUTCOMES:

On completion of the course, the students will able to

CO1: Understand and abide the rules of the Indian constitution.
CO2: Understand the functions of Central government.
CO3: Understand the function of state government.
CO4: Understand the various constitutional functions.
CO5: Understand the different culture among the people of India.

COURSE ARTICULATION MATRIX:

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1						M	M					M			L	
CO2						L						M		L		
CO3						L						M				
CO4						L						L		L		
CO5						L	L					L		L	L	
18NMC4Z7						L	L					M		L	L	

L-Low, M-Moderate (Medium), H-High

18NPC408	MICROPROCESSORS AND MICROCONTROLLERS LABORATORY	SEMESTER-IV

PRE-REQUISITES: NIL

Category : PC

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVE

* To provide training on programming of microprocessors and microcontrollers and understand the interface requirements.

LIST OF EXPERIMENTS

1. Programming using Arithmetic, Logical instructions of 8085 microprocessor.
2. Programming using Arithmetic, Logical and Bit manipulation instructions of 8051 microcontroller
3. Programming using arithmetic, logical, string instructions of 8086.
4. Interfacing of ADC with µp /µc.
5. Interfacing of stepper motor with µp /µc.
6. Interfacing of DAC with µp /µc.
7. Interfacing of Programmable Peripheral Interface (PPI) with µp / µc.
8. 7-Segment display interface with µp / µc.
9. Interfacing of Traffic Light Controller with µp / µc.
10. Interface of display/keyboard with µp / µc.
11. Turbo assembler programming. (TASM software)
12. Programs using PROTEUS software.

Contact Periods:
Lecture: 0 Periods **Tutorial: 0 Periods** **Practical:45 periods** **Total:45 periods**

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Explain the features/instruction of the microprocessor and microcontroller to develop microprocessor/microcontroller based system.
CO 2: Apply and simulate the software tools for automation solutions
CO 3: Facilitate interdisciplinary projects based on the acquired programming skills.
CO 4: Present the results in oral form as well as in written form as a report
CO 5: Interpret the results and draw meaningful conclusions.

COURSE ARTICULATION MATRIX::

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	L	L	L	M	M			H	H	M	L			
CO2	H	H	H	M	H	M			H	H	M	L	H	H	H
CO3	H	H	H	M	H	M			H	H	M	L		H	H
CO4	H	L	L	L	L	M			H	H	M	L			
CO5	H	L	L	L	L	M			H	H	M	L			
18NPC 408	H	L	L	L	H	M			H	H	M	L	H	H	H

L-Low, M-Moderate (medium), H-High

18NPC409	LINEAR AND DIGITAL CIRCUITS LABORATORY	SEMESTER-IV

PRE-REQUISITES: NIL

Category : PC

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVE

- To provide hands on experience on analog and digital circuit design.

LIST OF EXPERIMENTS

1. Realization of universal gates using basic logic gates
2. Design and implementation of combinational circuits
3. Design and implementation of flip flops using logic gates
4. Design and Implementation of registers
5. Design and Implementation of counters
6. Design of synchronous sequential circuit
7. Implementation of applications of operational amplifier
8. Design of Instrumentation amplifier
9. Implementation of voltage and current regulators
10. Realization of astable multivibrator using 555 Timer
11. Design and implementation of active filters
12. Design of phase lock loop

Contact Periods:

Lecture: 0 Periods **Tutorials: 0 Periods** **Practical: 45 Periods** **Total: 45 Periods**

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Build and debug circuits using op-amps and basic gates.

CO 2: Design analog and digital circuits for small applications

CO 3: Use apt application specific IC for different application

CO 4: Work as a member of a team while carrying out experiments.

CO 5: Develop generic skills in project management, project documentation and reporting.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	M	M	M		M	M		M	M	M	M	H	M	M
CO2	M	M	L	M		M	M		M	M	M	H	M	M	M
CO3	M	M	M	M		L	M		M	M	M	M	M	M	M
CO4	M	M	M	M		M	M		M	M	M	M	M	M	M
CO5	M	M	M	M		M	M		M	M	M	M	M	M	M
18NPC 409	M	M	M	M		M	M		M	M	M	M	M	M	M

L-Low, M-Moderate (medium), H-High

18NHS501	**TECHNOLOGY MANAGEMENT** *(Common to EEE, EIE, CSE IT & IBT branches)*	**SEMESTER-V**

PRE-REQUISITES: NIL

Category : HS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

Upon completion of this course, the students will be familiar with,

- Intricacies of technology selection.
- Role of technology in today's business.

UNIT – I : INTRODUCTION	**(9 Periods)**
Evolution, growth of technology, role and significance of technology management, forms of technology – process, product technology, impact of technology on society and business, technology and competition.	
UNIT – II : TECHNOLOGY FORECASTING	**(9 Periods)**
Technology forecasting, characteristics, principles, process, forecasting methods and techniques.	
UNIT – III : ACQUISITION OF NEW TECHNOLOGY	**(9 Periods)**
Alternative for acquiring new technology, reasons to obtain new technology, management of acquired technology, measures of scale and mechanisms for acquiring technologies. Technology transfer-models, modes of transfer, dimensions of technology transfer, features of technology package- routes of technology transfer.	
UNIT – IV : HUMAN ASPECTS OF TECHNOLOGY MANAGEMENT	**(9 Periods)**
Integration of people and technology, factors considered in technology management – organizational, psychological, organizational structure and technology –technological change and industrial relations.	
UNIT – V : SOCIAL ASPECTS OF TECHNOLOGY MANAGEMENT	**(9 Periods)**
Technology assessment and environmental impact analysis(EIA)-EIA-process, scope, issues in report preparation, elements of environmental problem, case study on social impact of technology.	

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Sanjiva Shankar Dubey,* ***"Technology and Innovation Management",*** *PHI Learning Private Ltd., 2017.*

REFERENCE BOOKS:

1. *Gerard H. Gaynor,* ***"Hand Book Technology of Management"****, McGraw Hill professional, 2009.*
2. *Khalil, T,* ***"Management of technology: The Key to competitiveness and wealth creation"*** *Tata McGraw Hill, Delhi, 2013.*
3. *Ralph Katz,* ***"The human side of Managing Technological Innovation: A Collection of Readings",*** *2nd Edition Oxford University Press, 2003*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to,

CO1: Learn to manage ideas and knowledge in a technology-based organization.

CO2: Equipped with skills needed to implement technology polices and strategies.

CO3: Formulate technology polices and strategies for businesses.

CO4: Appropriately choose the new technologies.

CO5: Ability to foresee future technological requirements.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	M				L	M	H		H	M	H	H	M	M
CO2	M	L	H	M	M	M	M					H	H	H	M
CO3	H	M	M	M			M				H	M	M	M	M
CO4	H	M	H	M									M	M	H
CO5	H	M	H	M								L	H	H	H
18NHS 501	H	M	H	M							M	L	H	H	H

L-Low, M-Moderate(medium), H-High

18NES502	INDUSTRIAL HYDRAULICS AND PNEUMATICS	SEMESTER-V

PRE-REQUISITES: NIL

Category : ES

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To provide exposure to development of hydraulic and pneumatic circuits for engineering applications

UNIT - I : FLUID POWER PRINCIPLES	**(9 Periods)**
Introduction to fluid power – advantages and applications – fluid power systems – types of fluids – properties of fluids -fluid power symbols – basic of hydraulics: pascal's law, principles of flow, work, power and torque. Applications of pascal's law-losses in pipe, valves and fittings.	
UNIT - II : HYDRAULIC SYSTEM AND COMPONENTS	**(9 Periods)**
Pumping theory – pump classification – fixed and variable displacement pumps: working, advantages, disadvantages and performances. Hydraulic actuators: cylinders, types and construction hydraulic motors – performance charts. Direction control, flow control and pressure control valves – types, applications accessories – accumulator and intensifiers.	
UNIT - III : CONTROL OF HYDRAULIC SYSTEMS	**(9 Periods)**
Reciprocating- sequencing – synchronizing – regenerative – pump unloading – double pump circuits – counterbalance valve application circuit - accumulators circuits - intensifier circuits - fail-safe circuits-hydrostatic transmission.	
UNIT - IV : PNEUMATIC SYSTEMS	**(9 Periods)**
compressors – filter, regulator, lubricator, muffler, air control valves, quick exhaust valves, pneumatic actuators. Introduction to Fluidics – Pneumatic logic circuits AND,OR, MEMORY, etc.	
UNIT - V : ELECTRO HYDRAULIC AND ELECTRO-PNEUMATIC CIRCUITS	**(9 Periods)**
Sequential circuits – design for simple applications using cascade method – Electro Pneumatic circuits – fluid power circuits-Low cost automation – Hydraulic and Pneumatic power packs – Installation, fault finding and maintenance.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Anthony Esposito **"Fluid Power with Applications"**, 7th edition, Pearson education, 2014.*
2. *Andrew Parr **"Hydraulics & Pneumatics"** Jaico Publishing House, 2011.*
3. *Majumdar **"Pneumatic system: Principles and Maintenance"** Tata McGraw Hill, 2012.*

REFERENCE BOOKS

1. *William W. Reaves, **"Technology of Fluid Power"**,. Delmer Publishers, 2007*
2. *Petor Rohner, **"Fluid Power Logic Circuit Design"** Macmillon Press Ltd, 2010*
3. *Harry L. Stevart D.B **"Practical Guide to Fluid Power"** Taraoeala sons and Port Ltd. ,Broadey, 2016.*
4. *Michael J, Prinches and Ashby J. G, **"Power Hydraulics"** Prentice Hall, 2009.*
5. *Dudelyt, A. Pease John T. Pippenger **"Basic Fluid Power"** Prentice Hall, 2016*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Identify the fluidics for industrial applications.
CO 2: Select the components of fluidics for industrial needs.
CO 3: Demonstrate the applicability of fluidic instruments for particular industry
CO 4: Design the hydraulic and pneumatic circuits
CO 5: Apply the maintenance procedures of fluidic systems

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	M	L	M				M	M	M	M	M	M	M	M
CO2	M	M	L	M				M	M	M	M	M	M	M	M
CO3	H	M	L	M				M	M	M	M	M	M	M	M
CO4	M	M	M	M				M	M	M	M	M	M	M	M
CO5	M	H	M	M				M	M	M	M	M	M	M	M
18NES 502	M	M	L	M				M	M	M	M	M	M	M	M

L-Low, M-Moderate(medium), H-High

18NPC503	CONTROL SYSTEM DESIGN	SEMESTER-V

PRE-REQUISITES:

1.18NBS102 – Calculus and Differential Equations

2. 18NBS202 – Linear Algebra, Numerical Methods and Transform Calculus

Category : PC

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

* To inculcate the necessary knowledge of system representation, transfer function derivation for a model, and to develop time domain and frequency domain analysis using root locus, bode plot, polar plot, Nyquist plot and design compensators for a given requirements.

UNIT I – TRANSFER FUNCTIONS	**(9 Periods)**
Basic components of control systems-classification of control systems- feedback and its effects– mathematical modelling of a system-Transfer function of mechanical (translational and rotational), Electrical, Thermal, electro-mechanical systems (AC, DC motors)-Block Diagram reduction technique and Signal flow graphs.	
UNIT II –- TRANSIENT AND STEADY STATE ANALYSIS	**(9 Periods)**
Test signals for time response of control systems-type and order of systems-Time response of first order and second order systems (under damping, critical, over damping) - Time domain specifications - Steady state error analysis.	
UNIT III – STABILITY: TIME AND FREQUENCY DOMAIN ANALYSIS	**(9 Periods)**
BIBO Stability – Determining the stability by Routh-Hurwitz criterion-Properties and construction of the root loci-effect of adding a pole and zeros to a system. Relative stability: gain margin and phase margin-stability analysis with Bode plots -polar plots-constant M and N circles- Nyquist stability criterion-Nichols chart.	
UNIT IV – COMPENSATORS DESIGN	**(9 Periods)**
Design specifications- compensator configuration (series and feedback)-design of cascade and feedback compensators (lag, lead, lag-lead) using bode plot.	
UNIT V – CONTROL SYSTEM COMPONENTS AND STATE SPACE	**(9 Periods)**
Potentiometer – Error detector –Synchros – Stepper motors –Tacho generators- PID controllers – Servo motors. Concepts of State, State variable and State space model – Introduction – State space representation of linear continuous time systems using physical variables, phase variables and canonical variables-diagonalization -Solution of state model – State transition matrix – Controllability and Observability.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Benjamin C.Kuo, **"Automatic Control Systems''**, PHI Learning Private Ltd, 2014*
2. *I.J. Nagarath and M.Gopal, **"Control Systems Engineering''**, Fourth Edition, New Age International (P) Ltd., Publishers, 2017.*
3. *M.Gopal, **"Control Systems Principles and Design''**, Tata McGraw-Hill, 2012*

REFERENCE BOOKS

1. *Norman S. Nise, **"Control System Engineering",** John Wiley& Sons, 6th Edition,2018.*
2. *Katsuhiko Ogata, **"Modern Control Engineering",** Pearson Education, New Delhi, 5th Edition. 2010.*
3. *Richard C. Dorf and Robert H. Bishop, **"Modern Control Systems",** Pearson Education Pvt. Ltd., New Delhi,4th Edition, 2010.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Determine the transfer function of linear, time-invariant mechanical and electrical systems using differential equations.

CO 2: Analyze poles and zeros of transfer functions to determine the time and frequency response of a control system.

CO 3: Comment on stability of the system and analyze using frequency domain plots.

CO 4: Design compensators using frequency domain plots

CO 5: Describe the working principle of control system components and acquire knowledge of state space analysis and to define controllability and observability

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	M	L	M	M	L	L	M	M	M	M	M	L	L
CO2	M	M	M	M	H	M	M	M	L	L	L	L	M	H	H
CO3	L	L	M	M	M	M	M	M	M	M	M	M	L	M	M
CO4	L	H	H	H	H	H	H	H	H	M	H	L	L	H	M
CO5	L	L	M	M	M	M	M	L	L	L	L	L	L	L	M
18NPC 503	L	M	M	M	M	M	M	M	M	M	M	L	L	M	M

L-Low, M-Moderate(medium), H-High

18NPC504	BASICS OF SIGNALS AND SYSTEMS	SEMESTER-V

Category : PC

PRE-REQUISITES:

1. 18NBS202 - Linear Algebra, Numerical Methods and Transform Calculus

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

* To familiarize signals and systems in terms of both time and transform domains, taking the advantage of the complementary insights and tools that these different perspectives provide.

UNIT I : **INTRODUCTION TO CONTINUOUS TIME SIGNALS (CT) AND SYSTEMS**	**(9 Periods)**
Introduction to signals and systems and their classifications. Definition of CT signal, Representation of elementary CT signals: Impulse, Pulse, Step, Ramp, Exponential and Sinusoidal. Classification of CT signals:–periodic and aperiodic, power and energy, deterministic and random signals. Definition of CT system, Classification and characterization with examples:–Static, dynamic, causal , non causal, linear, non linear, time variant, time invariant, stable and unstable, FIR, IIR, reversible and irreversible, recursive and non-recursive system.	
UNIT II : ANALYSIS OF CT SIGNALS AND SYSTEMS	**(9 Periods)**
Time domain analysis:-solutions of differential equation. Fourier transform analysis of signals, spectrum of CT signals, Analysis of random signals. Filter Realization: Structures for FIR filters, Structures for IIR filters, State-space analysis and filter structures.	
UNIT III : DISCRETIZATION AND SIGNAL RECONSTRUCTION	**(9 Periods)**
Discretization of signals: sample and hold circuit. Sampling:-Sampling theorem, selection of sampling rate, Types of sampling, Aliasing:-Aliasing effects, Anti-aliasing filter, Quantization:-Quantization errors due to truncation and rounding in fixed and floating point representations, signal reconstruction:-Interpolation using zero-order and first order hold.	
UNIT IV : CLASSIFICATION AND ANALYSIS OF DISCRETE TIME (DT) SIGNALS	**(9 Periods)**
DT signals: – Introduction, Definition, Elementary DT signals, Characterization. DT systems: Definition, Classification, Characterization. Time domain analysis: - Solutions of difference equations.	
UNIT V : TRANSFORM TECHNIQUES FOR DT SIGNALS AND SYSTEMS	**(9 Periods)**
Z-Transform–Definition, Properties, ROC and its properties, Inverse Z Transform. Analysis of DT systems using Z Transforms:–Stability, Causality, Recursive, Non-recursive systems.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Tarun Kumar Rawat **"Signals and System"** Oxford University Press,2010.*
2. *Proakis,J.G.,& Manolakis, D.G., **"Digital Signal Processing: Principles and Algorithms, & Applications"**, 3rd Edition, Prentice Hall of India, 2007.*

REFERENCE BOOKS

1. *Allan V. Oppenheim, S. Wilsky and S.H.Nawab, **"Signals and Systems",** Pearson Education, Indian Reprint, 2007.*
2. *H P Hsu, **"Signals and Systems (Schaum's Outlines)"** Tata McGraw Hill,2006*
3. *John Alan Stuller, **"An Introduction to signals and Systems",** Thomson, 2007.*
4. *Edward W Kamen, Bonnie S Heck, **"Fundamentals of Signals and Systems using the Web and MATLAB"** Pearson, Indian Reprint,2007.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Identify the types of signals and systems with general understanding of continuous time and discrete time signals and systems

CO 2: Analyze the spectral characteristics of continuous-time periodic and a periodic signals using Fourier analysis.

CO 3: Classify systems based on their properties and determine the response of LSI system using convolution.

CO 4: Apply Z- transform for analyze of continuous-time and discrete-time signals and systems.

CO 5: Understand the process of sampling and the effects of under sampling.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	M	M	L	M	L	L	M	M	H	H	H	L	M
CO2	H	H	H	M	M	L	L	M	M	M	M	M	H	M	M
CO3	H	M	M	H	M	L	L	L	M	M	M	M	H	L	M
CO4	H	H	H	H	M	M	L	L	M	M	L	M	H	M	M
CO5	H	M	M	M	M	L	L	L	M	M	M	H	H	M	H
18NPC 504	H	H	H	M	M	L	L	L	M	M	M	M	H	M	M

L-Low, M-Moderate(medium), H-High

18NPC507	CONTROL SYSTEMS LABORATORY	SEMESTER-V

PRE-REQUISITES: NIL

Category : PC

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVE

* To strengthen the knowledge of feedback control concepts, modelling and stability analysis

LIST OF EXPERIMENTS

1. Modelling of DC motor via Step test (Determination of Transfer function).
2. Step and Ramp response of first order systems.
3. Identification of parameters in second order systems.
4. Time domain specification of type-0 and type-1 systems.
5. Stability analysis of servo system via software and hardware integration.
6. Analog Simulation of first order and second order systems.
7. Analysis of second order system .
8. Frequency response of Lead, lag compensators.
9. Design and simulation of PI and PID controllers for a second order system.
10. Design and simulation of PI and PID controllers for a first order system with dead time.
11. Design and simulation of LAG, LEAD compensators by using bode plots.
12. Design and simulation of linear and nonlinear systems.

Contact Periods:
Lecture: 0 Periods Tutorial: 0 Periods Practical:45 Periods Total:45 Periods

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Develop mathematical model for DC motor.
CO 2: Analyse the response and stability of simple systems using modern engineering tools.
CO 3: Interpret the results of the response and prioritize the inferences.
CO 4: Design the compensators for a given specifications.
CO 5: Differentiate the response obtained for various input standards.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	M	H	M	M	M	L	M	M	H	H	M	H	M	L
CO2	M	M	M	L	L	M	M	M	M	M	M	M	H	L	L
CO3	M	L	M	L	M	H	L	L	H	H	H	H	M	M	L
CO4	L	L	H	L	L	H	M	H	M	M	M	M	H	L	M
CO5	H	H	H	M	M	M	M	M	L	L	L	M	H	M	M
18NPC 507	M	M	M	L	M	M	M	M	M	M	M	M	H	M	L

L-Low, M-Moderate (medium), H-High

18NEE508	VIRTUAL INSTRUMENTATION LABORATORY	SEMESTER-V

Category : EEC

PRE-REQUISITES: NIL

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVE

* To provide knowledge base on various signal conditioning circuits.

LIST OF EXPERIMENTS

1. Simple exercise with VI (creating, editing, developing).
2. Converting the VI into a Sub VI.
3. Create simple functions (FOR loop, While loop) using VI.
4. Lab VIEW – Traffic Light - Programming Structure, Arrays, Clusters
5. Voltage to frequency converter
6. Strain and Temperature with NI Elvis
7. Frequency analysis of Signal Using NI-DAQmx,
8. Oscilloscope - Attribute Nodes, Menus
9. RC Circuit measurement - Timing issues
10. Digital control of stepper motor
11. OPAMP circuits, characteristics
12. Digital-to-Analog acquisition interfacing
13. System identification and analysis of electrical circuits
14. GPIB and Serial interfaces based instrument communication

Contact Periods:
Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 45 Periods** **Total: 45 Periods**

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Get an adequate knowledge about selecting the amplifier circuits for the measurement of physical parameters.

CO 2: Analyze the measured value for controlling the physical variables.

CO 3: Design a signal conditioning circuit for interfacing sensor with controller.

CO 4: Demonstrate a working knowledge of Piping and Instrumentation practices used in real time processes.

CO 5: Demonstrate skills in trouble shooting problems with the measurement and control of industrial processes.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	H	H	H	L	M	H	H	H	H	M	M	M	H
CO2	M	M	H	H	H	M	L	H	H	M	H	H	H	H	M
CO3	M	M	H	H	H	M	L	H	H	M	H	H	H	H	M
CO4	M	M	H	H	H	M	L	H	H	M	H	H	H	H	M
CO5	M	M	H	H	H	M	L	H	H	M	H	H	H	H	M
18NEE 508	M	M	H	H	H	M	L	H	H	M	H	H	H	H	M

L-Low, M-Moderate(medium), H-High

18NPC601	PRINCIPLES OF COMMUNICATION	SEMESTER-VI

PRE-REQUISITES: NIL **Category : PC**

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To introduce the fundamental concept of analog and digital modulation techniques with different communication systems.

UNIT I – AMPLITUDE MODULATION	**(9 Periods)**
Basic principle of AM – Generation of AM waves – Frequency spectrum – Power relations – Demodulation – DSBSC – SSB – VSB – AM transmitter and receivers.	
UNIT II – ANGLE MODULATION	**(9 Periods)**
Definition of FM and PM – Single tone – Narrow band – Wide band – Multi tone FM – Generation and Demodulation of FM – FM transmitters and receivers – Frequency versus Phase modulation.	
UNIT III – PULSE MODULATION	**(9 Periods)**
Sampling – Quantization – TDM – FDM – PAM – PWM – PCM – Measure of Information – Channel capacity – DPCM – ASK – FSK – PSK	
UNIT IV – EFFECT OF NOISE	**(9 Periods)**
SNR – Noise in AM and FM receivers – Noise in FM reception – FM threshold effect – Pre-emphasis and de-emphasis – Noise in PCM system – Destination SNR in PCM system with quantization and channel noise.	
UNIT V – ADVANCED COMMUNICATION SYSTEMS	**(9 Periods)**
Introduction – Optical communication systems – Microwave communication systems – Satellite communication systems – Mobile communication systems – Transmitters and Receivers.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *G.Kennedy, **"Electronic Communication Systems",** Tata McGraw-Hill, Fourth Edition, 2017.*
2. *Louis E. Frenzel, **"Principles of Electronic Communication Systems",** Tata McGraw-Hill, Fourth Edition, 2016.*

REFERENCE BOOKS

1. *J.S.Beasley & G.M.Miler, **"Modern Electronic Communication",** Pearson Education, Ninth Edition, 2013.*
2. *R.Blake, **"Electronic Communication Systems",** Thomson Delmar, Second Edition, 2012.*
3. *S.Haykins, **"Communication Systems",** John Wiley Inc, Fifth Edition, 2009.*
4. *W.Tomasi, **"Electronic Communication Systems",** Pearson Education, Fifth Edition, 2004.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Define the concepts and types of modulation involved in communication systems.

CO 2: Illustrate the analog and digital communication techniques like AM and FM modulation, PWM, PAM and PCM.

CO 3: Analyze the effect of modulation techniques and the noise involved in modulation.

CO 4: Discuss the generation, detection, transmitter and receiver of AM and FM modulation.

CO 5: Define the basic principles and operation of optical, microwave, mobile and satellite communications.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	M	L		L	H			H				H	
CO2	H	H	M	L		L	H			H				H	
CO3	H	H	M	L		L	H			H				H	
CO4	H	H	M	L		L	H			H				H	
CO5	H	H	M	L		L	H			H				H	
18NPC 601	H	H	M	L		L	H			H				H	

L-Low, M-Moderate(medium), H-High

18NPC602	PROCESS CONTROL	SEMESTER-VI

PRE-REQUISITES: NIL

Category : PC

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To introduce the concept of process control and different control configurations

UNIT I – BASICS OF PROCESS CONTROL	**(9 Periods)**
Terms and objectives, instrument terms and symbols. Regulatory and servo control, classification of variables. Process characteristics: process equation, degrees of freedom, Lumped and distributed parameters, modelling of simple systems – thermal, gas and liquid systems. Process lag, load disturbance and their effects on processes.. Self-regulating processes, interacting and non-interacting processes.	
UNIT II – MODES OF CONTROLLER	**(9 Periods)**
Basic control action, two position, multi position, floating mode control. Continuous controller modes: proportional, integral, derivative. Composite controller modes: P-I, P-D, P-I-D, Integral wind-up and prevention. Auto/Manual transfer, Bumpless transfer. Response of controllers for different test inputs. Selection of control modes for processes like level, pressure, temperature and flow.	
UNIT III – EVALUATION CRITERIA	**(9 Periods)**
Evaluation criteria – IAE, ISE, ITAE. Process reaction curve method, continuous oscillation method, damped oscillation method. Realization of electronic PID controllers.	
UNIT IV – ADVANCED CONTROL TECHNIQUES	**(9 Periods)**
Feed forward control, cascade control, ratio control, selective control, split range. adaptive, inferential, dead time compensation, interaction between control loops, decoupling. Case study: Boiler, Distillation Column.	
UNIT V – CONTROL VALVES	**(9 Periods)**
Pneumatic and electrical actuators, valve positioners. Pneumatic and electrical dampers, control valves types, construction details and various plug characteristics. Valve sizing. Selection of control valves. Inherent and installed valve characteristics. Fail-safe operation, cavitation and flashing in control valves, instrument air supply specifications.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *George Stephanopoulos,* ***"Chemical Process Control-An Introduction to Theory and Practice",*** *Prentice Hall of India, New Delhi, Second Edition, 2015.*
2. *Curtis Johnson,* ***"Process Control Instrumentation Technology",*** *Prentice Hall of India, Eighth Edition,2016*

REFERENCE BOOKS

1. *B.Wayne Bequette,* ***"Process Control: Modelling, Design and Simulation",*** *Prentice Hall, 2010.*
2. *Bela G. Liptak,* ***"Instrument Engineer's Handbook, volume II, Process Control and Optimization",*** *CRC press, Fourth Edition, 2015.*
3. *Dale E. Seborg, Thomas F. Edgar, Duncan A. Mellichamp,* ***"Process Dynamics and Control",*** *John Wiley and Sons, Second Edition, 2014.*
4. *D.R. Coughanowr,* ***"Process Systems Analysis and Control",*** *McGraw Hill, Third Edition, 2009.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Model simple processes both mathematically and experimentally.

CO 2: Design and tune controllers for different process.

CO 3: Choose the appropriate controllers for particular applications.

CO 4: Select proper final control elements to ensure proper implementation of the control actions

CO 5: Illustrate the operation of basic units of industries.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	M	M	M		M	M	M		M	M	M	M	M
CO2	M	M	M	M	M		M	M	M		M	M	M	M	M
CO3	M	M	M	M	M		M	M	M		M	M	M	M	M
CO4	M	M	M	M	M		M	M	M		M	M	M	M	M
CO5	M	M	M	M	M		M	M	M		M	M	M	M	M
18NPC 602	M	M	M	M	M		M	M	M		M	M	M	M	M

L-Low, M-Moderate(medium), H-High

18NPC603	INDUSTRIAL INSTRUMENTATION	SEMESTER-VI

PRE-REQUISITES:
1. 18NPC305 Sensors and Transducers

Category : PC

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

* To provide knowledge on various techniques used for the measurement of industrial Parameters

UNIT I : TEMPERATURE MEASUREMENT	**(9 Periods)**
Definitions and standards – Different types of filled in system thermometer – Bimetallic thermometers – Thermocouples: Laws of thermocouple, Fabrication of industrial thermocouples, Reference junctions compensation, Signal conditioning for thermocouple, Commercial circuits for cold junction compensation, Response of thermocouple, Radiation fundamentals - Radiation methods of temperature measurement – Total radiation pyrometers – Optical pyrometers – Two colour radiation pyrometers – Fibre optic sensor for temperature measurement.	
UNIT II : PRESSURE MEASUREMENT	**(9 Periods)**
Units of pressure – Manometers: different types, Elastic type pressure gauges: Bourdon tube, Bellows, Diaphragms and Capsules - Electrical methods: Elastic elements with LVDT and strain gauges - Capacitive type pressure gauge – Piezo-resistive pressure sensor-Resonator pressure sensor - Measurement of vacuum: McLeod gauge, Thermal conductivity gauge, ionization gauges, Cold cathode type and hot cathode type – Pressure gauge selection, installation and calibration using dead weight tester.	
UNIT III : MEASUREMENT OF FLOW	**(9 Periods)**
Variable Head type flow meters : Expression for flow rate through restriction – Orifice plate –different types of orifice plates – Venturi tube – Flow nozzle – Pitot tube– installation and applications of head flow meters. Electrical type flow meters: Principle and constructional details of Electromagnetic flow meter – Ultrasonic flow meters – Laser Doppler anemometer – Vortex shedding flow meter. Positive displacement flow meters: Nutating disc, Reciprocating piston and Oval gear flow meters - Turbine flow meter – Variable area flow meter: Rota meter Calibration of flow meters.	
UNIT IV – LEVEL MEASUREMENT	**(9 Periods)**
Float type – Displacer type – Hydrostatic type–thermal effect type – Electrical methods – resistive, capacitive type - Rotating paddle switches – Conductivity sensors – Nucleonic gauge – ultrasonic sensors – nuclear radiation sensor -Boiler drum level measurement – Solid level measurement - level sensor application.	
UNIT V – MEASUREMENT OF VISCOSITY, HUMIDITY, MOISTURE AND DENSITY	**(9 Periods)**
Viscosity: Saybolt viscometer - Rotameter type and Torque type viscometers – Consistency Meters – Humidity: Dry and wet bulb psychrometers – Resistive and capacitive type hygrometers – Dew cell – Commercial type dew meter. Moisture: Different methods of moisture measurements – Conductivity, Capacitive, Microwave, IR sensors. Density measurement – float type, gas bridge type, pressure head type. Safety Practices - hazardous areas and classification - enclosures - NEMA types, Purging, explosion proofing and intrinsic safety.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Patranabis. D **"Principles of Industrial Instrumentation"** 3rd Edition, McGraw-Hill Education, 2015*
2. *Doebellin.E.O. and Manik D.N **"Measurement systems Application and Design"** 6th Edition, McGraw-Hill Education Pvt. Ltd, 2011*

REFERENCE BOOKS

1. *A.K. Sawhney, **"A Course in Electronic Measurements and Instrumentation",** Dhanpat Rai & Co. (P) Limited, 2015.*
2. *Singh,S.K **"Industrial Instrumentation and Control"** Tata Mc-Graw-Hill Education Pvt. Ltd., New Delhi, 2009*
3. *1 Liptak.B.G **"Instrumentation Engineers Handbook (Measurement)"** CRC Press, 2005.*
4. *Jones.B.E **"Instrument Technology"** Vol.2, Butterworth-Heinemann, International Edition, 2013*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Explain the construction and working of instruments used for measurement of flow level density, viscosity, humidity, moisture, temperature and pressure.

CO 2: Select the instruments according to the application.

CO 3: Compare the advantages and disadvantages of measuring devices and importance of calibration with procedure of calibration pertaining to various measurements.

CO 4: Design signal conditioning circuits and compensation schemes for temperature measuring instruments.

CO 5: Apply the safety methods in industrial areas to avoid any dangerous situation.

COURSE ARTICULATION MATRIX:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	M	M	M	L	H	M	M	H	M	H	H	H	L	H
CO2	H	M	M	M	L	H	M	M	H	M	H	H	H	L	H
CO3	H	M	M	M	L	H	M	M	H	M	H	H	H	L	H
CO4	H	M	M	M	L	H	M	M	H	M	H	H	H	L	H
CO5	H	M	M	M	L	H	M	M	H	M	H	H	H	L	H
18NPC 603	H	M	M	M	L	H	M	M	H	M	H	H	H	L	H

L- Low, M-Moderate (Medium), H-High

18NPC607	PROCESS CONTROL LABORATORY	SEMESTER-VI

PRE-REQUISITES: NIL

Category : PC

L	T	P	C
0	0	4	2

COURSE OBJECTIVE

* To provide hands on experience in measuring and controlling different industrial parameters

LIST OF EXPERIMENTS

1. Characteristics of control valves.
2. Characteristics of process with and without transportation delay.
3. Experimental modeling of a flow process.
4. Characteristics of non- interacting and interacting systems.
5. Comparison of controller responses for a level process.
6. Comparison of controller responses for a flow process.
7. Comparison of controller responses for a pressure process.
8. Comparison of controller responses for a temperature process.
9. Cohen coon method of tuning of controllers.
10. Ziegler Nichols method of tuning of controllers.
11. Characteristics of feed forward controller.
12. Characteristics of cascade controller

Contact Periods:
Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 60 Periods** **Total: 60 Periods**

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Model a system experimentally
CO 2: Choose the appropriate controllers to control the process parameters
CO 3: Tune the controller parameters effectively.
CO 4: Interpret the results and draw meaningful conclusions
CO 5: Present the results in oral form as well as in written form as a report

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	M	M	M		M	M	M		M	M	M	M	M
CO2	M	M	M	M	M		M	M	M		M	M	M	M	M
CO3	M	M	M	M	M		M	M	M		M	M	M	M	M
CO4	M	M	M	M	M		M	M	M		M	M	M	M	M
CO5	M	M	M	M	M		M	M	M		M	M	M	M	M
18NPC 607	M	M	M	M	M		M	M	M		M	M	M	M	M

L-Low, M-Moderate(medium), H-High

18NEE608	INDUSTRIAL INSTRUMENTATION LABORATORY	SEMESTER-VI

PRE-REQUISITES: NIL

Category : EEC

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVE

* To impart adequate knowledge and expertise to handle different types of instruments.

LIST OF EXPERIMENTS

1. Calibration of pressure gauge using Dead weight Tester.
2. Measurement of discharge co efficient - Orifice meter and Venturimeter
3. Measurement of flow rate using Rotameter.
4. Characteristics of I/P and P/I Converters.
5. Measurement of Humidity, pH and Conductivity
6. Measurement of Absorbance and Transmittance of Test solutions using UV visible Spectrometer
7. Measurement of Viscosity using Saybolt Viscometer.
8. Level measurement using DPT
9. Calibration of temperature sensor.
10. Design of alarm circuit.
11. Cold junction compensation of Thermocouple.
12. Linearization of Thermistor.

Contact Periods :

Lecture : 0 Periods Tutorials : 0 Periods Practical : 45 Periods Total : 45 Periods

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Explain the procedures for measuring the industrial process parameters such as flow, level, temperature, pressure and viscosity.

CO 2: Analyze and measure pH, conductivity, UV absorbance and transmittance.

CO 3: Develop the interdisciplinary projects based on the acquired knowledge.

CO 4: Design circuits for Alarm, Cold Junction Compensation and Linearization.

CO 5: Discuss about the results and draw meaningful conclusions.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	L	M	L		M	L		H	H	M			M	H
CO2	H	H	M	L		M	L		H	H	M			H	H
CO3	H	L	H	L		M	L		H	H	M			H	H
CO4	H	L	H	L		M	L		H	H	M			H	M
CO5	H	L	L	L		M	L		H	H	M			L	M
18NEE 608	H	L	H	L		M	L		H	H	M			H	H

L-Low, M-Moderate(medium), H-High

18NPC701	SOFT COMPUTING TECHNIQUES	SEMESTER-VII

Category : PC

PRE-REQUISITES:

1. 18NPC405 – Digital Electronics

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To study various architectures of neural network, concepts of fuzzy control and Genetic algorithms and its hybrid schemes.

UNIT I – INTRODUCTION TO NEURAL NETWORKS	**(9 Periods)**
Motivation for the development of neural networks - artificial neural networks - biological neural networks - application areas. Typical architectures - setting weights - common activation functions. McCulloch-pitts neuron: architecture, algorithm, applications. Simple neural networks for pattern classification: Architecture, biases and thresholds, linear separability, data representation - Hebb Net: algorithm and application - Architecture, algorithm and application of perceptron - perceptron learning rule convergence theorem - delta rule.	
UNIT II – NEURAL NETWORK ALGORITHMS	**(9 Periods)**
Back propagation algorithm (BPA) –Recurrent neural network (RNN) – Adaptive resonance theory (ART) based network – Radial basis function network – online learning algorithms, BP through time – RTRL algorithms –Reinforcement learning. Kohonen's Self Organizing map- Counter propagation Networks – Neural networks for control: Schemes of neuro control – Inverse dynamics. Case study: Neuro controller for a temperature process.	
UNIT III – FUZZY SET THEORY	**(9 Periods)**
Fuzzy set theory – Fuzzy sets – Operation on fuzzy sets – Scalar cardinality, fuzzy cardinality, union and intersection, complement (Yager and Sugeno), equilibrium points, aggregation, projection, composition, cylindrical extension, fuzzy relation – Fuzzy membership functions-Fuzzy logic Controller : Functional diagram. Membership functions: Triangular, Trapezoidal - scale factors.	
UNIT IV - FUZZY CONTROLLER STRUCTURE	**(9 Periods)**
Fuzzy Logic controller – Fuzzification –Knowledge base – Decision making logic – Defuzzification Fuzzification: Membership value assignments using intuition - knowledge base. Defuzzification: Max-Membership principle - centroid method - weighted average method - rule base. Choice of variable - derivation of rules, data base. Modelling of nonlinear systems using fuzzy models (Mamdani and Sugeno) –Takagi-Sugeno-Kang (TSK) model– Case study : Fuzzy logic Controller design for a temperature process.	
UNIT V – HYBRID CONTROL SCHEMES	**(9 Periods)**
Neuro fuzzy systems –Adaptive neuro fuzzy inference system(ANFIS) – Introduction to GA – Optimization of membership function and rule base using Genetic Algorithm- Basic concept of Genetic algorithm – flow chart of GA – Genetic representations –encoding – Initialization and selection, Genetic operators – Mutation, Generational Cycle.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Laurene. V, Fausett, **"Fundamentals of Neural Networks, Architecture, Algorithms, and Applications",** Pearson Education, 2008.*
2. *Timothy. J, Ross, **"Fuzzy Logic with Engineering Applications",** Wiley, Third Edition, 2010.*
3. *David Goldberg. V **"Genetic Algorithms in Search, Optimization, and Machine Learning",** Pearson Education, 2009.*

REFERENCE BOOKS

1. *Jacek. M. Zurada **"Introduction to Artificial Neural Systems",** Jaico Publishing House, 1999.*
2. *Miller W.T, Sutton . R.S and Webrose . P.J, **"Neural Networks for Control",** MIT Press, 1996.*
3. *Driankov D, Hellendoorn H. and Reinfrank M., **"An Introduction to Fuzzy Control",** Narosa Publishing House, New Delhi, 1996.*
4. *Zimmermann. H.J, **"Fuzzy set theory-and its Applications"-** Springer International edition, 2011.*
5. *EthemAlpaydin, **"Introduction to Machine learning (Adaptive Computation and Machine Learning series)",** MIT Press, 2004.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Familiarize the various architectures of neural networks.
CO 2: Describe the concepts of fuzzy sets and logic.
CO 3: Apply the concepts to simple problems of digital applications.
CO 4: Acquire knowledge on Terminologies and operations of GA.
CO 5: Explore the configurations of Hybrid schemes.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	L	H	M	M	L	L	L	M	L	M	M	H	M	L
CO2	H	L	M	L	M	M	M	H	L	H	L	H	H	M	L
CO3	M	M	H	M	H	L	L	L	M	L	M	M	H	M	L
CO4	H	H	M	L	M	M	M	H	L	H	L	L	H	L	M
CO5	H	H	H	M	M	L	M	L	M	L	M	L	M	L	M
18NPC 701	M	M	M	M	M	M	M	L	L	L	M	M	M	M	L

L-Low, M-Moderate (medium), H-High

18NPC702	ANALYTICAL INSTRUMENTATION	SEMESTER-VII

PRE-REQUISITES: NIL

Category : PC

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

* To impart the knowledge on the working principles of spectrophotometer, NMR spectrometer, gas analyzers, pH meter, dissolved oxygen and pollution monitoring instruments.

UNIT - I : SPECTROPHOTOMETRY	**(9 Periods)**
Spectral methods of analysis – Beer-Lambert law – UV-Visible spectroscopy – IR Spectrophotometer- FTIR spectrophotometer – Atomic absorption spectrophotometer - Flame emission and atomic emission photometry – Construction, working principle, sources detectors and applications.	
UNIT - II : CHROMATOGRAPHY	**(9 Periods)**
General principles – classification – chromatographic behavior of solutes – quantitative determination – Gas chromatography – Liquid chromatography – High-pressure liquid chromatography – Applications.	
UNIT - III : INDUSTRIAL GAS ANALYZERS AND POLLUTION MONITORING INSTRUMENTS	**(9 Periods)**
Gas analyzers – Oxygen, NO_2 and H_2S types, IR analyzers, thermal conductivity detectors, analysis based on ionization of gases. Measurement of air pollution due to carbon monoxide, hydrocarbons, nitrogen oxides, sulphur dioxide - Dust and smoke measurements.	
UNIT - IV : pH METERS AND DISSOLVED COMPONENT ANALYZERS	**(9 Periods)**
Selective ion electrodes - Principle of pH and conductivity measurements - dissolved oxygen analyzer – Sodium analyzer – Silicon analyzer – Water quality Analyzer.	
UNIT - V : NUCLEAR MAGNETIC RESONANCE AND MASS SPECTROMETRY	**(9 Periods)**
NMR – Basic principles – Continuous and Pulsed Fourier Transform NMR spectrometer – Mass Spectrometry – Sample system – Ionization methods – Mass analyzers – Types of mass spectrometry.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Willard, H.H., Merritt, L.L., Dean, J.A., Settle, F.A **"Instrumental methods of analysis"** CBS publishing & distribution, 7th Edition, 2012.*
2. *Khandpur. R.S **"Handbook of Analytical Instruments"** Tata McGraw-Hill publishing Co. Ltd., 2nd Edition 2007.*

REFERENCE BOOKS

1. *Liptak.B.G **"Process Measurement and Analysis"** CRC Press, 5th Edition, 2015.*
2. *Ewing, G.W **"Instrumental Methods of Chemical Analysis"** McGraw-Hill, 5th Edition Reprint 1985. (Digitized in 2007).*
3. *Braun. R.D **"Introduction to Instrumental Analysis"** Pharma Book Syndicate, Singapore, 2006.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Explain the fundamental principles of analytical instruments.

CO 2: Analyze the strengths and limitations of the various instrumental methods.

CO 3: List the applications and usage of chromatography in real time industrial environments.

CO 4: Select Instrument for a particular analysis with some idea of its merits, demerits and limitations.

CO 5: Describe the specific technique employed for monitoring different pollutants in air and water.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	L				M	M			L					H
CO2	H	L				M	M			L					H
CO3	H	L				M	M			L					H
CO4	H	L				M	M			L					H
CO5	H	L				M	M			L					H
18NPC 702	H	L				M	M			L					H

L-Low, M-Moderate(medium), H-High

18NPC703	INDUSTRIAL AUTOMATION SYSTEMS	SEMESTER-VII

PRE-REQUISITES: NIL

Category : PC

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To induct knowledge on various industrial automation controllers like PLC, DCS and the supervisory functions like SCADA.

UNIT I – PROGRAMMABLE LOGIC CONTROLLER (PLC) BASICS	**(9 Periods)**
Overview of PLC systems – parts of PLC –Input/output modules – power supplies and isolators – Fundamental PLC wiring diagram – relays – switches –transducers – sensors –seal-in circuits.	
UNIT II – PLC PROGRAMMING	**(9 Periods)**
Fundamentals of logic – Program scan – Relay logic – PLC programming languages – Construction of PLC ladder diagram – basic components and their symbols - timers – counters - math instructions – data manipulation instructions – Analog PLC operation – PID control of continuous process - Sequencer instruction - connecting PLC to computer – Application of PLC – Bottle filling System	
UNIT III – SCADA	**(9 Periods)**
Introduction - Supervisory Control and Data Acquisition Systems (SCADA) – SCADA HMI Essentials – SCADA Components – SCADA Configuration and Software – HMI hardware and software.	
UNIT IV – DISTRIBUTED CONTROL SYSTEMS	**(9 Periods)**
DCS – Various Architectures – Comparison – Local control unit – Process interfacing issues – Communication facilities – Low and High level engineering and operator interfaces- case studies in DCS.	
UNIT V – FIELD BUS	**(9 Periods)**
MODBUS – HART Protocol - Profibus – Profinet - Foundation Fieldbus – H1 and HSE.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *John.W.Webb & Ronald A Reis,* ***"Programmable Logic Controllers - Principles and Applications",*** *Prentice Hall of India, Fifth Edition, 2003.*
2. *M.P.Lukas,* ***"Distributed Control Systems",*** *Van Nostrand Reinhold Co, First Edition, 1986.*
3. *G.Clarke, D.Reynders and E.Wright,* ***"Practical Modern SCADA Protocols:DNP3, 60870.5 and Related Systems",*** *Newnes, First Edition, 2004.*

REFERENCE BOOKS

1. *Bela.G.Liptak,* ***"Process Software and Digital Networks – Volume 3",*** *CRC Press, Fourth Edition, 2012.*
2. *F.D.Petruzella,* ***"Programmable Logic Controllers",*** *Tata McGraw Hill, Third Edition, 2017.*
3. *Krishna Kant,* ***"Computer based Industrial Control",*** *Prentice Hall of India, Second Edition, 2010.*
4. *T.A.Hughes,* ***"Programmable Controllers",*** *ISA Press, Fourth Edition, 2005.*
5. *John R. Hackworth and Frederick D. Hackworth Jr,* ***"Programmable Logic Controllers",*** *Pearson Education, Second Edition, 2004.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Elaborate the architecture of PLC, DCS and its functions.

CO 2: Construct ladder logic program using basic PLC functions like timers, counters.

CO 3: Develop ladder logic program for advanced process control applications.

CO 4: Explain various design approaches, engineering and operator interfaces in distributed control system.

CO 5: Define the structure of network protocols and list their advantages and disadvantages.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H								H			L	L		H
CO2	H	H	H				M		H			L	L		H
CO3	H	H	H			L	M		H			L	L		H
CO4	H						M		H			L	L		H
CO5	H		H			L	M		H			L	L		H
18NPC 703	H	H	H			L	M		H			L	L		H

L-Low, M-Moderate(medium), H-High

18NPC707	INDUSTRIAL AUTOMATION LABORATORY	SEMESTER-VII

PRE-REQUISITES: NIL

Category : PC

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVE

∗ To introduce the practical methods of automatic control of machines, processes and systems.

LIST OF EXPERIMENTS

1. Simple exercises using the instruction set of an industrial type PLC.
2. Interfacing transmitter and control valve with personal computer.
3. (i) Study of PLC field device interface modules (AI, AO, DI, DO Modules)
   (ii) Interfacing Analog/Digital input/output devices with industrial type PLC
4. Bottle filling/draining control operation using PLC
5. Reversal of DC motor direction using PLC
6. Traffic light control using PLC
7. Batch Process Reactor system using PLC
8. Control of Level Process using PLC
9. (i) Study of DCS field device interface modules (AI, AO, DI, DO, H1 Modules)
   (ii) Interfacing Analog/Digital input/output devices with an industrial type DCS
10. (i) Interfacing HART and FF enabled field devices with industrial type DCS.
11. Design of flow and level control with DCS.
12. Study of SCADA.

Contact Periods:
Lecture: 0 Periods Tutorial: 0 Periods Practical: 45 Periods Total: 45 Periods

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Get hands on experience in working with Industrial Automation Systems (Industrial Type DCS & PLC)
CO 2: Configure PLC and DCS
CO 3: Monitor and control a plant using PLC/DCS
CO 4: Facilitate the interdisciplinary projects based on programming skills.
CO 5: Present the results in oral form as well as in written form as a report

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H						M	H	H			H	M	
CO2	H	H	M				M	M	H	H			H	M	
CO3	H	H	M		H		M	M	H	H			H	M	
CO4	H	H	M		H		M	M	H	H			H	M	
CO5							M	M	H	H					
18NPC707	H	H	M		H		M	M	H	H			H	M	

L-Low, M-Moderate(medium), H-High

18NEE708	MINI PROJECT	SEMESTER-VII

PRE-REQUISITES: NIL

Category : EEC

L	T	P	C
0	0	8	4

COURSE OBJECTIVES:

- To identify a topic of interest in consultation with Faculty/Supervisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Demonstrate the novelty of the project through the results and outputs.

- The progress of the mini project is evaluated based on three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The evaluation will be made based on this report and a viva- voce examination, conducted internally by a member com

- Committee appointed by Head of the Department.

Contact Periods:
Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 120 Periods** **Total: 120 Periods**

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Select a good project and able to work in a team leading to development of hardware/software product.

CO 2: Prepare a good technical report and able to present the ideas with clarity.

CO 3: Gain knowledge on various terminologies related to industrial environment.

CO 4: Work efficiently as a member of different teams related to multidisciplinary projects.

CO 5: Acquire skills to communicate efficiently and gain management skills related to industry and research organizations.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	H	H	M	H	H	H	M	H	H	M	M	M	H
CO2	H	M	H	H	M	M	M	L	M	M	H	M	H	M	M
CO3	H	M	L	M	L	M	M	M	M	M	H	H	H	L	M
CO4	H	H	H	H	M	M	M	L	M	M	H	H	H	M	M
CO5	M	H	H	M	M	M	L	M	M	H	H	H	M	M	H
18NEE 708	M	M	H	M	M	M	M	M	M	M	H	H	H	M	M

L-Low, M-Moderate (medium), H-High

18NEE803	PROJECT WORK	SEMESTER VIII

PRE-REQUISITES : NIL **Category : EEC**

L	T	P	C
0	0	16	8

COURSE OBJECTIVES:

- To use the knowledge acquired in various subjects of Electrical and Electronics Engineering.
- To motivate students come up with new designs and Fabrication, algorithms and software programs expressing their ideas in a novel way.
- To learn methodology for selecting a good project and work in a team for developing the hardware/software product.

PROJECT:

- A Project topic must be selected either from research literature or their own innovative technical ideas in consultation with the guide. The aim of the project work is to deepen Comprehension of principles by applying them to a new problem which may be the design, fabrication of Sensor/Actuator/Controller, a research investigation, or a design problem. The progress of the project is evaluated based on a minimum of two reviews.
- A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners based on oral presentation and the project report.

Contact Periods:

Lecture: 0 Periods Tutorial: 0 Periods Practical: 240 Periods Total: 240 Periods

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Select a good project and able to work in a team leading to development of hardware/software product.

CO 2: Prepare a good technical report and able to present the ideas with clarity.

CO 3: Gain knowledge on various terminologies related to industrial environment.

CO 4: Able to work efficiently as a member of different teams related to multidisciplinary projects.

CO 5: Acquire skills to communicate efficiently and gain management skills related to industry / research organizations.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	H	H	M	H	H	H	M	H	H	M	M	M	H
CO2	H	M	H	H	M	M	M	L	M	M	H	M	H	M	M
CO3	H	M	L	M	L	M	M	M	M	M	H	H	H	L	M
CO4	H	H	H	H	M	M	M	L	M	M	H	H	H	M	M
CO5	M	H	H	M	M	M	L	M	M	H	H	H	M	M	H
18NEE 803	M	M	H	M	M	M	M	M	M	M	H	H	H	M	M

L-Low, M-Moderate(medium), H-High

18NPE$01	ADVANCED CONTROL THEORY

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES:

1. 18NPC503- Control System Design

COURSE OBJECTIVE

- To instill the proficiency of controller design, state variable and phase plane analysis and need of optimal control.

UNIT - I: CONTROLLER DESIGN AND STATE SPACE ANALYSIS.	**(9 Periods)**
System performance and specifications – Feedback compensators – Proportional Derivative (PD), Proportional Integral (PI) and PID controllers -Design of PD,PI,PID controllers (cascade)using time and Frequency domain methods. Concepts of state, state variable and state space model- State space representation of discrete time systems-solutions of state equations- state transition matrix.	
UNIT - II : CONTROLLABILITY AND OBSERVABILITY	**(9 Periods)**
BIBO Stability – Determining the stability by Routh-Hurwitz criterion- Properties and construction of the root loci-effect of adding a pole and zeros to a system. Jordan and Canonical forms, Controllability and observability - Condition for controllability and observability, Gilbert method and Kalman decomposition-Design of state feedback by pole placement.	
UNIT - III : NON-LINEAR CONTROL	**(9 Periods)**
Non-linear systems-properties-common physical non-linearity's-dead zone, relay, saturation nonlinearities Phase plane analysis - isocline method, Delta method-Existence of limit cycles. Describing function fundamentals- Definitions-Assumptions-Computing describing functions-Nyquist criterion and its extension-Existence of limit cycles-Stability of limit cycles.	
UNIT - IV : LYAPUNOV STABILITY	**(9 Periods)**
Lyapunov direct method, positive definite functions and lyapunov functions, invariant set theorems, lyapunov analysis of linear time invariant systems, the variable gradient method, performance analysis, existence of Lyapunov functions.	
UNIT - V : OPTIMAL CONTROL	**(9 Periods)**
Problem formulation – necessary conditions of optimality – state regulator problem – Matrix Riccati equation – infinite time regulator problem – output regulator and tracking problems.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Benjamin C. Kuo **"Digital control systems"** Oxford University Press, 2004*
2. *Ogata K.H **"State Space Analysis of Control Systems"** Prentice Hall Publications, 1967.*
3. *Kirk D.E, **"Optimal control theory-an introduction",** Prentice Hall, N.J. 1970.*

REFERENCE BOOKS

1. *Gopal M, Second Edition* ***"Modern Control Theory"*** *Wiley Eastern Publishers, 1993.*
2. *Tou T.J.* ***"Modern control theory"*** *McGraw-Hill publications, 1964*
3. *Nagarath I.J. & Gopal.M* ***"Control Systems Engineering"*** *Second Edition, Wiley & Sons, 1985.*
4. *Torkel Glad & Lennart Ljung* ***"Control Theory - Multi Variable and Non-linear Methods"*** *Taylor's & Francis Group, 2002.*
5. *Hasan Saeed.S,* ***"Automatic Control Systems"*** *S.K. Kataria & Sons, 2002.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Design cascade controllers in time and frequency domain.
CO 2: Develop and derive state space model for various systems.
CO 3: Analyze the state space parameters and design state feedback.
CO 4: Describe the common non-linearity's and its stability.
CO 5: Explain the need of optimality.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	H	H	H	M	L	M	H	M	M	M	M	H	M	L
CO2	M	M	M	M	H	H	M	M	M	L	L	L	H	H	L
CO3	H	H	H	M	M	M	M	M	M	M	L	L	H	M	M
CO4	H	M	H	M	H	M	L	M	L	L	M	L	H	M	L
CO5	M	M	M	M	M	L	L	M	L	M	L	M	M	M	M
18NPE$01	M	M	M	M	M	M	M	M	M	M	L	L	M	M	L

L-Low, M-Moderate(medium), H-High

18NPE$02	DIGITAL CONTROL SYSTEM

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES:

1. 18NPC503 –Control System Design

COURSE OBJECTIVE

- To nurture the needs of Digital control design in view of stability conditions and controller design in Z-domain using time domain and frequency domain techniques.

UNIT I –MODELING OF DIGITAL CONTROL SYSTEMS	**(9 Periods)**
Structure of Digital control system Examples of Digital control system.– ADC-DAC model – Transfer function of ZOH – Effect of sampler on transfer function – Analog disturbances in a digital system – Sampled Step input and Ramp input - .	
UNIT II – STABILITY OF DIGITAL CONTROL SYSTEMS	**(9 Periods)**
Stability – Stable Z-domain pole locations – Asymptotic stability - BIBO stability – Internal Stability – Stability determination - Jury Stability Test- Schur-Cohn stability Test- Nyquist criterion.	
UNIT III – DIGITAL CONTROL DESIGN	**(9 Periods)**
Z-domain root locus – Proportional control design in Z-domain – Digital implementation of analog controller design - - Bilinear transformation- Empirical Digital PID controller tuning- Direct Z-domain Digital controller design – Frequency response design.	
UNIT IV – DISCRETE-TIME STATE SPACE EQUATIONS	**(9 Periods)**
Discrete- time state-space equations- Solutions-Z-transform solutions- Z-transfer function- similarity transformation- Invariance and characteristic equations.	
UNIT V - ELEMENTS OF NONLINEAR DIGITAL CONTROL SYSTEMS	**(9 Periods)**
Discretization of Nonlinear systems – Extended linearization – Input, state and output Differentiation-Lyapunov stability theorems – Controller design.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Gopal, M. **"Digital Control and State Variable Methods"** Tata McGrawHill, 2003*
2. *Deshpande. Pm,and Ash **"Elements of Computer Control System"** ISA Press, USA, 1998.*
3. *Ioan D.Landau and G.Zito, **"Digital Control Syatems",** Springer-verlag Ltd.,2006.*

REFERENCE BOOKS

1. *C.L. Smith **"Digital Computer Process Control"** Intext Educational Publishers, 1972.*
2. *Coughanowr, D.R. **"Process Systems Analysis and Control"** McGraw - Hill International Edition, 2004.*
3. *Richard. H, Middleton and Graham. C, Goodwin **"Digital Control and Estimation A Unified Approach"** Prentice Hall NJ, 1990.*
4. *Dale Seborg. E, Thomas. F, Edgar, Duncan. A, Mellichamp **"Process Dynamics and Control",** Willey India, 2006*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Explain why difference equations result from digital control of analog systems.

CO 2: Obtain Z-transfer function of Linear system and closed loop transfer function for a digital control system.

CO 3: Determine the stability of Z-transfer function and stability of Z-polynomial using Jury criterion and Nyquist criterion.

CO 4: Sketch the Z-domain root locus for a digital control system.

CO 5: Design a digital controller using root locus and frequency techniques.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	H	H	L	L	M	M	M	L	M	L	H	M	L
CO2	H	H	H	M	M	L	M	L	M	L	M	M	H	M	M
CO3	H	M	H	M	L	M	M	M	M	L	L	L	H	L	M
CO4	H	H	H	L	M	L	M	L	M	L	M	M	M	M	L
CO5	H	H	M	M	M	L	M	H	M	L	H	M	M	L	L
18NPE$02	H	H	H	M	M	L	M	M	M	L	M	M	M	M	L

L-Low, M-Moderate(medium), H-High

18NPE$03	COMPUTER CONTROL OF PROCESS

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES:

1. 18NPC503 – Control System Design

COURSE OBJECTIVE

- To embed the necessity of computer controlled process and its variants and to design the process via digital control algorithms, and to explore the branches of adaptive multivariable control.

UNIT I – SAMPLED DATA CONTROL SYSTEM	**(9 Periods)**
Introduction – Review of Z transform – modified Z transform – need of computer in a control system – functional block diagram of a computer control system – direct digital control(DDC) – supervisory control – data logger –SCADA .	
UNIT II – SYSTEM MODELLING AND IDENTIFICATION	**(9 Periods)**
Introduction to pulse transfer function – open loop and closed loop response of SDS – pulse testing for process identification – linear least square algorithm – implementation of digital controllers – digital temperature control system – digital position control system – stepping motors and their control.	
UNIT III – DESIGN OF DIGITAL CONTROL ALGORITHM	**(9 Periods)**
Design and implementation of different digital control algorithm – Dead beat – Dahlin – Kalmans algorithm – pole placement controller – position and velocity form algorithm – selection of sampling time – Smith predictor algorithm – Jury's stability test – Schur Cohn stability criterion.	
UNIT IV – ADAPTIVE CONTROL	**(9 Periods)**
Self tuning – gain scheduling – Model Reference Adaptive Control – self tuning regulator – auto tuning and gain scheduling adaptive control design with examples .	
UNIT V – MULTI VARIABLE CONTROL SYSTEM	**(9 Periods)**
Multi variable Control- Transfer matrix representation- poles and zeros of MIMO system- Multi loop control- Process Interaction-Pairing of inputs and outputs- Relative Gain array (RGA)- Multivariable PID control.	
Contact Periods:	
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods	

TEXT BOOKS

1. *Dale Seborg. E, Thomas. F, Edgar, Duncan. A, Mellichamp, **"Process Dynamics and Control"** Willey India, 2006.*
2. *Astrom .K. J, Bjorn Wittenmark, **"Adaptive Control",** Second Edition, Prentice Hall of India,2004.*
3. *Deshpande. Pm,and Ash, **"Elements of Computer Control System"** ISA Press, USA, 1998*

REFERENCE BOOKS

1. *Bequette, B.W.,* ***"Process Control Modeling, Design and Simulation",*** *Prentice Hall of India, 2008.*
2. *Thomas E. Marlin,* ***"Process Control – Designing Processes and Control systems for Dynamic Performance",*** *Mc-Graw-Hill, 2000.*
3. *Stephanopoulos, G.,* ***"Chemical Process Control -An Introduction to Theory and Practice",*** *Prentice Hall of India, 2005*
4. *Sigurd Skogestad, Ian Postlethwaite,* ***"Multivariable Feedback Control: Analysis and Design",*** *John Wiley and Sons, 2005*
5. *P. Albertos and A. Sala,* ***"Multivariable Control Systems An Engineering Approach",*** *Springer Verlag, 2006.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Recognize the basics of Z-transform and model the process.
CO 2: Acquire knowledge on identification.
CO 3: Realize the digital control algorithm.
CO 4: Realize the concepts of adaptive control.
CO 5: perceive the essentials of multivariable control

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	L	H	M	L	L	M	M	M	L	M	M	H	M	L
CO2	H	H	L	M	M	L	L	L	H	M	H	L	M	M	L
CO3	H	M	H	L	L	L	M	M	M	M	H	M	M	L	M
CO4	H	H	H	M	M	L	H	L	L	L	H	L	L	M	L
CO5	H	H	L	M	M	L	M	L	M	L	M	M	L	M	M
18NPE$03	H	H	M	M	M	L	M	L	M	L	M	M	M	M	L

L-Low, M-Moderate(medium), H-High

18NPE$04	ADVANCED PROCESS CONTROL

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES:

1. 18NPC503 – Control System Design

COURSE OBJECTIVE

- To investigate the behavior of various control schemes, need of Fractional order systems, H-Infinity systems, and to introduce fault diagnosis techniques.

UNIT I – ADVANCED CONTROL TECHNIQUES	**(9 Periods)**
Brief review of dynamic behavior of processes, single-loop feedback control systems, – Enhanced single loop control strategies – selective control/override systems, PID enhancements: anti-reset windup, auto-tuning, gain scheduling and self tuning -Time delay compensation.	
UNIT II – MODEL BASED CONTROL SCHEMES	**(9 Periods)**
Internal model control preliminaries and model predictive control – model predictive control elements and algorithms – Batch control systems: control during the batch – run-to-run control – batch scheduling and hierarchy. Plant wide control issues – steady state and dynamic effects of recycle –control and optimization hierarchy – plant wide control examples: MPN and HDA process – interaction of plant design and control system design. Case study.	
UNIT III – FRACTIONAL ORDER SYSTEM & CONTROLLER	**(9 Periods)**
Fractional-order Calculus and Its Computations – Frequency and Time Domain Analysis of Fractional-Order Linear Systems - Filter Approximations to Fractional-Order Differentiations – Model reduction Techniques for Fractional Order Systems –Controller Design Studies for Fractional Order.	
UNIT IV – H-INFINITY CONTROLLER	**(9 Periods)**
Introduction – Norms for Signals – Robust Stability – Robust Performance – Small Gain Theorem – Optimal H2 Controller Design - H-Infinity Controller Design — Effects of Weighting Functions in H Infinity Control.	
UNIT V – FAULT DIAGNOSIS AND FAULT-TOLERANT CONTROL	**(9 Periods)**
Process Monitoring - Introduction – Statistical Process Control – Fault Detection with Principal Component Analysis – Fault Detection with State Observers – Fault Detection with signal models - Fault Detection of Control Loops- Sensor and Actuator Fault-Tolerant Control Design.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Dale E. Seborg, Thomas F. Edgar, Duncan A. Mellichamp* ***" Process Dynamics and Control"*** *John Wiley &sons, 2010*
2. *B. Wayne Bequette* ***"Process Control: modelling, Design, and simulation"*** *PHI learning Pvt. Ltd., New Delhi,2008*
3. *R. Isermann,* ***"Fault-Diagnosis Systems: An Introduction from Fault Detection to Fault Tolerance",****Springer, 2006.*

REFERENCE BOOKS

1. *M. Chidambaram **"Computer Control of Processes"** Narosa publishing house, 2010.*
2. *Thomas E. Marlin, Marlin Thomas **"Process Control: Designing Processes And Control Systems for Dynamic Performance"** McGraw Hill Publication, 2000*
3. *Lennart Ljung, Ellen J. Ljung **"System Identification: Theory for the user"** Prentice Hall, 1999.*
4. *Pradeep B. Deshpande, Raymond H. Ash **"Computer Process Control With Advanced Control Applications"** Instrument Society of America, 1988*
5. *Ray Ogunnaike, Babatunde A. ,et.al **"Process Dynamics, Modeling, And Control"** Oxford University Press, 1994*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Identify the advanced control schemes.
CO 2: Formulate the calculus of fractional order systems.
CO 3: Describe the H-infinity controller.
CO 4: Utilize fault- diagnosis as a tool to detect faults in sensors and actuators.
CO 5: Control the parameter of advanced process in real time.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	H	M	L	L	M	M	H	L	M	H	H	M	H
CO2	H	L	L	H	M	M	H	M	M	M	H	H	M	L	L
CO3	H	M	H	M	L	L	M	L	H	L	M	M	L	L	L
CO4	H	H	M	H	M	M	H	L	H	M	H	H	M	L	M
CO5	H	H	H	M	M	L	M	M	M	L	M	M	M	M	M
18NPE$04	H	M	M	M	M	L	M	M	M	L	M	M	M	L	M

L-Low, M-Moderate(medium), H-High

18NPE$05	SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

- To acquire knowledge in modeling and controller design

UNIT I – INTRODUCTION TO SYSTEM IDENTIFICATION	**(9 Periods)**
Identification based on differential equations, Laplace transforms, frequency responses, difference equations. Stationarity, auto-correlation, cross-correlation, power spectra. Random and deterministic signals for system identification: pulse, step, pseudo random binary sequence (PRBS), signal spectral properties, persistent excitation.	
UNIT II – NONPARAMETRIC MODEL ESTIMATION	**(9 Periods)**
Estimates of the plant impulse, step and frequency responses from identification data, Correlation and spectral analysis for non-parametric model identification, parametric models-Equation error, output error models, and determination of model order.	
UNIT III – PREDICTION-ERROR MODEL STRUCTURES	**(9 Periods)**
Parametric estimation using one-step ahead prediction error model structures and estimation techniques (Least Square (LS) - convergence, consistency, Bias, Instrumental Variable, Correlation function LS, generalized LS) for ARX, ARMAX, Box-Jenkins, FIR, Output Error models. Residual analysis for determining adequacy of the estimated models.	
UNIT IV – RECURSIVE SYSTEM IDENTIFICATION ADAPTIVE CONTROL	**(9 Periods)**
Stability Issues in Time-varying Systems, Stability of an Adaptive Systems, Direct and Indirect adaptive control, Self-tuning regulators, MRAC-MIT rule, Lyapunov theory, Adaptive gain calculation, Auto-tuning techniques.	
UNIT V – ADVANCED TECHNIQUES	**(9 Periods)**
Adaptive Smith predictor control, Auto-tuning and self-tuning Smith predictor. Case study-Online and offline Identification and design of adaptive control for different process.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Kannan Moudgalya,* ***"Digital Control",*** *JohnWiley & Sons, Ltd, 2017*
2. *Arun K Tangirala,* ***"Principles of System Identification",*** *CRC press , 2014*
3. *L.Ljung,* ***"System Identification: Theory for the User",*** *Prentice-Hall, 2nd Edition, 1999*

REFERENCE BOOKS

1. *Karel J. Keesman,* ***"System Identification, an introduction",*** *Springer, 2011.*
2. *Åstrom and Wittenmark,* ***"Adaptive Control",*** *Dover Publications INC, 2nd Edition, 2008.*
3. *Y.Zhu,* ***"Multivariable System Identification for Process Control",*** *Pergamon, 2001.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Understand the knowledge of the process in system identification and adaptive control

CO 2: Recognize the need of system identification to engage the technological change

CO 3: Identify the model structure & order determination for an unknown process.

CO 4: Apply estimation techniques for parametric & nonparametric models.

CO 5: Develop an adaptive control schemes for time varying system

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	H	H	H	M	L	M	H	M	M	M	M	H	M	L
CO2	M	M	M	M	H	H	M	M	M	L	L	L	H	H	L
CO3	H	H	H	M	M	M	M	M	M	M	L	L	H	M	M
CO4	H	M	H	M	H	M	L	M	L	L	M	L	H	M	L
CO5	M	M	M	M	M	L	L	M	L	M	L	M	M	M	M
18NPE$05	M	M	M	M	M	M	M	M	M	M	L	L	M	M	L

L-Low, M-Moderate(medium), H-High

18NPE$06	OPTIMAL CONTROL

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

* To provide an understanding of the main results in optimal control and how they are used in various applications in Engineering

UNIT I – **OPTIMAL CONTROL PROBLEM AND PERFORMANCE MEASURES**	**(9 Periods)**
Statement of optimal control problem - problem formulation and forms of optimal control – selection of performance measures	
UNIT II – **CALCULUS OF VARIATION**	**(9 Periods)**
Fundamental concepts - extreme functional involving single and several Independent functions - piecewise smooth extremes - constrained extreme.	
UNIT III – **VARIATIONAL APPROACH TO OPTIMAL PROBLEMS**	**(9 Periods)**
Necessary conditions for optimal control - Pontriyagin's minimum principle (PMP) - state inequality constraints - minimum time problem - minimum control effort problems.	
UNIT IV – **LINEAR QUADRATIC CONTROL PROBLEM**	**(9 Periods)**
Problem formulation – Finite-Time Linear quadratic regulator – Analytical solution to the matrix Differential Riccati equation – Infinite time LQR system (I and II) - Linear quadratic tracking system: Finite time case – infinite time case – fixed-end point regulator system	
UNIT V – **DYNAMIC PROGRAMMING (DynP)**	**(9 Periods)**
Principle of optimality - recurrence relation of dynamic programming for optimal control problem - computational procedure for solving optimal control problems - characteristics of dynamic programming solution - dynamic programming application to discrete and continuous systems - Hamilton Jacobi Bellman equation. Numerical Techniques: Numerical solution of two - point boundary value problem and Fletcher Powell method - solution of Ricatti equation by iterative method.	
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**	

TEXT BOOKS

1. *D.E. Kirk, **"Optimal Control Theory-An Introduction",** Prentice Hall, 2004.*
2. *Desineni Subbaram Naidu, **"Optimal Control Systems",** 1st edition CRC Press 2003*
3. *M. Gopal, **"Modern Control Systems Theory",** 5th Edition, New Age International, 2005*

REFERENCE BOOKS

1. *Moore John B and Brian D O Anderson, **"Optimal Control: Linear Quadratic methods",** Dover Publications 2007.*
2. *Arturo Locatelli, "**Optimal control: An introduction",** 1st edition Birkhauser Basel, June 15, 2001.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Explain the principles behind the most standard algorithms for numerical solution of optimal control problems.

CO 2: Explain how PMP and DynP relates to each other and know their respective advantages and disadvantages

CO 3: Combine the mathematical methods used in optimal control to derive the solution to variations of the problems

CO 4: Explain how various control objectives affect the optimal performance.

CO 5: Use continuous time dynamic programming and the associated Hamilton-Jacobi-Bellman equation to solve linear quadratic control problems.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	H	H	H	M	L	M	H	M	M	M	M	H	M	L
CO2	M	M	M	M	H	H	M	M	M	L	L	L	H	H	L
CO3	H	H	H	M	M	M	M	M	M	M	L	L	H	M	M
CO4	H	M	H	M	H	M	L	M	L	L	M	L	H	M	L
CO5	M	M	M	M	M	L	L	M	L	M	L	M	M	M	M
18NPE$06	M	M	M	M	M	M	M	M	M	M	L	L	M	M	L

Low, M-Moderate(medium), H-High

18NPE\$07	MACHINE LEARNING TECHNIQUES

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

PRE-REQUISITES:

1. 18NPC405 – Digital System Design

COURSE OBJECTIVE

- To introduce the need for machine learning and understand its trends and design appropriate algorithms for posted problems.

UNIT I – NEURAL NETWORK AND GENETIC ALGORITHM	**(9 Periods)**
Neural Network Representation – Problems – Perceptrons – Multilayer Networks and Back Propagation Algorithms – Advanced Topics – Genetic Algorithms – Hypothesis Space Search – Genetic Programming – Models of Evaluation and Learning.	
UNIT II – MACHINE LEARNING – INTRODUCTION	**(9 Periods)**
Machine Learning- Types- Curse of dimensionality – Overfitting and Linear regression – Bias and variance- Learning curve – Classification – Error and noise – Parametric and non-parametric models.	
UNIT III – BAYESIAN AND COMPUTATIONAL LEARNING	**(9 Periods)**
Bayes Theorem – Concept Learning – Maximum Likelihood – Minimum Description Length Principle – Bayes Optimal Classifier – Gibbs Algorithm – Naïve Bayes Classifier – Bayesian Belief Network – EM Algorithm – Probability Learning – Sample Complexity – Finite and Infinite Hypothesis Spaces – Mistake Bound Model.	
UNIT IV – INSTANT BASED LEARNING	**(9 Periods)**
K- Nearest Neighbour Learning – Locally weighted Regression – Radial Basis Functions – Case Based Learning.	
UNIT V – ADVANCED LEARNING	**(9 Periods)**
Learning Sets of Rules – Sequential Covering Algorithm – Learning Rule Set – First Order Rules – Sets of First Order Rules – Induction on Inverted Deduction – Inverting Resolution – Analytical Learning – Perfect Domain Theories – Explanation Base Learning – FOCL Algorithm – Reinforcement Learning – Task – Q-Learning – Temporal Difference Learning.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Tom M. Mitchell, **"Machine Learning",** McGraw-Hill Education (India) Private Limited, 2013.*
2. *Laurene Fausett, **" Fundamentals of Neural Networks, Architectures, Algorithms and Applications",** PearsonEducation,2008 .*
3. *Stephen Marsland, **"Machine Learning: An Algorithmic Perspective",** CRC Press, 2009.*

REFERENCE BOOKS

1. *Kevin P. Murphy,* ***"Machine Learning: A Probabilistic Perspective",*** *MIT Press, 2012 .*
2. *Ethem Alpaydin* ***"Introduction to Machine Learning (Adaptive Computation and Machine Learning)",*** *The MIT Press 2004.*
3. *Christopher Bishop,* ***"Pattern Recognition and Machine Learning"*** *Springer, 2006 .*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Recognize the concepts of machine learning.
CO 2: Familiarize the utilization techniques of machine learning.
CO 3: Visit the neural architectures.
CO 4: Discuss and apply algorithms for problems like over fitting.
CO 5: Apply and suggest learning approaches.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	M	H	M	M	L	M	M	M	L	M	M	M	L	L
CO2	H	H	L	H	H	M	L	M	H	M	L	L	M	M	L
CO3	M	M	H	M	M	L	M	L	H	L	M	L	M	L	M
CO4	M	H	L	L	M	L	L	M	M	M	L	L	H	M	M
CO5	H	M	H	M	M	M	M	L	M	L	L	M	H	L	M
18NPE$07	M	M	M	M	M	L	M	M	M	L	L	L	M	L	M

L-Low, M-Moderate(medium), H-High

18NPE$08	FAULT DIAGNOSIS AND TOLERANCES

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

- To learn the concepts and design issues involved in Fault Diagnosis.

UNIT I – INTRODUCTION TO FAULT DETECTION AND DIAGNOSIS	**(9 Periods)**
Scope of FDD – Types of faults and different tasks of Fault Diagnosis and Implementation – Different approaches to FDD – Model free and Model based approaches. Classification of Fault and Disturbances – Different issues involved in FDD.	
UNIT II – ANALYTICAL REDUNDANCY CONCEPTS	**(9 Periods)**
Mathematical representation of Fault and Disturbances – Additive and Multiplicative types – Residual Generation: Detection, Isolation, Computational and Stability properties – Design of Residual generator – Residual specification and Implementation.	
UNIT III – DESIGN OF STRUTURED RESIDUALS	**(9 Periods)**
Introduction – Residual structure of Single fault isolation: Structural and Canonical structures – Residual structure of Multiple fault isolation: Diagonal and Full Row canonical concepts – Introduction to parity equation implementation and alternative representation.	
UNIT IV – DESIGN OF DIRECTIONAL STRUCTURED RESIDUALS	**(9 Periods)**
Introduction – Directional specifications: Directional specification with and without disturbances – Parity equation implementation – Linearly dependent column.	
UNIT V – ADVANCED LEVEL ISSUES AND DESIGN INVOLVED IN FDD	**(9 Periods)**
Introduction of Residual generation of parametric fault – Robustness Issues – Statistical Testing of Residual generators – Application of Neural and Fuzzy logic schemes in FDD – Case study.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Janos J. Gertler,* ***"Fault Detetion and Diagnosis in Engineering Systems",*** *Macel Dekker, Second Edition, 1998.*
2. *Sachin C. Patwardhan,* ***"Fault Detection and Diagnosis in Industrial Process",*** *Lecture Notes, IIT Bombay, 2005.*

REFERENCE BOOKS

1. Rami S. Mangoubi, **"Robust Estimation and Failure Detection",** Springer-Verlag,1998.
2. Mufeed M. Mahmoud, Jin Jiang, Youmin Zhang, **"Active Fault Tolerant Control Systems",** Springer, 2003.
3. Tushar Jain, Joseph J. Yame, Dominique Sauter, **"Active Fault – Tolerant Control Systems",** Springer, 2018.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Define the different type of faults.
CO 2: Explain the structure of residuals and its use in Fault diagnosis.
CO 3: Give the mathematical representation of faults and residuals.
CO 4: List out the issues involved in design od FDD
CO 5: Model the fault and disturbances involved in system.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	M								H			L	M	
CO2	H	H								H			L	M	
CO3	H	H	H			M				H			L	M	
CO4	H	H	H							H			L	M	
CO5	H	H	H			M				H			L	M	
18NPE$08	H	H	H			M				H			L	M	

L-Low, M-Moderate(medium), H-High

18NPE$09	INSTRUMENT STANDARDS

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

- To impart the basic knowledge on instrument standards

UNIT - I STANDARDS ORGANIZATION	**(9 Periods)**
Standards: Introduction to International and National Standards organization: IEC, ISO, NIST, IEEE, ISA, API, BIS, DIN, JISC and ANSI. API: Process Measurement and Instrumentation (APIRP551): recommended practice for installation of the instruments – flow, level, temperature, pressure - Process Instrument and Control (API RP554): performance requirements and considerations for the selection, specification, installation and testing of process instrumentation and control systems.	
UNIT - II ISA STANDARDS	**(9 Periods)**
Documentation of Measurement and Control, Instruments and System (ISA 5): 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7 - General Requirements for Electrical Equipment in Hazardous Location (ISA 12): 12.2, 12.4, 12.24, 12.29 – Instrument Specification Forms (ISA20): – Measurement Transducers (ISA37).	
UNIT - III ISA STANDARDS - CONTROL VALVE AND ACTUATOR	**(9 Periods)**
Control Valve Standards (ISA75): 75.01, 75.04, 75.05, 75.7, 75.11, 75.13, 75.14, 75.23, 75.24, 75.26.Valve Actuator (ISA 96): 96.01, 96.02, 96.03, 96.04.	
UNIT - IV ISA STANDARDS - FOSSIL AND NUCLEAR POWER PLANTS	**(9 Periods)**
Fossil Power Plant Standards (ISA 77): 77.14, 77.22, 77.30, 77.41, 77.42, 77.44, 77.60, 77.70. Nuclear Power Plant Standards (ISA67): 67.01, 67.02, 67.03, 67.04, 67.06.	
UNIT - V BS , ISO, IEC, & ANSI	**(9 Periods)**
Measurement of Fluid Flow by means of Orifice Plates (ISO 5167/ BSI042) IEC 61131-3 – Programmable Controller – Programming Languages – Specification for Industrial Platinum Resistance Thermometer Sensors (BSI904) – International Thermocouple Reference Tables (BS4937) – Temperature Measurement Thermocouple (ANSIC96.1)	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *API Recommended Practice 554* ***"Process Instrumentation and Control – 3 parts"*** *American Petroleum Institute, Washington, D.C., 1st Edition, 2008.*
2. *2. ISA standard 5* ***"Documentation of Measurement and Control Instruments and Systems",*** *ISA, North Carolina, USA.*
3. *3. ISA standard 12* ***"Electrical Equipment for Hazardous Locations"*** *ISA, North Carolina, USA.*

REFERENCE BOOKS

1. *ISA standard 20* ***"Instrument Specification Forms"*** *ISA, North Carolina, USA*
2. *ISA standard 75* ***"Control Valve Standards"*** *ISA, North Carolina, USA.*
3. *ISA standard 96* ***"Valve Actuator"*** *ISA, North Carolina, USA.*
4. *ISA standard 77* ***"Fossil Power Plant Standards"*** *ISA, North Carolina, USA.*
5. *BS EN 60584-1* ***"Thermocouples - EMF specifications and tolerances"*** *British Standard, 2013.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Understand the role of standards organization.

CO 2: Interpret and follow different standards while carrying out installation of sensors, transmitters, Industrial automation systems, PLC programming, documentation, equipment selection in hazardous area and instrument specification forms.

CO 3: Understand and follow different standards while performing control valve sizing, actuator sizing and orifice sizing etc.

CO 4: Get acquainted with different standards for monitoring and control of fossil fuel power plants and nuclear power plants.

CO 5: Select Specify, Install and Test Process instrumentation and control systems.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	L	L	L	L	M	L	L	L	L	L	L	L	H	H	H
CO2	H	H	H	H	M	L	L	M	M	M	M	M	H	H	H
CO3	M	L	L	H	H	L	L	L	M	L	L	L	H	H	H
CO4	M	L	L	H	H	L	L	L	M	L	L	L	H	H	H
CO5	M	M	M	H	H	L	L	L	M	M	M	M	H	H	H
18NPE$09	M	M	M	H	H	L	L	L	M	L	L	L	H	H	H

L-Low, M-Moderate(medium), H-High

18NPE$10	MEMS AND NANOTECHNOLOGY

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

* To illustrate the fundamentals of MEMS, nanotechnology and their importance in multidisciplinary fields.

UNIT - I : MEMS	**(9 Periods)**
Introduction, emergence, devices and application, scaling issues, materials for MEMS, Thin film deposition, lithography and etching.	
UNIT - II : MICROSYSTEM FABRICATION PROCESSES	**(9 Periods)**
Introduction to Microsystems Fabrication Process, Photolithography, Ion Implantation, Diffusion, Oxidation, Chemical Vapour Deposition (CVD), Physical Vapour Deposition-Sputtering, Deposition by Epitaxial, Etching. LIGA Process: General Description of LIGA Process, Materials for Substrates and Photo resists, Electroplating and SLIGA Process.	
UNIT - III : NANOTECHNOLOGY	**(9 Periods)**
History of Nanotechnology, Introduction & overview of Quantum concepts. Overview of 1st, 2nd and 3rd generation biomaterials, structures and properties of carbon based, metal based, bio-nano materials and hybrids: Bucky Ball, Nano-tubes, Diamond like carbon(DLC),Quantum Dots, Magnetic, Nano Shells, Dendrimers, Nano-carriers, Nano-crystals, Nano-wires, Nano-membranes, Thin films, hybrid biological/inorganic, protein and DNA based nanostructures. Nano-safety Issues: Toxicology health effects caused by nano-particles.	
UNIT - IV : MICRO & NANO-ELECTROMECHANICAL SYSTEMS AND MICRO-FLUIDICS	**(9 Periods)**
MEMS/NEMS: Magnetic, Chemical and Mechanical Transducers –Sensing and Actuators. **Microfludics**: Laminar flow, Hagen-Peouiselle equation, basic fluid ideas, Special considerations of flow in small channels, mixing. Micro valves and micro pumps.	
UNIT - V : INDUSTRIAL APPLICATIONS	**(9 Periods)**
Molecular electronics, molecular switches, mechanical cutting tools, machine components, magnets, DLC coated grinding wheels. Electrical, electronic, solar cells, Batteries, fuel cells, Nanofilters. Medical nanotechnology: in Diagnostics, Therapeutics, Drug delivery and Nanosurgery.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Tai Ran Hsu **"MEMS & Microsystem Design and Manufacture"** Tata McGraw Hill, New Delhi 2017.*
2. *B.S. Murty., P. Shankar., B.Raj, et.al **"Textbook of Nanosciences and Nanotechnology"** University Press (India) Pvt. Ltd. VCH, XII. 2013*
3. *Bharat Bhushan **"Handbook of Nanotechnology"** 3rd Edition, Springer, 2010.*

REFERENCE BOOKS

1. *Krzysztof Iniewski., Vikas Choudhary.* ***"MEMS: Fundamental Technology and Applications (Devices, Circuits, and Systems)"*** *CRC press, 2013.*
2. *Marc Madou* ***"Fundamentals of Micro fabrication"*** *2/e ,CRC Press, 2011.*
3. *Julian W. Gardner and Vijay K. Varadan* ***"Micro sensors, MEMS, and Smart devices"*** *John Wiley & Sons Ltd, 2001.*
4. *Michael Wilson, Kamali Kannangara, Geoff Smith* ***"Nanotechnology, Basic Science and Emerging technologies"*** *Taylor & Francis Group, 2002.*
5. *Akhlesh Lakhtakia* ***"Hand Book of Nano Technology, Nano-meter Structure, Theory, Modelling and Simulations"*** *Prentice-Hall of India (P) Ltd, New Delhi, 2007.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Explain the steps needed to be followed in micro and nano scale material preparation.

CO 2: Analyze methods involving preparation of micro and Nano scale devices

CO 3: Describe the necessity of micro and nano materials and its applications.

CO 4: Design the micro devices, micro systems using the MEMS fabrication process.

CO 5: Design nano devices, nano systems using the preparation methods..

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	M	L	L		L	L		M	M	L			L	L
CO2	H	H	L	H		L	L		M	M	L			L	L
CO3	H	M	L	L		L	L		M	M	L			L	L
CO4	H	M	H	L		L	L		M	M	L			L	L
CO5	H	M	H	L		L	L		M	M	L			L	L
18NPE$10	H	M	L	L		L	L		M	M	L			L	L

L-Low, M-Moderate(medium), H-High

18NPE$11	SAFETY INSTRUMENT SYSTEMS

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

- To make aware of basic concepts of instrument safety and risk analysis techniques.

UNIT I – CONCEPTS	**(9 Periods)**
History of Safety movement –Evolution of modern safety concept- general concepts of management – planning for safety for optimization of productivity -line and staff functions for safety- budgeting for safety- safety policy.	
UNIT II – TECHNIQUES	**(9 Periods)**
Incident Recall Technique (IRT), disaster control, job safety analysis, safety survey, safety inspection, safety sampling, Safety Audit.	
UNIT III – ACCIDENT INVESTIGATION AND REPORTING	**(9 Periods)**
Concept of an accident, reportable and non reportable accidents, reporting to statutory authorities – principles of accident prevention – accident investigation and analysis – records for accidents, departmental accident reports, documentation of accidents – unsafe act and condition – domino sequence – supervisory role – role of safety committee –cost of accident.	
UNIT IV – SAFETY PERFORMANCE MONITORING	**(9 Periods)**
ANSI (Z16.1) Recommended practices for compiling and measuring work injury experience – permanent total disabilities, permanent partial disabilities, temporary total disabilities - Calculation of accident indices, frequency rate, severity rate, frequency severity incidence, incident rate, accident rate, safety "t" score, safety activity rate – problems.	
UNIT V – SAFETY EDUCATION AND TRAINING	**(9 Periods)**
Importance of training-identification of training needs-training methods – programmes, seminars, conferences, competitions – method of promoting safe practice - motivation – communication - role of government agencies and private consulting agencies in safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign – Domestic Safety and Training.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Krishnan N.V. **"Safety Management in Industry"** Jaico Publishing House, Bombay, 2016*
2. ***"Accident Prevention Manual for Industrial Operations",** N.S.C.Chicago, 2011*

REFERENCE BOOKS

1. *Heinrich H.W. **"Industrial Accident Prevention"** McGraw-Hill Company, New York, 2010.*
2. *John Ridley, **"Safety at Work",** Butterworth & Co., London, 2013*
3. *Blake R.B., **"Industrial Safety"** Prentice Hall, Inc., New Jersey, 2014*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Understand the roles of safety instruments in industry.

CO 2: Identify the hazards to take preventive actions.

CO 3: Identify the techniques for safety of instrument.

CO 4: Recommend the practices for compiling and measuring work injury experience

CO 5: Know the importance of safety education and rules followed in industry.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	L	L	M	M	L	M	M	M	M	H	M	M	H
CO2	M	M	L	L	M	M	L	M	M	M	M	H	M	M	H
CO3	M	M	L	L	M	M	L	M	M	M	M	H	M	M	H
CO4	M	M	L	L	M	M	L	M	M	M	M	H	M	M	H
CO5	M	M	L	L	M	M	L	M	M	M	M	H	M	M	H
18NPE$11	M	M	L	L	M	M	L	M	M	M	M	H	M	M	H

L-Low, M-Moderate(medium), H-High

18NPE$12	ENERGY HARVESTING

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

* To introduce basic energy harvesting techniques using smart materials and structures and combining with mechanisms.

UNIT I – ENERGY HARVESTING BASICS	**(9 Periods)**
Energy Harvesting Basics, Analysis of ambient energy- Vibration, shock, wind, Thermal, RF, energy transducers- electromagnet, photovoltaic, piezoelectric and other smart materials- working principle, equivalent circuit models.	
UNIT II – VIBRATIONAL ENERGY HARVESTING	**(9 Periods)**
Vibrational energy harvesting- Electromechanical Modelling of Cantilevered Piezoelectric Energy Harvester For Persistent Base Motion-lumped parameter model, correction factors, coupled distributed parameter model, modelling assumptions, closed form solution for unimorph and bimorph configuration, harvesting techniques for broadband excitation	
UNIT III – PIEZOELECTRIC ENERGY HARVESTING	**(9 Periods)**
Piezoelectric energy harvesting circuits-low power rectifier circuits with resistive, linear and nonlinear reactive input impedance, piezoelectric pre biasing, self-tuning, DC-DC switch mode converters, impedance matching circuits for maximum output power.	
UNIT IV – ELECTROMAGNETIC ENERGY HARVESTING	**(9 Periods)**
Electromagnetic energy harvesting- Wire wound coil properties, micro fabricated coils, magnetic materials, scaling of electromagnetic vibration generators and damping, maximizing power from an EM generator, micro and macro scale implementation.	
UNIT V – THERMOELECTRIC ENERGY HARVESTING	**(9 Periods)**
Thermoelectric Energy harvesting- Harvesting Heat, thermoelectric theory, thermoelectric generators and its efficiency, matched thermal resistance, Heat flux, design consideration, optimization for maximum output, Matching thermoelectric to heat exchangers- thin film devices.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Danick Briand, Eric Yeatman, and Shad Roundy,* ***"Micro energy Harvesting",*** *Wiley-VCH Verlag GmbH & Co, 2015.*
2. *Shashank Priya and Daniel J.Inman,* ***"Energy Harvesting Technologies",*** *Springer-Verlag New York, Inc., 1st Edition, 2010.*

REFERENCE BOOKS

1. *Alper Erturk and Daniel J Inman,* ***"Piezoelectric Energy Harvesting",*** *John Wiley and Sons.Ltd.1st Edition ,2011.*
2. *Tom J.Kazmiershi, Steve Beeby,* ***"Energy Harvesting System, Principles, Modelling and Application",*** *springer, Newyork, 2011.*
3. *Stephen Beeby, Neil white,* ***"Energy Harvesting for Autonomous Systems",*** *Artech house, Norwwood,1st Edition ,2010.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Comprehend in the concept of various ambient energy harvesting techniques.
CO 2: design optimal power converting circuits for different harvesters
CO 3: Design vibration energy harvester for narrow and wide band excitation.
CO 4: Design electromagnetic and thermoelectric based energy harvesters.
CO 5: Apply the energy harvesting concepts to common engineering problems.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	L	L	M	M	L	M	M	M	M	H	M	M	H
CO2	M	M	L	L	M	M	L	M	M	M	M	H	M	M	H
CO3	M	M	L	L	M	M	L	M	M	M	M	H	M	M	H
CO4	M	M	L	L	M	M	L	M	M	M	M	H	M	M	H
CO5	M	M	L	L	M	M	L	M	M	M	M	H	M	M	H
18NPE$12	M	M	L	L	M	M	L	M	M	M	M	H	M	M	H

L-Low, M-Moderate(medium), H-High

18NPE$13	POWER ELECTRONICS AND DRIVES

PRE-REQUISITES:

1. 18NPC304 Electronic Circuits

Category : PE

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To acquire the principles of operation of power electronic converters, Rectifiers and Switching circuits.

UNIT I – POWER SEMICONDUCTOR DEVICES	**(9 Periods)**
Basic structure and Switching characteristics of Power diode- Power transistor- SCR- Triac- GTO- MOSFET and IGBT- ratings of SCR- series parallel operation of SCR- di/dt and dv/dt protection Introduction of ICT- SIT- SITH and MCT- Triggering Circuits.	
UNIT II – CONTROLLED RECTIFIERS	**(9 Periods)**
Operation of single phase half wave rectifiers with R- RL- and RLE load – single phase Full Wave Rectifier with R- RL and RLE load (Fully controlled and half controlled) operation and analysis of rectifiers operation of three phase Half Wave Rectifier and Full Wave Rectifier with R and RL loads - Effect of source inductance in single phase Full Wave Rectifier - single phase dual converter operation.	
UNIT III – DC CHOPPERS	**(9 Periods)**
Types of forced commutation- classification and operation of different types of choppers (A- B- C- D- E) - Control strategies - operation of voltage- current and load commutated choppers -Multiphase chopper operation - SMPS.	
UNIT IV – INVERTERS	**(9 Periods)**
Types of inverters- operation of single phase - three phase (120^o and 180^o) modes for R- load operation of CSI with ideal switches- single phase ASCSI, basic series Inverter- modified series and Improved series inverter - single phase parallel inverter - single phase basic McMurray inverter.	
UNIT V – AC VOLTAGE CONTROLLERS	**(9 Periods)**
Types of control (Phase and Integrated cycle control) - Operation of single phase voltage regulator with R-RL loads. Operation of three phase AC voltage controller with R load - single phase step up and step down cyclo converters. Three phase cyclo converter with R- RL loads.	
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**	

TEXT BOOKS

1. *Muhammad H. Rashid- **"Power Electronics - Circuits- Devices and Applications"**- Prentice Hall of India- New Delhi- Third Edition- 2005.*
2. *Ned Mohan, **"Power Electronics-Converter Applications and Design",** Wiley, 3rd Edition, Reprint 2009.*
3. *Bose, B.K., **"Modern Power Electronics and AC Drives",** Pearson Education, 2002.*

REFERENCE BOOKS

1. *Dr. P.S.Bhimbra., **"Power Electronics"** Khanna Publishers, 3rd edition, 2006.*
2. *Singh. M.D and Khanchandani. K.B **"Power Electronics"** Tata McGraw Hill Publishing Co. Ltd. - New Delhi- 3rd Reprint 2008.*
3. *Dubey- G.K., Doradla.S.R., Joshi.A., Sinha.R.M.K- **"Thyristorised Power Controllers"**- New Age International Publishers Ltd.-1st Edition, Reprint 2010.*
4. *Vedam Subramaniam- **"Power Electronics"**- New Age International (P) Publishers Ltd. - 2nd Edition, Reprint 2011.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Explain the components of power electronics and learn their key characteristics.

CO 2: Know the basic operation, losses and efficiency of the power electronics converters.

CO 3: Use various methods to analyse power electronics circuits.

CO 4: Gain skills to understand operational issues and limitations of practical converters in industrial applications.

CO 5: Use the converters in given applications based on requirements.

COURSE ARTICULATION MATRIX:

PO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	M	M					M	L	M	L	M	M	L
CO2	M	M	M	M					M	L	M	L	M	M	L
CO3	M	M	H	M					L	M	M	L	M	M	M
CO4	M	M	M	M					M	M	M	M	M	M	M
CO5	M	M	M	M					M	M	M	M	M	M	M
18NPE$13	M	M	M	M					M	M	M	M	M	M	M

L-Low, M-Moderate(medium), H-High

18NPE$14	INDUSTRIAL DATA NETWORKS

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

* To introduce the data network technology fundamentals and various industrial network process protocols.

UNIT I – DATA NETWORK FUNDAMENTALS	**(9 Periods)**
Introduction to Network – Component and Categories – Types of connections – Topologies – Transmission media – ISO/OSI model – Various layers – TCP/IP Protocol.	
UNIT II – RS 232, RS422 AND RS 485	**(9 Periods)**
EIA 232 Interface standard – EIA 422 Interface standard – EIA 485 Interface standard – 20mA Current loop – Serial Interface converters.	
UNIT III – MODBUS, AS- INTERFACE AND HART	**(9 Periods)**
MODBUS Protocol structure –Function codes – Data highway (Plus) protocols – HART Protocol – AS – Interface (AS-I) protocol.	
UNIT IV – DEVICENET AND PROFIBUS PA/DP/FMS AND FF	**(9 Periods)**
Devicenet protocol structure - Profibus – Profinet– Interbus – protocol stack – communication model – communication objects – Foundation Fieldbus – H1 and HSE – CAN bus – IEEE488.	
UNIT V – INDUSTRIAL ETHERNET AND WIRELESS COMMUNICATION	**(9 Periods)**
Industrial Ethernet – Introduction – 10Mbps Ethernet and 100Mbps Ethernet – Radio and wireless communication – components of radio link - radio spectrum – frequency allocation – Comparison between various industrial networks.	
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**	

TEXT BOOKS

1. *A.S.Tanenbaum, **"Computer Networks",** Pearson Education, Fifth Edition, 2011.*
2. *E.Wright, **"Practical Industrial Data Networks, Design, Installation and Troubleshooting",** Newnes, First Edition, 2004.*
3. *W.Buchanan, **"Computer Buses",** CRC Press, 2000.*

REFERENCE BOOKS

1. *Behrouz.A.Forouzan, **"Data Communication and Networking",** McGraw Hill, Fifth Edition, 2013.*
2. *S.Mackay, **"Practical Data Communications for Instrumentation and Control",** Newnes, First Edition, 2003.*
3. *L.Thompson, **"Industrial Data Communication"**, ISA, Fourth Edition, 2016.*
4. *T.S.Rappaport, **"Wireless Communication: Principles and Practice",** Pearson Education, Second Edition, 2001.*
5. *W.Stallings, **"Wireless Communication and networks",** Prentice Hall of India, Second Edition, 2005.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Define the network protocols and its purpose.

CO 2: Elaborate the structure of network protocols at par with OSI model and its functions

CO 3: List out the advantages and limitations of various industrial network protocols.

CO 4: Select suitable communication technology for various industrial applications.

CO 5: Describe the structure and function of industrial Ethernet and wireless communication.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H				M	L			H				M	H
CO2	H	H				M	L			H				M	H
CO3	H	H	H			M	L			H				M	H
CO4	H	H	H			M	L			H				M	H
CO5	H	H				M	L			H				M	H
18NPE$14	H	H	H			M	L			H				M	H

L-Low, M-Moderate(medium), H-High

18NPE$15	INDUSTRIAL INTERNET OF THINGS

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

- To explain in concise manner how IoT is used in industry.

UNIT - I : INTERNET OF THINGS	**(9 Periods)**
Internet in general and Internet of Things: layers, protocols, packets, services, performance parameters of a packet network as well as applications such as web, Peer-to-peer, sensor networks, and multimedia.	
UNIT - II : LAYERS IN IoT	**(9 Periods)**
Transport services: TCP, UDP, socket programming. Network layer: forwarding and routing algorithms (Link, DV), IP-addresses, DNS, NAT and routers.	
UNIT - III : LOCAL AREA NETWORKS	**(9 Periods)**
Local Area Networks, MAC level, link protocols such as: point-to-point protocols, Ethernet, WiFi 802.11, cellular Internet access, and Machine-to-machine and IoT Analytics.	
UNIT - IV : INDUSTRIAL AUTOMATION	**(9 Periods)**
Service-oriented architecture-based device integration, SOCRADES: realizing the enterprise integrated Web of Things, IMC-AESOP: from the Web of Things to the Cloud of Things.	
UNIT - V : IoT APPLICATIONS FOR INDUSTRY	**(9 Periods)**
Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT For Oil and Gas Industry, Opinions on IoT Application and Value for Industry.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Dr. Ovidiu Vermesan, Dr. Peter Friess* ***"Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems"*** *River Publishers, 2013*
2. *Vijay Madisetti and Arshdeep Bahga,* ***"Internet of Things (A Hands-on-Approach)"*** *1st Edition, VPT, 2015*
3. *Adrian McEwen* ***"Designing the Internet of Things"*** *Wiley Publishers, 2013*

REFERENCE BOOKS

1. *Manoel Carlos Ramon* ***"Intel® Galileo and Intel® Galileo Gen 2: API Features and Arduino Projects for Linux Programmers"*** *Apress, 2014.*
2. *Mark Harrison, Florian Michahelles* ***"Architecting the Internet of Things"*** *Springer – 2011*
3. *Olivier Hersent, David Boswarthick, Omar Elloumi* ***"The Internet of Things – Key applications and Protocols"*** *Wiley, 2012*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Understand the vision of IoT from a global context.

CO 2: Understand constraints and opportunities of wireless and mobile networks for Internet of things.

CO 3: Use of Devices, Gateways and Data Management in IoT.

CO 4: Apply the IoT in Industrial Automation and Real World Design Constraints.

CO 5: Analyze trade-offs in interconnected wireless embedded sensor networks

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	M	L		M		M	M	M	M	M	M	M	M	M
CO2	H	M	L		M		M	M	M	M	M	M	M	M	M
CO3	H	M	L		M		M	M	M	M	M	M	M	M	M
CO4	M	M	M		M		M	M	M	M	M	M	M	M	M
CO5	M	M	M		M		M	M	M	M	M	M	M	M	M
18NPE$15	M	M	M		M		M	M	M	M	M	M	M	M	M

L-Low, M-Moderate(medium), H-High

18NPE$16	WIRELESS SENSOR NETWORK

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

- To understand the state-of-the-art in network protocols, architectures and applications of sensor network.

UNIT I – BASICS CONCEPTS OF SENSOR NETWORKS	**(9 Periods)**
Introduction – Difference between sensor networks and traditional networks - sensor node architecture - Functional architecture of sensor networks —Challenges for WSNs – WSN vs Adhoc Networks - Sensor node architecture – Commercially available sensor nodes.	
UNIT II – COMMUNICATION AND ROUTING PROTOCOLS	**(9 Periods)**
Fundamentals of medium access control protocols - Requirements and design constraints for MAC for WSN - The S-MAC protocol - IEEE 802.15.4 standard. Routing Challenges and Design Issues in Wireless Sensor Networks, Flooding and gossiping – Data centric Routing – SPIN – Directed Diffusion – Energy aware routing.	
UNIT III – TRACKING TECHNOLOGIES	**(9 Periods)**
Tracking scenario – Problem formulation – Sensing model – Fundamentals - ToA, TDoA, and AoA Positioning by signal strength - positioning and location tracking algorithms –Trilateration - Multilateration - Pattern matching - Nearest neighbor algorithms, location tracking - network based tracking.	
UNIT IV – ENERGY MANAGEMENT AND SECURITY	**(9 Periods)**
Idle power management - Active power management - Design challenges in energy efficient medium access control – IEEE 802.11- operation - power saving mode – merits - draw-backs implications in WSN, Bluetooth – operation - Merits – implications, Security: Security architecture - Cell based WSNs - Privacy of local information.	
UNIT V – APPLICATIONS OF WSN: WSN APPLICATIONS	**(9 Periods)**
Home Control - Building Automation - Industrial Automation - Medical Applications - Reconfigurable Sensor Networks - Highway Monitoring - Military Applications - Civil and Environmental Engineering Applications - Wildfire Instrumentation - Habitat Monitoring - Nanoscopic Sensor Applications – Case Study: IEEE 802.15.4 LR-WPANs Standard - Target detection and tracking - Contour/edge detection - Field sampling	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Mohammad Ilyas and Imad Mahgoub,* ***"Handbook of Sensor Networks: Compact Wireless and Wired Sensing Systems",*** *CRC Press, 2004.*
2. *Kazem Sohraby, Daniel Minoli and Taieb Znati,* ***" Wireless Sensor Networks: Technology, Protocols, and Applications",*** *John Wiley & Sons, 2007.*

REFERENCE BOOKS

1. *Holger Karl and Andreas Willig,* ***"Protocols and Architectures for Wireless Sensor Networks",*** *John Wiley & Sons, 2005.*
2. *Feng Zhao, Leonidas J. Guibas,* ***"Wireless Sensor Networks: An Information Processing Approach",*** *Morgan Kaufmann Publishers, 2004.*
3. *Michel Banatre, Pedro Jose Marron, Anibal Ollero and Adam Wolisz,* ***"Cooperating Embedded Systems and Wireless Sensor Networks",*** *John Wiley & Sons, 2008.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Comprehend the challenges of WSN
CO 2: Choose suitable medium access protocols and routing protocols
CO 3: Apply IEEE 802.15.4/ Zigbee/Bluetooth standards for Wireless Sensor Network application
CO 4: Illustrate tracking techniques and sensor database
CO 5: Analyze energy management and security in WSN applications

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	L			L			M	M	M	M	M	L	L	L
CO2	M	L			L			M	M	M	M	M	L	L	L
CO3	M	L			L			M	M	M	M	M	L	L	L
CO4	M	L			L			M	M	M	M	M	L	L	L
CO5	M	L			L			M	M	M	M	M	L	L	L
18NPE$16	M	L			L			M	M	M	M	M	L	L	L

L-Low, M-Moderate(medium), H-High

18NPE$17	FIBER OPTICS AND LASER INSTRUMENTATION

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

- To elaborate the fundamentals of optic fiber and laser, types, properties and its applications

UNIT I – FUNDAMENTALS OF OPTICAL FIBRE	**(9 Periods)**
Principles of light propagation through a fiber - Different types of fibers and their properties, fiber characteristics – Absorption losses – Scattering losses – Dispersion – Connectors and splicer – Fiber termination – Optical sources – Optical detectors.	
UNIT II – MEASUREMENT USING OPTICAL FIBRES	**(9 Periods)**
Fiber optic sensors – Fiber optic instrumentation system - Measurement of pressure, temperature, current, voltage, liquid level and strain.	
UNIT III – FUNDAMENTALS OF LASER	**(9 Periods)**
Fundamental characteristics of lasers – Three level and four level lasers – Properties of laser – Laser modes – Resonator configuration – Q-switching and mode locking – Cavity damping – Types of lasers – Gas lasers, solid lasers, liquid lasers, semiconductor lasers.	
UNIT IV – MEASUREMENT USING LASERS	**(9 Periods)**
Laser for measurement of distance, length, velocity, acceleration, current, voltage and Atmospheric effect – Material processing – Laser heating, welding, melting and trimming of material – Removal and vaporization.	
UNIT V – HOLOGRAPHY AND MEDICAL APPLICATIONS	**(9 Periods)**
Holography – Basic principle - Methods – Holographic interferometry and application, Holography for non-destructive testing. Medical applications of lasers - Laser instruments for surgery and removal of tumors.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *John M. Senior **"Optical Fiber Communications: Principles And Practice"** Pearson Education, 3rd Edition, 2009.*
2. *Eric Udd, William B.,and Spillman, Jr., **"Fiber Optic Sensors: An Introduction for Engineers and Scientists ",** John Wiley & Sons, 2011.*

REFERENCE BOOKS

1. *R.P.Khare **"Fibre Optics and Optoelectronics"** Oxford Press, 2004.*
2. *John F. Read **"Industrial Applications of Lasers"** Academic Press, 2nd Edition, 2008*
3. *M. Arumugam **"Optical Fibre Communication and Sensors"** Anuradha Agencies, 2010*
4. *P Bhattacharya **"Semiconductor optoelectronics"** Prentice Hall, 2nd Edition, 2003.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Explain the basic concepts, different types of fibre and also the losses involved in the fibers.

CO 2: Analyze the application of the fiber optic sensors used in the measurement of pressure, temperature, level etc

CO 3: Describe the fundamental characteristics and properties of laser and its configuration

CO 4: Apply laser for the measurement of pressure, temperature, distance and current

CO 5: Select the particular type of laser for specific industrial and medical applications.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	L		L		M	L		M	M		L		L	L
CO2	H	H		H		M	L		M	M		L		H	L
CO3	H	L		L		M	L		M	M		L		L	L
CO4	H	H		L		M	L		M	M		L		L	H
CO5	H	H		L		M	L		M	M		L		L	H
18NPE$17	H	H		L		M	L		M	M		L		L	L

L-Low, M-Moderate (medium), H-High

18NPE$18	AIRCRAFT INSTRUMENTATION

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES:

1. 18NPC503 –Control System Design

COURSE OBJECTIVE

- To preface or open the concepts and equations of motion of aircraft systems and its modeling and to familiarize the stability design and state space form of Aircraft systems.

UNIT I – BASIC CONCEPTS	**(9 Periods)**
Air craft and aerospace vehicle instrumentation: Air data instruments: altimeter, air speed rate of climb – gyroscopic instruments – turn and back indicator – artificial horizon – directional Gyro Schuler Tuning, Stable Platform – Automatic pilots – integrated flight instruments – Capacitance type fuel level indicating system – altitude compensation – magnetic compass. Aircraft Instrument Elements and mechanisms- Pitot- static instruments –Primary Flight Instruments-Heading Indicating Instruments-Remote Indicating compasses.	
UNIT II – AIRCRAFT EQUATIONS OF MOTION	**(9 Periods)**
Conservation of linear, angular momentum equations with rotor effects-Euler angles-flight path equations-kinematic equations-gravity equations-equations at steady-state and perturbed conditions.	
UNIT III AIRCRAFT PERFORMANCE AND MODELING	**(9 Periods)**
Different Aircraft Propulsion systems-Propeller-Turboprop Aircraft Engine-Turbojet –Turbofan-Modelling of Thrust forces and moments during steady state and perturbation.	
UNIT IV – AIRCRAFT STABILITY AND DESIGN	**(9 Periods)**
Aircraft Static Stability-Longitudinal analysis-Lateral Directional analysis-Lift chart –Trim diagram-Application of Laplace Transforms to Longitudinal Perturbation Equations and Lateral Directional analysis - Routh-Hurwitz analysis of Longitudinal Stability- Dynamic modes-Solution of Longitudinal Equations-Rolling, Spiral and Dutch roll.	
UNIT V – STATE VARIABLE MODELLING OF AIRCRAFT DYNAMICS	**(9 Periods)**
State variable modeling of Longitudinal Dynamics-Lateral Directional Dynamics-Modeling of Altitude, Flight path angle, Engine Dynamics, Actuator Dynamics, Atmospheric Turbulence.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Pallett E.G.H. **"Aircraft Instrumentation and Integrated Systems"** Longman Scientific and Technical,1992.*
2. *Nagaraja N.S. **"Elements of Electronic Navigation"** Tata McGraw Hill Publishing Ltd., New Delhi, 1975.*

REFERENCE BOOKS

1. *Mekinley, J.L. and Bent, R.D.* ***"Aircraft Power Plants"*** *McGraw-Hill, 1993*
2. *Pallet, E.H.J* ***"Aircraft Instruments & Principles"*** *Pitman & Co., 1993*
3. *McKinley, J.L., and Bent, R.D.* ***"Aircraft Maintenance & Repair"*** *McGraw-Hill, 1993.*
4. *Marcello R. Napolitano* ***"Aircraft Dynamics -From Modeling to Simulation"*** *John Wiley & Sons, Inc., 2012.*
5. *Jan R. Wright, Jonathan E. Cooper* ***"Introduction to Aircraft Aero elasticity and Loads"*** *John Wiley & Sons, Inc., 2007.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Describe the terminologies of aircraft systems.
CO 2: Formulate the essential angles in the aircraft design.
CO 3: Identify the forces and moments of aircraft.
CO 4: Perform stability analysis using various techniques for aircraft systems.
CO 5: Model the aircraft dynamics.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	L	H	M	M	L	M	L	M	L	M	M	M	L	M
CO2	H	L	H	M	H	H	L	H	L	M	H	M	M	L	M
CO3	L	M	M	H	M	M	M	L	M	L	M	L	H	L	L
CO4	H	H	H	L	M	L	H	L	M	M	H	M	H	M	L
CO5	H	L	H	M	L	L	M	M	L	L	M	M	H	H	L
18NPE$18	H	M	M	M	M	M	M	L	M	L	M	M	M	L	L

L-Low, M-Moderate(medium), H-High

18NPE$19	SMART AND WIRELESS INSTRUMENTATION

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

* To provide adequate knowledge on smart instrumentation and wireless sensor networks and to impart knowledge on various standard protocols used in wireless instrumentation.

UNIT I – SENSORS	**(9 Periods)**
sensor classification-thermal sensors-humidity sensors-capacitive sensors-planar inter digital sensors-planar electromagnetic sensors-light sensing technology-moisture sensing technology-carbon dioxide (co_2) sensing technology-sensors parameters	
UNIT II – WIRELESS SENSOR NETWORK	**(9 Periods)**
Frequency of Wireless communication-Development of Wireless Sensor Network based Project-Wireless sensor based on microcontroller and communication device-Zigbee Communication device.	
UNIT III – ENERGY HARVESTING	**(9 Periods)**
Power sources- Energy Harvesting –Solar and Lead acid batteries-RF Energy /Harvesting-Energy Harvesting from vibration-Thermal Energy Harvesting-Energy Management Techniques. Calculation for Battery Selection	
UNIT IV – WIRELESS COMMUNICATION	**(9 Periods)**
Tedes IEEE 1412- Brief description of API mode data transmission-Testing the communication between coordinator and remote XBee- Design and development of graphical user interface for receiving sensor data using C++. A brief review of signal processing techniques for structural health monitoring.	
UNIT V – WSN APPLICATIONS	**(9 Periods)**
WSN based physiological parameters monitoring system- Intelligent sensing system for emotion recognition-WSN based smart power monitoring system. Digital light processor (DLP)	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Subhas Chandra Mukhopadhyay, **"Smart Sensors, Measurement and Instrumentation",** Springer Heidelberg, New York, Dordrecht London, 2013.*
2. *Halit Eren, **"Wireless Sensors and Instruments: Networks, Design and Applications",** CRC Press, Taylor and Francis Group, 2006.*

REFERENCE BOOKS

1. *Uvais Qidwai, **"Smart Instrumentation: A data flow approach to Interfacing",** Chapman & Hall, 1st Edition, 2013.*
2. *Waltenegus Dargie, Christian Poellabauer , **"Fundamentals of wireless sensor networks : theory and practice",** A John Wiley and Sons, Ltd.,2009*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Analyze Smart and Wireless Instrumentation with respect to various performance parameters.
CO 2: Demonstration of various Node architectures
CO 3: Demonstration of Fundamentals of wireless digital communication
CO 4: Demonstrate an ability to design strategies as per needs and specifications
CO 5: Design and develop Applications using WSN (Wireless sensor Network

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	L	H	M	M	L	M	L	M	L	M	M	M	L	M
CO2	H	L	H	M	H	H	L	H	L	M	H	M	M	L	M
CO3	L	M	M	H	M	M	M	L	M	L	M	L	H	L	L
CO4	H	H	H	L	M	L	H	L	M	M	H	M	H	M	L
CO5	H	L	H	M	L	L	M	M	L	L	M	M	H	H	L
18NPE$19	H	M	M	M	M	M	M	L	M	L	M	M	M	L	L

L-Low, M-Moderate (medium), H-High

18NPE$20	POWER PLANT INSTRUMENTATION *(Common to EEE & EIE)*

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

* To understand the important process variables and their measurements and thereby develop control loops for optimal performance of power plant.

UNIT - I: METHODS OF POWER GENERATION	**(9 Periods)**
Methods of power generation – hydro, thermal, nuclear, solar and wind power –Importance of instrumentation in power generation – basic building block for all types of power generation plants - details of boiler processes – P and I diagram of boiler - cogeneration.	
UNIT - II: MEASUREMENTS IN POWER PLANTS	**(9 Periods)**
Measurement of feed water flow, air flow, steam flow and coal flow – Drum level measurement– Steam pressure and temperature measurement – Turbine speed and vibration measurement – Flue gas analyzer – Fuel composition analyzer.	
UNIT - III: ANALYZERS IN POWER PLANTS	**(9 Periods)**
Analysis of impurities in feed water and steam- Flue gas oxygen analyzer - dissolved oxygen analyzer - chromatography - pH Meter - Fuel analyzer -pollution monitoring instruments.	
UNIT - IV: CONTROL LOOPS IN BOILER	**(9 Periods)**
Combustion Control-air/fuel ratio control - furnace draft control - drum level control - main steam and reheat steam temp control - super heater control - attemperator – de-aerator control -distributed control system in power plants - interlocks in boiler operation.	
UNIT – V: TURBINE AND CONTROL	**(9 Periods)**
Types of steam turbines – impulse and reaction turbines – compounding – Turbine governing system– Speed and Load control – Transient response rise – Free governor mode operation – Automatic Load Frequency Control – Turbine oil system – Oil pressure drop relay – Oil cooling system– Turbine run up system.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS:

1. *Sam Dukelow **"Control of Boilers"** Instrument Society of America, 1991*
2. *Gill.A.B **"Power Plant performance"** Butterworth and Co (Publishers) Ltd, 2003.*

REFERENCE BOOKS:

1. *Liptak B.G **"Instrumentation in Process Industries"** Chilton Book Company, 2005.*
2. *Jain R.K **"Mechanical and Industrial Measurements"** Khanna Publishers, New Delhi, 1999.*
3. *Krishnaswamy, K. and Ponnibala.M **"Power Plant Instrumentation"** PHI Learning Pvt. Ltd., New Delhi, 2011.*

COURSE OUTCOMES

Upon completion of the course, the student will be able to

CO 1: Explain the different methods of generating power

CO 2: Select instruments for both online and off line measurements in power plants

CO 3: Differentiate between conventional and nonconventional power generation techniques

CO 4: Analyze the control strategies implemented in different stages of power plant

CO 5: Understand the operation of hydro, thermal, nuclear, wind and solar power plants.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	M	M	M	L	M	M	H	H	H	M	M	H	L	M
CO2	H	M	M	M	L	M	M	H	H	H	M	M	H	L	M
CO3	H	M	M	M	L	M	M	H	H	H	M	M	H	L	M
CO4	H	M	M	M	L	M	M	H	H	H	M	M	H	L	M
CO5	H	M	M	M	L	M	M	H	H	H	M	M	H	L	M
18NPE$20	H	M	M	M	L	M	M	H	H	H	M	M	H	L	M

L-Low, M-Moderate (medium), H-High

18NPE$21	**BIOMEDICAL INSTRUMENTATION** *(Common to EEE & EIE)*

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES:

1. 18NBS302- Biology for Engineers

COURSE OBJECTIVE

- To give a knowledge about the various electro physiological measurements in human body and to present terminologies of the measurement of non-electrical parameter in the human body.

UNIT - I : PHYSIOLOGY	**(9 Periods)**
Cell and its structure – Resting and action potential – Propagation of action potentials – The heart and cardiovascular system - Electrophysiology of cardiovascular system – Physiology of the respiratory system – Nervous system - Central nervous system and Peripheral nervous system – Electrode theory – Bio-potential electrodes - Transducers for biomedical applications.	
UNIT - II : ELECTRO PHYSIOLOGICAL MEASUREMENT	**(9 Periods)**
ECG – Vector cardiographs – EEG – EMG – ERG – EOG – Lead system and recording methods – Typical waveforms. Electrical safety in medical environment, shock hazards– leakage current- Instruments to protect against electrical hazards.	
UNIT - III : NON- ELECTRICAL PARAMETER MEASUREMENTS	**(9 Periods)**
Measurement of blood pressure, blood flow and cardiac output – Plethysmography – Measurement of heart sounds – Gas analysers – Blood gas analysers – Oximeters.	
UNIT - IV : MEDICAL IMAGING AND TELEMETRY	**(9 Periods)**
X-ray machine – Echocardiography – Computer tomography – MRI – Diagnostic ultrasound – PET – SPECT – Electrical impedance tomography – Thermograph – Biotelemetry.	
UNIT - V : ASSISTING AND THERAPEUTIC DEVICE	**(9 Periods)**
Pacemakers – Defibrillators – Ventilator – Anaesthesia machine – Nerve and muscle stimulator – Heart lung machine – Kidney machine – Audiometers – Diathermy –Endoscopes – Lasers in biomedicine.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Leslie Cromwell **"Biomedical Instrumentation and Measurement"** PHI, New Delhi, 2007.*
2. *Khandpur. R.S **"Handbook of Biomedical Instrumentation"** 2nd edition, Tata McGraw Hill,2011.*

REFERENCE BOOKS

1. *Joseph J Carr and John M.Brown, **"Introduction to Biomedical Equipment Technology'',** John Wiley and sons, New York, 4th edition, 2012*
2. *John G. Webster, **"Medical Instrumentation Application and Design",** John Wiley and sons, New York, 2009.*
3. *Ed. Joseph D. Bronzino **"The Biomedical Engineering Handbook"** Third Edition, BocaRaton, CRC Press LLC, 2014.*
4. *M.Arumugam, **"Bio-Medical Instrumentation",** Anuradha Agencies, 2018.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1 Explain the physical foundations of biological systems and the various electrodes used in medical field.

CO 2 Discuss about the various electro physiological measurements in the human body.

CO 3 Choose the instrument for the measurement of non-electrical parameter in the human body.

CO 4 Compare the various medical imaging techniques and their applications.

CO 5 Explain the working of medical assisting and therapy equipments.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	L	L	L	L	M	H	L	L	L	M	H	M	L
CO2	M	M	L	M	L	M	M	H	L	M	M	L	H	L	L
CO3	L	L	L	M	L	M	M	H	M	L	H	M	H	L	M
CO4	L	M	L	M	L	M	M	H	M	M	M	H	H	M	M
CO5	L	L	L	M	L	L	M	H	L	M	H	L	H	M	H
18NPE$21	L	M	L	M	L	M	M	H	L	M	M	M	H	M	L

L-Low, M-Moderate (medium), H-High

18NPE$22	INSTRUMENTATION AND CONTROL IN PETROCHEMICAL INDUSTRIES

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

- To familiarize on unit - operations in petroleum refinery and petrochemical industry.

UNIT - I : DISTILLATION COLUMNS & REACTORS.	**(9 Periods)**
Introduction to petroleum exploring, processing and refining constituents of crude oil - Piping and Instrument diagram of petroleum refinery. Instrumentation and control in distillation columns: distillation equipment- variable and degrees of freedom - measurement and control of column pressure - liquid distillate - Vapor distillate and inerts - control of feed, re-boiler and reflux - use of gas chromatograph- cascade and feed forward controls. Temperature control and pressure control in batch reactors.	
UNIT - II : DRYERS AND HEAT EXCHANGERS.	**(9 Periods)**
Control of batch dryers and continuous dryers.- Instrumentation and control in heat exchangers: variables and degree of freedom - liquid to liquid heat exchangers - steam heaters - condensers – re-boilers and vaporizers -use of cascade and feed forward control.	
UNIT - III : CONTROL OF PUMPS.	**(9 Periods)**
Centrifugal pumps- ON-OFF control-pressure control-flow control- throttling control Rotary pump - Reciprocating pumps- throttling.	
UNIT - IV : EFFLUENT AND WATER/ WASTE WATER TREATMENT.	**(9 Periods)**
Chemical oxidation -chemical reduction -neutralization -precipitation -biological control- waste water management process.	
UNIT - V : EVAPORATORS AND INTRINSIC SAFETY.	**(9 Periods)**
Types Of Evaporators - Measurement and Control of Absolute Pressure, Density, Conductivity, Differential Pressure And Flow In Evaporators- Intrinsic Safety Of Instruments.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Bela. G. LIPTAK **"Instrumentation in Processing Industries"** Chilton Book Company, 2012.*
2. *Considine D.M **"Handbook Of Applied Instrumentation"** Mcgraw Hill, 1964.*

REFERENCE BOOKS

1. *Goldstien R.F, Waddams A.L **"Petroleum Chemicals Industry"** Spon-Publisher, 3rd Edition,1967.*
2. *George.T. Austin **"Shreve's Chemical Process Industries"** 5th Edition, McGraw Hill, 1998.*
3. *Balchan J.G and Mumme K.I **"Process Control Structures and Applications"** Van Nostrand Reinhold Company, New York, 1988.*
4. *Curtis D. Johnson **"Process Control Instrumentation Technology"** 17th Edition, Pearson Education, New Delhi, 2002.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Develop the control algorithms for various distillation column to meet petroleum industry requirements.

CO 2: Have an in-depth understanding of the various control circuits for chemical reactors and various dryers.

CO 3: Control heat exchangers, and evaporators and to meet petroleum industry requirements.

CO 4: Evolve the appropriate control strategy for selective UNIT - operations in a refinery.

CO 5: Understand safety instrumentation followed in process industries.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	H	H	H	M	M	L	L	M	M	M	H	H	H
CO2	H	M	M	M	M	M	L	L	L	L	M	M	H	H	H
CO3	H	H	H	H	H	M	M	L	L	M	M	M	H	H	M
CO4	H	H	H	H	H	M	M	L	L	M	M	M	H	H	M
CO5	H	M	M	M	M	M	L	L	L	L	M	M	H	H	M
18NPE$22	H	M	M	M	M	M	M	L	L	M	M	M	H	H	M

L-Low, M-Moderate(medium), H-High

18NPE$23	INSTRUMENTATION AND CONTROL IN IRON AND STEEL INDUSTRIES

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

- To describe the processes taking place in iron and steel industries.

UNIT I - FLOW DIAGRAM AND DESCRIPTION OF PROCESSES	**(9 Periods)**
Raw materials preparation - Iron making blast furnaces – Stoves - Raw steel making – Basic Oxygen furnace - Electric furnace	
UNIT II – STEEL ROLLING	**(9 Periods)**
Casting of steel – Primary rolling – Cold rolling and Finishing	
UNIT III - INSTRUMENTATION	**(9 Periods)**
Measurement of level, pressure, density, temperature, flow, weight, thickness and shape - Graphic displays and alarms	
UNIT IV – CONTROL SYSTEMS	**(9 Periods)**
Blast furnace stove combustion control systems - Gas and water controls in BOF furnaces - Stand casting mould level control.	
UNIT V – COMPUTER APPLICATIONS	**(9 Periods)**
Model calculating and logging - Rolling mill - Annealing processes control computer – Centre utilities dispatch computer.	
Contact Periods:	
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods	

TEXT BOOKS

1. *Liptak B.G,* ***"Instrumentation in the processing industries",*** *1st Edition, Chilton book company, 2011*
2. ***"Instrumentation Reference book",*** *4th Edition, Butterworth, 2010.*

REFERENCE BOOKS

1. *Considine D.M.,****"Handbook of Applied Instrumentation",*** *McGraw Hill, 2014*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Know common issues related with environment.
CO 2: Know the sources, causes and effects of water pollution
CO 3: Attain knowledge related with air and noise pollution
CO 4: Understand the various management techniques of solid waste and soil Pollution.
CO 5: Acquire knowledge on Environmental Management Systems.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	L					M						L	H	
CO2	L	M			L		H					L	H	H	L
CO3	L	M			L		H					L	H	H	L
CO4	L	M			L		H					L	H	H	L
CO5	M	L					M						L	H	L
18NPE$23	L	M			L		M					L	L	H	L

L-Low, M-Moderate (medium), H-High

18NPE$24	ROBOTICS AND ITS APPLICATIONS

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

- To impart knowledge on structure, kinematics, dynamics and control of robotics

UNIT I – INTRODUCTION TO ROBOTICS	**(9 Periods)**
History of Robots – Classifications – Various fields of Robotics – Actuators – Sensors – Manipulators – End effectors – Application areas – Robot programming languages	
UNIT II – ROBOT KINEMATICS	**(9 Periods)**
Mathematical representation – Homogeneous transformation – DH representation of standard robots – Inverse kinematics	
UNIT III – ROBOT DYNAMICS	**(9 Periods)**
Velocity kinematics – Jacobian and Inverse Jacobian – Lagrangian formulation – Eulers-Lagrangian formulation – Robot equation of motion.	
UNIT IV – TRAJECTORY PLANNING	**(9 Periods)**
Introduction – Path Vs Trajectory – Joint space Vs Cartesian – Space descriptions – Basics of trajectory planning – Joint space trajectory planning – Cartesian space trajectories.	
UNIT V – CONTROL AND APPLICATIONS OF ROBOTS	**(9 Periods)**
Linear control of robot manipulation – Second order systems – Trajectory following control – Modeling and control of single joint - Architecture of Industrial robotic controllers – Robots in manufacturing and non-manufacturing applications	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *R.K.Mittal and I.J.Nagrath,* ***"Robotics and Control",*** *Tata McGraw Hill, Fourth Edition, 2005.*
2. *Sayed B. Niku,* ***"Introduction to Robotics, Analysis, Systems and Applications",*** *Pearson Education, Second Edition, 2011.*

REFERENCE BOOKS

1. *R.D.Klafter, T.A.Chimielewski, M.Negin,* ***"Robotic Engineering – An Integrated Approach",*** *Prentice Hall of India, 2010.*
2. *Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey,* ***"Industrial Robotics Technology Programming and Applications",*** *Tata McGraw Hill, Second Edition 2012.*
3. *John J. Craig,* ***"Introduction to Robotics Mechanics and Control",*** *Pearson Education, Third Edition, 2018.*
4. *Ashitava Ghoshal,* ***"Robotics – Fundamental Concepts and Analysis",*** *Oxford University Press, Sixth Edition, 2010.*
5. *B.K.Ghosh,* ***"Control in Robotics and Automation: Sensor Based Integration",*** *Allied Publishers, 1999.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Explain the various parts and its functions in a robot

CO 2: Mathematically represent the kinematics and dynamics using various formulations and transformations.

CO 3: Choose proper sensor, actuator and end effector for specific applications

CO 4: Outline the overall approach in design of a robot.

CO 5: Apply the different control techniques for robot manipulators.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	H							H				M	H
CO2	H	H	H			L	M			H				M	H
CO3	H	H	H			L	M			H				M	H
CO4	H	H	H	M		M	M			H				M	H
CO5	H	H	H	M		M				H				M	H
18NPE$24	H	H	H	M		M	M			H				M	H

L-Low, M-Moderate(medium), H-High

18NPE$25	REAL TIME EMBEDDED SYSTEMS

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

* To elaborate the basic concepts of embedded systems and the details about the design of processor hardware.

UNIT I – INTRODUCTION TO EMBEDDED SYSTEMS	**(9 Periods)**
Embedded system model – embedded standards – block diagrams – powering the hardware - embedded board using von Neumann model. embedded processors: ISA architecture models – application specific ISA models – general purpose ISA models – instruction level parallelism	
UNIT II – PROCESSOR HARDWARE	**(9 Periods)**
Internal processor design: ALU – registers – control UNIT - - clock – on chip memory – processor i/o – interrupts – processor buses – processor performance.	
UNIT III – EMBEDDED PROGRAMMING	**(9 Periods)**
C and Assembly - Programming Style - Declarations and Expressions - Arrays, Qualifiers and Reading Numbers - Decision and Control Statements - Programming Process - More Control Statements - Variable Scope and Functions - C Preprocessor - Advanced Types - Simple Pointers - Debugging and Optimization – In-line Assembly.	
UNIT IV – ARM ARCHITECTURE	**(9 Periods)**
Architecture – memory organization – addressing modes – I/O Memory – EEPROM – I/O Ports – SRAM – Timer –UART – Interrupt Structure- Serial Communication with PC – ADC/DAC Interfacing	
UNIT V – REAL TIME OPERATING SYSTEMS	**(9 Periods)**
Basic Principles - Operating System structures – System Calls – Files – Processes – Design and Implementation of processes – Communication between processes – Introduction to Distributed operating system – issues in distributed system: states, events, clocks-Distributed scheduling-Fault &recovery. RTOS Task and Task state –Multithreaded Preemptive scheduler- Process Synchronization- Message queues– Mail boxes -pipes – Critical section – Semaphores – Classical synchronization problem – Deadlocks	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Rajkamal **"Embedded Systems Architecture, Programming and Design"** Tata McGraw Hill, 2nd Edition, 2008.*
2. *Steve Furber **"ARM system on chip architecture"** Pearson Education, 2nd Edition, 2015.*

REFERENCE BOOKS

1. *Silberschatz, Galvin,Gagne **"Operating System Concepts"** John Wiley, 6th Edition, 2003.*
2. *David E Simon **"An Embedded Software Primer"** Addison Wesley, 2003.*
3. *Tammy Noergaard **"Embedded system architecture"** Elsevier, 2006*
4. *Jean J. Labrosse **"Embedded Systems Building Blocks: Complete and Ready-To-Use Modules in C"** The publisher, Paul Temme, 2011.*
5. *Jonathan W. Valvano **"Embedded Microcomputer Systems, Real Time Interfacing",** Brooks cole, 2004.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Outline the concepts of embedded systems

CO 2: Explain the basic concepts of real time Operating system design.

CO 3: Use the system design techniques to develop software for embedded systems

CO 4: Describe the scheduling policies and

CO 5: Model real-time applications using embedded-system concepts

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	M	M	L	L	L	L	L	M	L	L	H	L	L
CO2	H	H	M	M	L	L	L	H	L	M	L	L	H	L	L
CO3	H	H	H	H	L	L	L	H	L	M	L	L	H	L	L
CO4	H	H	M	M	L	L	L	H	L	M	L	L	H	L	L
CO5	H	H	M	M	L	L	L	H	L	M	L	L	H	L	L
18NPE$25	H	H	M	M	L	L	L	H	L	M	L	L	H	L	L

L-Low, M-Moderate(medium), H-High

18NPE$26	AUTOMOTIVE INSTRUMENTATION

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

- To illustrate the application of sensors and actuators used in automotive field.

UNIT - I : AUTOMOTIVE SYSTEM	**(9 Periods)**
Evolution of electronics in automobiles, emission laws, introduction to Euro standards, equivalent Bharat standards. Basics of combustion, engine fuelling and exhaust emission, electronic control of carburetion, petrol fuel injection, diesel fuel injection. Ignition systems: Ignition fundamentals, Electronic Ignition system, programmed ignition, distribution less ignition, direct ignition, spark plugs.	
UNIT - II : SENSORS AND ACTUATORS	**(9 Periods)**
Working principle and characteristics of airflow rate, engine crank shaft angular position, hall effect, throttle angle, temperature, exhaust gas oxygen sensors. Fuel injector, exhaust gas recirculation actuators, stepper motor actuator and vacuum operated actuator.	
UNIT - III : MEASUREMENT AND DIAGNOSTICS	**(9 Periods)**
Measurements – fuel quality, coolant temperature, oil pressure vehicles speed, Display devices – LED, LCD, VFD, CRT and types, CAN network, the glass cockpit and information system. Onboard diagnostics – fault code displays. Off board diagnostics – engine data display, expert system occupant protection system – Airbag deployment system security and warning system	
UNIT - IV : ENGINE CONTROL SYSTEM	**(9 Periods)**
Control modes for fuel control, engine control subsystems and ignition control methodologies. Electronic transmission control-Shift point control, Lockup control/torque converter clutch, Engine torque control during shifting Different Engine Control Units used in engine management.	
UNIT - V : CHASSIS AND SAFETY SYSTEMS	**(9 Periods)**
Traction control system, antilock braking system, electronic suspension system, Steering system basics, Fundamentals of electronically controlled power steering, centralized door locking system, climate control of cars.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Tom Denton **"Automobile Electrical and Electronic Systems"** Arnold Publishers, Fourth Edition 2012.*
2. *Robert Bosch **"Automotive Electrics and Automotive Electronics"** Springer, Fifth Edition, 2014.*

REFERENCE BOOKS

1. *V A W Hillier **"Fundamentals of Automotive Electronics"** OUP Oxford, Second Edition 2001.*
2. *Ronald K Jurgen **"Automotive Electronic Handbook"** McGraw Hill, Second Edition, 1999.*
3. *William B Ribbens **"Understanding Automotive Electronics"** Sixth Edition, Newnes Pubilishers, 2003*
4. *Bogdan M. Wilamowski, J. David Irwin **"The Industrial Electronics Handbook"** CRC Press, Second Edition, 2011.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Perceive the electronics involved in automotive systems
CO 2: Understand the fundamentals involved in ignition systems
CO 3: Choose appropriate sensors for automobiles based on applications
CO 4: Work as a team and implement simple and safe control systems in automobiles
CO 5: Analyze the safety issues that occur in automotive systems

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	L				L	L	L	M	M	M	L	M	M	L
CO2	M	L				L	L	L	M	M	M	L	M	M	L
CO3	M	L				L	L	L	M	M	M	L	M	M	L
CO4	M	L				L	L	L	M	M	M	L	M	M	L
CO5	M	M				L	L	L	M	M	M	L	M	M	L
18NPE$26	M	L				L	L	L	M	M	M	L	M	M	L

L-Low, M-Moderate(medium), H-High

18NPE$27	DISCRETE TIME SIGNAL PROCESSING

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES:

1. 18NPC504- Basics of Signals and Systems

COURSE OBJECTIVE

- To impart the concepts of convolution, DFT, aliasing effects and to know how to design the types of filter using transformation methods.

UNIT I – : CONVOLUTION	**(9 Periods)**
Block diagram, advantages and applications- Linear and circular convolution, convolution techniques for long duration sequence, overlap save-overlap add methods. autocorrelation and cross correlation, aliasing effects in time domain.	
UNIT II – : DISCRETE TIME FOURIER TRANSFORM	**(9 Periods)**
Discrete time Fourier series and its convergence, discrete time Fourier Transform, its properties, frequency response. Introduction to radix -2 DFT- decimation in time (DIT) FFT , decimation in frequency (DIF) FFT- IDFT using DFT.	
UNIT III – : FIR FILTERS	**(9 Periods)**
Ideal digital filters, Reliability and filter specifications, Classification of linear phase FIR filters, Design using direct truncation, window methods and frequency sampling, Least-squares optimal FIR filters, Minimal optimal FIR filters, Design of digital differentiators and Hilbert transformers, comparison of design methods.	
UNIT IV – : IIR FILTERS	**(9 Periods)**
Introduction to Infinite Impulse Response filter, Butterworth, Chebyshev approximation. - Design of analog prototype filters, Analog frequency transformations, Impulse invariance method and digital frequency transformations, Bi-linear transformation, Analog prototype to digital transformations, Difficulties in direct IIR filter design, Comparisons with FIR filters.	
UNIT V – : DSP PROCESSORS	**(9 Periods)**
Architectures for signal processing – Harvard architecture and pipelining, interrupts. Addressing modes and programming of DSP processors. Special purpose hardware – hardware digital filters and hardware FFT processors, Evaluation boards for real-time DSP- realization of PID controller using DSP processors.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Proakis,J.G.,& Manolakis, D.G.,* ***"Digital Signal Processing: Principles and Algorithms, & Applications"*** *3/e Prentice Hall of India, 2007.*
2. *Chen, C.T.* ***"Digital Signal Processing: Spectral Computation & Filter Design"*** *Oxford Univ. Press, 2001*

REFERENCE BOOKS

1. *McClellan, J.H., Schafer, R.W., & Yoder, M.A **"DSP First: A Multimedia Approach"** 2/e, Prentice Hall Upper Saddle River, NJ, 2003*
2. *Mitra, S.K. **"Digital Signal Processing: A Computer-Based Approach"** 4/e, McGraw Hill, NY 2011*
3. *Embree, P.M., & Danieli, D **"C++ Algorithms for Digital Signal Processing"** Prentice Hall Upper Saddle River, NJ, 1999.*
4. *Steven Smith. **"The Scientist and Engineer's Guide to Digital Signal Processing"** California technical publishing, CA,2001*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: To provide knowledge to analyze linear systems with difference equations

CO 2: Analyze discrete-time signals and systems using DFT and FFT.

CO 3: Design and implement digital finite impulse response (FIR) filters and infinite impulse response (IIR) filter.

CO 4: Explain the selection of DSP processor for signal processing applications.

CO 5: Apply the digital processing techniques for online processing of sensor data's.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	M	M	L	L	M	M	L	M	M	H	H	M	H
CO2	H	H	M	M	M	M	L	M	M	M	M	M	H	M	M
CO3	H	H	M	M	M	M	L	M	M	M	M	M	H	M	M
CO4	H	H	M	M	M	M	L	M	M	M	M	M	H	M	M
CO5	H	H	M	M	M	M	L	M	M	M	M	M	H	M	M
18NPE$27	H	H	M	M	M	M	L	M	M	M	M	M	H	M	M

L-Low, M-Moderate(medium), H-High

18NPE$28	BASICS OF VLSI TECHNOLOGY

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

* To Introduce the technology, design concepts, electrical properties and modeling of Very Large Scale Integrated circuits.

UNIT I – VLSI DESIGN PROCESS	**(9 Periods)**
VLSI design process - Layout styles: Full-custom, Semi-custom approaches. Electrical Properties of MOS and CMOS Circuits: MOS Transistor – Threshold voltage - Basic DC equations - Second order effects - Small signal AC characteristics. nMOS and CMOS inverters - Inverter delay – Power consumption in CMOS gates: Static dissipation – Dynamic Dissipation. Pass transistor - Transmission gate.	
UNIT II – VLSI FABRICATION TECHNIQUES	**(9 Periods)**
CMOS processes – n well - p well - Twintub - Silicon on insulator. Design rules - Mead Conway design rules for the silicon gate nMOS, CMOS process – CMOS. Sheet resistance - Resistance estimation - Capacitance estimation - Driving large capacitive loads. Layer representations - Stick diagrams - nMOS design style - CMOS design style - Simple layout examples.	
UNIT III – LOGIC DESIGN	**(9 Periods)**
Switch logic- Pass transistor and transmission gate. Other forms of CMOS logic: Dynamic CMOS logic - Clocked CMOS logic - Precharged domino CMOS logic - Combinational logic design. Clocked sequential circuits - Two phase clocking - Charge storage - Dynamic register element - nMOS and CMOS Dynamic shift register - JK flip flop.	
UNIT IV – SUBSYSTEM DESIGN PROCESS	**(9 Periods)**
General arrangement of a 4-bit arithmetic processor - Design of a 4-bit shifter - Design of an ALU subsystem - Implementation of ALU functions with an adder - Carry look ahead adder – Multipliers: Serial parallel multipliers - Pipelined multiplier array.	
UNIT V – VHDL	**(9 Periods)**
Introduction-identifiers-data objects- data types – operators- structural modeling – dataflow modeling- behavioural modeling- hardware modeling: encoder, clock divider, pulse shifter, adder, multiplexer, demultiplexer, decoder, parity generator and checker.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Douglas A. Pucknell, Kamran Eshraghian, **"Basic VLSI Design",** Prentice Hall of India, New Delhi, Third Edition, 2009.*

2. *Bhasker J, **"VHDL Primer",** Pearson Education, Third Edition, 2009.*

REFERENCE BOOKS

1. *Neil H. E. Weste and David Money Harris,* ***"CMOS VLSI design: A circuits and Systems Perspective"****, Pearson Education, Fourth Edition, 2015.*

2. *Jan M Rabaey, Anantha Chandrakasan and Nikolic B,* ***"Digital Integrated Circuits: A Design Perspective"****, Pearson Education, New Delhi, Second Edition, 2009.*

3. *James D. Plummer, Michael D. Deal and Peter B. Griffin,* ***"Silicon VLSI Technology: Fundamentals, Practices and Modeling"****, Pearson Education, 2009.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Use mathematical methods and circuit analysis models in analysis of CMOS digital electronics circuits, including logic components and their interconnect.

CO 2: Create models of moderately sized CMOS circuits that realize specified digital functions.

CO 3: apply CMOS technology-specific layout rules in the placement and routing of transistors and interconnect, and to verify the functionality, timing, power, and parasitic effects

CO 4: understanding of the characteristics of CMOS circuit construction and the comparison between different CMOS technologies and processes

CO 5: Complete a significant VLSI design project having a set of objective criteria and design constraints.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	M							L			H		M
CO2	H	H	M				M			L			H		M
CO3	H	H	M				M			L			H		M
CO4	H	H	M				M			L			H		M
CO5	H	H	H				M			L			H		M
18NPE$28	H	H	M				M			L			H		M

L-Low, M-Moderate(medium), H-High

18NPE$29	VHDL BASED DIGITAL SYSTEM DESIGN

Category : PE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVE

* To learn the simulation of various digital circuit design using VHDL.

UNIT I – INTRODUCTION TO DIGITAL CIRCUITS	**(9 Periods)**
Modern digital design – CMOS Technology – Programmable logic – Electrical properties – Boolean algebra – Logic gates.	
UNIT II – COMBINATIONAL LOGIC USING VHDL GATE MODELS	**(9 Periods)**
Combinational logic design – Entities, architectures, identifiers, spaces, comments, netlists, signal assignments, generics, and configurations. Combinational building blocks – Three state buffers, decoders, Multiplexers, Priority encoder, Adder, Parity checker, Test benches.	
UNIT III – SYNCHRONOUS SEQUENTIAL DESIGN USING VHDL	**(9 Periods)**
Model of synchronous sequential systems – Algorithmic state machines – Synthesis from ASM charts – State machines in VHDL – Sequential logic blocks: Latches, Flipflops, Shift Registers, Counters – VHDL test benches.	
UNIT IV – ASYNCHRONOUS SEQUENTIAL DESIGN	**(9 Periods)**
Asynchronous circuits – Analysis – Design – Asynchronous state machines – Setup and hold times.	
UNIT V – VHDL SIMULATION AND TESTING	**(9 Periods)**
Event driven Simulation – Simulation of VHDL models – Simulation modelling issues – File operations – Testing digital systems – fault models – fault test pattern recognition – fault simulation in VHDL – Design for testability.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**	

TEXT BOOKS

1. *Mark Zwolinski, **"Digital System Design with VHDL",** Pearson Education, Second Edition, 2004.*
2. *Stephen Brown, **"Fundamentals of Digital Logic with VHDL Design",** Tata McGraw Hill, Third Edition, 2009.*

REFERENCE BOOKS

1. *Charles H. Roth,Jr., **"Digital Systems Design using VHDL",** PWS Publishing company,2018.*
2. *Jayaram Bhasker, **"A VHDL Primer",** Pearson Education, Third Edition, 1999.*
3. *William J. Dally, **"Digital Design using VHDL: A Systems Approach",** Cambridge University Press, 2015.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Define the function of various digital systems
CO 2: Explain the building blocks in VHDL gate models
CO 3: Design the digital circuits using hardware descriptive language.
CO 4: Simulate and test a VHDL model for fault analysis.
CO 5: Design digital circuits for a real time system using VHDL.

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H								H			H		
CO2	H	H	M				M			H			H		
CO3	H	H	M		H		M			H			H		
CO4	H	H	M		H		M			H			H		
CO5	H	H	H		H		M			H			H		
18NPE$29	H	H	M		H		M			H			H		

L-Low, M-Moderate(medium), H-High

18COE$01	**CLIMATE CHANGE AND ADAPTATION** *(Common to All Branches)*

Category : OE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

- Able get knowledge about Climate system and its changes and causes
- Able to learn about impacts, adaptation and mitigation of climate change
- Able to learn about clean technology and clean energy

UNIT – I : EARTH'S CLIMATE SYSTEM	**(9 Periods)**
Introduction-Climate in the spotlight - The Earth's Climate Machine – Climate Classification - Global Wind Systems – Trade Winds and the Hadley Cell – The Westerlies - Cloud Formation and Monsoon Rains – Storms and Hurricanes - The Hydrological Cycle – Global Ocean Circulation – El Nino and its Effect - Solar Radiation – The Earth's Natural Green House Effect – Green House Gases and Global Warming – Carbon Cycle.	
UNIT – II : OBSERVED CHANGES AND ITS CAUSES	**(9 Periods)**
Observation of Climate Change – Changes in patterns of temperature, precipitation and sea level rise – Observed effects of Climate Changes – Patterns of Large Scale Variability – Drivers of Climate Change – Climate Sensitivity and Feedbacks – The Montreal Protocol – UNFCCC – IPCC – Evidences of Changes in Climate and Environment – on a Global Scale and in India – climate change modeling.	
UNIT – III : IMPACTS OF CLIMATE CHANGE	**(9 Periods)**
Impacts of Climate Change on various sectors – Agriculture, Forestry and Ecosystem – Water Resources – Human Health – Industry, Settlement and Society – Methods and Scenarios – Projected Impacts for Different Regions – Uncertainties in the Projected Impacts of Climate Change – Risk of Irreversible Changes.	
UNIT – IV : CLIMATE CHANGE ADAPTATION AND MITIGATION MEASURES	**(9 Periods)**
Adaptation Strategy/Options in various sectors – Water – Agriculture –- Infrastructure and Settlement including coastal zones – Human Health – Tourism – Transport – Energy – Key Mitigation Technologies and Practices – Energy Supply – Transport – Buildings – Industry – Agriculture – Forestry - Carbon sequestration – Carbon capture and storage (CCS) - Waste (MSW & Bio waste, Biomedical, Industrial waste – International and Regional cooperation.	
UNIT – V : CLEAN TECHNOLOGY AND ENERGY	**(9 Periods)**
Clean Development Mechanism – Carbon Trading - examples of future Clean Technology – Biodiesel – Natural Compost – Eco- Friendly Plastic – Alternate Energy – Hydrogen – Bio-fuels – Solar Energy – Wind – Hydroelectric Power – Mitigation Efforts in India and Adaptation funding.	

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1 *Jan C. van Dam,* ***"Impacts of Climate Change and Climate Variability on Hydrological Regimes"****, Cambridge University Press, 2009.*
2 *Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds.,* ***"Climate Change and Water"****. Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, 2008.*
3 *Dash Sushil Kumar,* ***"Climate Change – An Indian Perspective"****, Cambridge University Press India Pvt. Ltd, 2007.*
4 *IPCC Report Technical paper VI – Climate change and Water, 2008.*

REFERENCE BOOKS:

1 *IPCC fourth assessment report - The AR4 synthesis report, 2007*
2 *IPCC fourth assessment report –Working Group I Report, " The physical Science Basis",2007*
3 *IPCC fourth assessment report - Working Group II Report,* ***"Impacts, Adaptation and Vulnerability"****, 2007*
4 *Climate change 2014: Impacts, Adaptation and Vulnerability, IPCC*
5 *Climate change 2013: The Physical Science basis, IPCC.*
6 *www.environment.gov.au/climate-change/adaptation.*
7 *www.environment.org/explore-topics/climate-change/what.we.do/climate-adaptation.*

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1: Understand the climatic system and the factors influencing the climatic changes
CO2: Assess the uncertainty and impact of climatic changes
CO3: Understand the impacts of climate change in various sectors.
CO4: Develop strategies for adaptation and mitigation of climatic changes
CO5: Identify clean technologies for sustainable growth

COURSE ARTICULATION MATRIX:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1			M			L	L					L	L	L	L	L
CO2	L					L	L					L	M	M	M	L
CO3						L	L					L		H	H	
CO4	M	M	L	M		L	M					L	L	M	M	M
CO5	L	M	M	M		L	H					L	L	M	L	M
18COE $01	L	M	M	M		L	M					L	L	M	M	M

L-Low, M-Moderate (Medium), H-High

18COE$02	**DISASTER MANAGEMENT AND MITIGATION** *(Common to All Branches)*

Category : OE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

- To give knowledge about basics of Disaster Management.
- To impart knowledge about Hazards and Vulnerability.
- To give knowledge about mitigation and preparedness.
- To teach about Response and Recovery.
- To impart knowledge about the participants involved in the disaster management activity.

UNIT - I : INTRODUCTION	**(9 Periods)**
Disaster throughout history, History of disaster management, Capacity by demand, UN International strategy for disaster reduction, the Hyogo framework for action, Post 2015 framework, Disaster trends.	
UNIT – II : HAZARDS AND RISK VULNERABILITY	**(9 Periods))**
Hazard Identification and Hazard Profiling, hazard analysis, Types of hazards- Natural and technological Components of Risk- likelihood and Consequence, Trends and Computation of likelihood and Consequence. Risk Evaluation – purpose, Risk Acceptibility, Alternatives, Personnel. Political/ social, Economic. vulnerability-Physical Profile, Social Profile, Environmental Profile, Economic Profile. Factors Influncing Vulnerability, risk Perception.	
UNIT - III : MITIGATION AND PREPAREDNESS	**(9 Periods)**
Mitigation - types of mitigation ,Ostacles in mitigation, Assement and selection of Mitigation options, Emergency response capacity as , Incorporating Mitigation into development and relief projects. Prepareness- Government Preparedness, Public Preparedness, Media as a public educator. Obstacles to public education and preparedness.	
UNIT – IV : RESPONSE AND RECOVERY	**(9 Periods)**
Response the Emergency- Pre disaster, post disaster, Provision of water, food and shelter, volunteer management , command , control and coordination. Recovery- short term and long term recovery components of recovery- planning, coordination, information, money and supplies, allocation of relief funds, personnel. Types of recovery- Government, Infrastructure, Debris removal disposal and processing, environment, housing, economic and livelihood, individual, family and social recovery-special considerations in recovery.	
UNIT – V : PARTICIPANTS	**(9 Periods)**
Governmental Disaster management agencies- Fire, law, emergency management, Emergency medical service, Millitary and other resources. Structures- local, regional, national. Bilateral assistance and its types. Types of national agencies involved in international disaster management. Political implications of bilateral assistance. Non GovernmentalOrganaisations – operations, NGO/ Millitary coordination, standard of conduct. The role of Private sector and academia. Multilateral organaisations - UN agencies and progammes, Regional &Inernationalorganaisations. International Financial Institutions- the world bank, IMF, ADB, IADB. Special considerations.	

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

*1. Damon P. Coppola, **"Introduction to International Disaster management"**, Elsevier publication, 2015*

REFERENCE BOOKS:

*1. Brassard, Caroline, Giles, David W., Howitt, Arnold M., **"Natural Disaster Management in the Asia-Pacific"**, Policy and Governance.*
*2. **"Disaster Management",** Global Challenges and Local Solutions, Universities Press, 2009.*
*3. Jack Pinkowski, **"Disaster Management Handbook"**, CRC Press , January 22, 2008.*
4. Disaster Management Guidelines, GOI-UNDP Disaster Risk Reduction Programme (2009-2012).

COURSE OUTCOME:

CO1: Able to get knowledge about basics of Disaster management.
CO2: Able to impact knowledge about Hazards and vulnerability
CO3: Able to know about Mitigation and preparedness.
CO4: Able to attain knowledge about response and recovery.
CO5: Able to learn about the participants involved in the disaster management activity.

COURSE ARTICULATION MATRIX:

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS01	PS02	PS03	PS04
CO1		L			L	L		L								L
CO2	L	H		M	L	M						L	L			L
CO3	L	L			H	M						L	L			L
CO4	L	M		L	L	M	M									L
CO5		M		L	L	M										L
18COE $02	L	M		L	L	M	M					L	L			L

L-Low, M-Moderate (Medium), H-High

18COE$03	**ENERGY EFFICIENT BUILDINGS** *(Common to All Branches)*

Category : OE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

- To understand the Concepts of Sustainable Environment, basics of energy analysis, simulation and management.
- To understand the concept of managing air quality.
- To understand the Green building concepts.

UNIT – I : INTRODUCTION	**(9 Periods)**
Life cycle impacts of materials and products – sustainable design concepts – strategies of design for the environment -the sun-earth relationship and the energy balance on the earth's surface, climate, wind – solar radiation and solar temperature – sun shading and solar radiation on surfaces – energy impact on the shape and orientation of buildings – thermal properties of building materials.	
UNIT – II : ENERGY EFFICIENT TECHNIQUES	**(9 Periods)**
Passive Cooling And Day Lighting – Active Solar And Photovoltaic- Building Energy Analysis Methods- Building Energy Simulation- Building Energy Efficiency Standards- Lighting System Design- Lighting Economics and Aesthetics- Impacts of Lighting Efficiency – Energy Audit and Energy Targeting- Technological Options For Energy Management.	
UNIT – III : INDOOR ENVIRONMENTAL QUALITY MANAGEMENT	**(9 Periods)**
Psychrometry- Comfort Conditions- Thermal Comfort- Ventilation And Air Quality Air Conditioning Requirement- Visual Perception- Illumination Requirement- Auditory Requirement-Energy Management Options- Air Conditioning Systems- Energy Conservation In Pumps- Fans And Blowers-Refrigerating Machines- Heat Rejection Equipment- Energy Efficient Motors- Insulation.	
UNIT – IV : GREEN BUILDING CONCEPTS	**(9 Periods)**
Green Building Concept- Green Building Rating Tools- Leeds And IGBC Codes. – Material Selection Embodied Energy- Operating Energy- Façade Systems- Ventilation Systems- Transportation- Water Treatment Systems- Water Efficiency- Building Economics.	
UNIT – V : GREEN BUILDING DESIGN CASE STUDY	**(9 Periods)**
Students To Work Through A Controlled Process of Analysis And Design To Produce Drawings and Models Of Their Own Personal Green Building Project. Topics Include Building Form, Orientation and Site Considerations; Conservation Measures; Energy Modeling; Heating System And Fuel Choices; Renewable Energy Systems; Material Choices; and Construction Budget-Students Will Research Green Construction and Design in A Particular -Construction Context and Report Their Results to the Class.	

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1 *Kibert, C.* ***"Sustainable Construction: Green Building Design and Delivery"****, John Wiley & Sons, 4th Edition, 2016.*

2 *Edward G Pita,* ***"An Energy Approach- Air-Conditioning Principles and Systems"****, Pearson Education, 2003.*

3 *Satyajit Ghosh, Abhinav Dhaka,* ***"Green structures: Energy efficient buildings"****, 2015.*

REFERENCE BOOKS:

1 *Colin Porteous,* ***"The New Eco-Architecture"****, Spon Press, 2002.*

2 *Ganesan T P,* ***"Energy Conservation in Buildings"****, ISTE Professional Center, Chennai, 1999.*

3 *NPTEL* ***"Energy Efficiency and Simulation"****, Prof.E.Rajsekar., IIT Roorkee.*

4 *Energy Conservation Building Codes: www.bee-india.nic.in*

5 *Lever More G J,* ***"Building Energy Management Systems"****, E And FN Spon, London, 2000.*

6 *NPTEL* ***"Energy efficiency acoustics and day lighting in building"****, Prof.B.Bhattacharjee., IIT Delhi.*

COURSE OUTCOMES:

On completion of the course, the students will be able to

CO1: Understand the Concepts of Sustainable Environment.

CO2: Understand the basics of energy analysis, simulation and management.

CO3: Understand the concept of managing air quality.

CO4: Understand the Green building concepts.

CO5: Create drawings and models of their own personal green building project

COURSE ARTICULATION MATRIX:

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	L	M	L			M	M	L	L	L		L	L	M	L	L
CO2			L	L		L	L					L		L		
CO3		L				L	M	L				L		L		
CO4	L	M					H					M		M		
CO5	M	M	H	L			H	L	M		M	M		H	L	M
18COE $03	L	M	H	L		M	H	L	L	L	M	M	L	H	L	M

L-Low, M-Moderate (Medium), H-High

18MOE$04	NANOTECHNOLOGY AND SURFACE ENGINEERING *(Common to All Branches)*

Category : OE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

- To Understand and analyze the concepts of Quantum confinement, Dimensional structures and Properties of Nanosystems
- To be familiar with various methods of synthesis of Nanomaterials
- To analyze and understand the mechanical and electrical properties of Nanomaterial and its applications

UNIT – I: PROPERTIES OF NANOMATERIALS	**(9 Periods)**
Size effect and properties of nanoparticles - particle size - particle shape - particle density - melting point, surface tension, wettability - specific surface area and pore size – Properties of Individual nanoparticles. Quantum confinement in 3D, 2D, 1D and zero dimensional structures -Size effect and properties of nanostructures- Top down and Bottom up approach.	
UNIT – II : SYNTHESIS OF NANOMATERIALS	**(9 Periods)**
Sol-Gel Process - Self-assembly – Electrodeposition - Spray Pyrolysis - Flame Pyrolysis – Metal nano-crystals by Reduction – Solvo-thermal Synthesis - Chemical Vapor Deposition (CVD) – Metal Orgonic Chemical Vapor Deposition (MOCVD).Ball Milling - Inert Gas Condensation Technique (IGCT) – Thermal evaporation – Pulsed Laser Deposition (PLD) – DC/RF Magnetron Sputtering - Molecular Beam Epitaxy (MBE) – Melt Spinning process – Applications	
UNIT – III : MECHANICAL AND ELECTRICAL PROPERTIES	**(9 Periods)**
Nanoscale Mechanics - Introduction – Mechanical properties – The Elasticity of Nanomaterials – Elasticity of Bulk Nanomaterials –Plastic Deformation of Nanomaterials – Crystals and Crystal Plasticity – From Crystal Plasticity to Polycrystal Plasticity. Introduction - Energy Storage Basics - Electrical Energy Storage Devices and Impact of Nanomaterials - Electrochemical Properties of Nanoscale Materials - Aerogels and Structure-Directed Mesoporous and Macroporous Solids - Nanoparticles - Nanotubes, Nanowires, and Nanorolls	
UNIT – IV : FUNDAMENTALS OF SURFACE ENGINEERING	**(9 Periods)**
Surface engineering - classification, definition, scope and general principles, Conventional surface engineering - Surface engineering by material removal: Cleaning, pickling, etching, grinding, polishing, buffing / puffing, Surface engineering by material addition - From liquid bath, hot dipping, Electro-deposition / plating.	
UNIT – V : SURFACE MODIFICATION	**(9 Periods)**
Surface modification of steel and ferrous components - Pack carburizing, Aluminizing, calorizing, diffusional coatings (principle and scope of application), Surface modification using liquid/molten bath: Cyaniding, liquid carburizing (diffusion from liquid state), Surface modification using gaseous medium: Nitriding, Carbo-nitriding (diffusion from gaseous state).	

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical:0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Kelsall Robert W, Ian Hamley and Mark Geoghegan, —**"Nanoscale Science and Technology"**‖, Wiley Eastern, 2004.*
2. *N John Dinardo, **"Nanoscale Charecterisation of Surfaces & Interfaces**", 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000*
3. *ASM Metals Hand Book –Vol. 5, **"Surface Engineering"**, 1996*

REFERENCE BOOKS:

1. *G. Timp. Editor, **"Nanotechnology"** AIP press, Springer-Verlag, New York, 1999*
2. *Hari Singh Nalwa, Editor, **"Nanostructured materials and Nanotechnology''**, Concise Edition, Academic Press, USA (2002).*
3. *GuozhongGao,**"Nanostructures & Nanomaterials: Synthesis, Properties & Applications**", Imperial College Press (2004).*
4. *K.G. Budinski, **"Surface Engineering for Wear Resistances",** Prentice Hall, Englewood Cliffs, 1988.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Analyze the particle size, particle shape, particle density, Size effect and properties of Nanostructures.

CO2: Acquire knowledge in various methods of synthesis of Nanomaterials.

CO3: Analyze the Elasticity of Nanomaterials, Electrical Energy Storage Devices and Aerogels.

CO4: Apply various Nanomaterials to the LED, Transistor Applications.

CO5: Apply various surface engineering techniques

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	L	L	M	L	M	M	M	L	M	M	M	M	M
CO2	H	H	M	H	H	L	L	M	M	M	L	H	M	H	M
CO3	H	H	L	H	M	M	L	L	M	M	M	M	M	H	M
CO4	L	H	M	H	M	M	L	L	M	M	M	M	M	H	M
CO5	M	M	L	M	M	L	M	M	M	L	M	M	M	H	M
18MOE$04	H	H	L	M	H	M	H	H	M	H	M	M	M	M	M

L-Low, M-Moderate(Medium), H-High

18MOE$05	**MECHATRONICS** *(Common to All Branches)*

Category : OE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

* To study the mechatronics system and understanding the concepts of integration and design of mechatronics system.

UNIT – I : SYSTEM MODELS	**(9 Periods)**
Introduction - Definition of Mechanical Systems, Philosophy and approach. Systems and Design - Mechatronic approach, Integrated Product Design - Modeling- Analysis and Simulation, Man-Machine Interface.	
UNIT – II : SENSORS AND TRANSDUCERS	**(9 Periods)**
Sensors and transducers - classification, Development in Transducer technology, Optoelectronics - Shaft encoders, CD Sensors, Vision System.	
UNIT – III : DRIVES AND ACTUATORS	**(9 Periods)**
Drives and Actuators - Hydraulic and Pneumatic drives - Electrical Actuators - servo motor and Stepper motor, Drive circuits, open and closed loop control - Embedded Systems - Hardware Structure, Software Design and Communication, Programmable Logic Devices, Automatic Control and Real Time Control Systems.	
UNIT – IV : SMART MATERIALS	**(9 Periods)**
Smart materials - Shape Memory Alloy, Piezoelectric and Magnetostrictive Actuators - Materials, Static and dynamic characteristics, illustrative examples for positioning, vibration isolation.	
UNIT – V : MICROMECHATRONIC SYSTEMS	**(9 Periods)**
Micromechatronic systems - Microsensors, Microactuators - Micro-fabrication techniques - LIGA Process- Lithography, etching, Micro-joining. Application examples - Case studies Examples of Mechatronic Systems from Robotics Manufacturing, Machine Diagnostics, Road vehicles and Medical Technology.	

Contact Periods:
Lecture: 45Periods **Tutorial: 0Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

*1. W.Bolton, **"Mechatronics"**, Longman,2nd Edition,1999*

REFERENCE BOOKS:

1. *Michael B. Histand and David G.Alciatore,* ***"Introduction to Mechatronics and Measurement Systems"****, Tata McGraw Hill, 2nd Edition,2003*
2. *D.A.Bradley, D.Dawson, N.C.Buru and A.J.Loader****, "Mechatronics"*** *Chapman and Hall,1993*
3. *Dan S Necsulescu,* ***"Mechatronics"****, Pearson Education Asia,2005*
4. *Devdas Shetty, Richard A. Kolk,* ***"Mechatronics System Design"****, Thomson, PWS publishing, 2007.*
5. *Smaili.A and Mrad.F, "****Mechatronics: Integrated Technologies for Intelligent Machines****", Oxford university press, 2008*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Identify the key elements of mechatronics system and models.

CO2: Select appropriate sensors and transducers for industrial application.

CO 3: Integrate mechanical, electrical, electronics, control systems in the mechatronics system design

CO 4: Select the proper smart material for mechatronics system.

CO 5: Apply the principles of mechatronics in industrial needs.

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	H	M	L	H	L	L	H	L	M	L	M	H	L
CO2	H	H	H	L	L	H	L	L	M	L	M	L	M	H	L
CO3	H	H	H	L	L	H	L	L	M	L	M	L	M	H	L
CO4	H	H	H	M	H	H	L	L	M	M	L	L	H	H	L
CO5	H	H	H	M	L	H	L	L	H	M	M	M	H	H	L
18MOE$05	H	H	H	H	L	H	L	L	M	L	M	L	M	H	L

L-Low, M-Moderate (Medium), H-High

18MOE$06	**RENEWABLE ENERGY SOURCES** *(Common to All Branches)*

Category : OE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

- To elucidate the technologies used for generation and utilization of power from renewable energy resources.

UNIT – I: SOLAR ENERGY	**(9 Periods)**
Solar radiation, solar spectra-latitude and longitude, Declination angle, solar window, cosine law, seasonal variations, hour angle, calculation of angle of incidence, angstroms equation and constants, Photo voltaic: p-n junctions. Solar cells, PV systems, Standalone, Grid connected solar power - Types of solar thermal collectors – Flat and concentrating collectors, solar thermal applications -water heaters, dryers, stills, refrigeration, air-conditioning, solar pond, central receiver power generation.	
UNIT – II: WIND ENERGY	**(9 Periods)**
Wind energy - Basic principle of wind energy conversion system, wind data and energy estimation, site selection, components of wind energy conversion systems, design consideration of horizontal axis wind mill- merits and limitations- application.	
UNIT – III: BIOMASS ENERGY	**(9 Periods)**
Biomass, sources of biomass, thermo-chemical and bio-chemical conversion of biomass - Pyrolysis, gasification, combustion and fermentation. Gasifiers – Up draft, downdraft and fluidized bed gasifier. Digesters- Fixed and floating digester biogas plants, economics of biomass power generation.	
UNIT – IV: OCEAN AND GEOTHERMAL ENERGY	**(9 Periods)**
Ocean energy resources - Principles of ocean thermal energy conversion systems - ocean thermal power plants - Principles of ocean wave energy conversion and tidal energy conversion - Difference between tidal and wave power generation, Economics of OTEC. Definition and classification of Geothermal resources, Utilization for electricity generation and direct heating, Wellhead power generating units. Overview of micro and mini hydel power generation.	
UNIT – V: RENEWABLE ENERGY POLICIES	**(9 Periods)**
Renewable energy policies - Feed-in tariffs, portfolio standards, policy targets, tax incentives, and biofuels mandates. International policies for climate change and energy security. Economic analysis and comparisons, Life cycle analysis, financial analysis, cost of conserved energy, and externalities. Cost assessment of supply technologies versus energy- Efficiency.	

Contact Periods:

Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total: 45 Periods

TEXT BOOKS:

*1. Sunil S. Rao and Dr. B.B. Parulekar, **"Energy Technology",** Khanna Publishers, Second Ed. 1997*
*2. Pai and Ramaprasad,**"Power Generation through Renewal sources",** Tata McGraw Hill – 1991*

REFERENCE BOOKS:

*1. Rai , G.D., **"NonConventional sources of Energy"**, Khanna Publishers , IV Ed.,2009*
*2. Bansal NK, Kleeman and Meliss, M **"Renewable Energy Sources and Conversion Techniques"**, Tata McGraw Hill, 1996*
*3. Roland Wengenmayr, Thomas Buhrke, **"Renewable energy: Sustainable energy concepts for the future"**, Wiley-VCH, 1st edition, 2008.*

COURSE OUTCOMES:

On completion of the course students will be able to

CO1: Realize the need for utilizing the energy from clean and Sustainable energy resources.
CO2: Describe the principles of operation of the broad spectrum of renewable energy Technologies
CO3: Analyze energy technologies from a systems perspective.
CO4: Articulate the technical challenges for each of the renewable sources
CO5: Create solutions for alternate energy issues
CO6: Discuss economic, technical and sustainability issues involved in the integration of renewable energy systems

COURSE ARTICULATION MATRIX

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	M	M	M	M	M	M			L	L	L	H	M	M
CO2	H	H	M	M	M	M	M	L		L	L	L	H	H	H
CO3	H	M	M	M	M	M	M	M			L	L	M	H	H
CO4	M	H	M	L	M	H	M	M		L	L	L	H	H	H
CO5	M	H	H	H	M	M	M	M		L	L	L	M	H	M
CO6	H	M	M	M	M	M	M		H	H	L	L	M	H	M
18MOE$06	H	H	M	M	M	M	M	L	L	L	L	L	H	H	H

L-Low, M-Moderate(Medium), H-High

18EOE$07	**RENEWABLE POWER GENERATION SYSTEMS** *(Common to All Branches)*

PRE-REQUISITES: NIL

Category : OE

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To elucidate the technologies used for generation and utilization of power from renewable energy resources.

UNIT-I : SOLAR ENERGY	**(9 Periods)**
Solar radiation, solar spectra-latitude and longitude, Declination angle, solar window, cosine law, seasonal variations, hour angle, calculation of angle of incidence, angstroms equation and constants, Photo voltaic: p-n junctions. Solar cells, PV systems, Standalone, Grid connected solar power - Types of solar thermal collectors – Flat and concentrating collectors, solar thermal applications -water heaters, dryers, stills, refrigeration, air-conditioning, solar pond, central receiver power generation.	
UNIT-II : WIND ENERGY	**(9 Periods)**
Wind energy - Basic principle of wind energy conversion system, wind data and energy estimation, site selection, components of wind energy conversion systems, design consideration of horizontal axis wind mill- merits and limitations- application.	
UNIT-III : BIOMASS ENERGY	**(9 Periods)**
Biomass, sources of biomass, thermo-chemical and bio-chemical conversion of biomass - Pyrolysis, gasification, combustion and fermentation. Gasifiers – Up draft, downdraft and fluidized bed gasifier. Digesters - Fixed and floating digester biogas plants, economics of biomass power generation.	
UNIT-IV : OCEAN AND GEOTHERMAL ENERGY	**(9 Periods)**
Ocean energy resources - Principles of ocean thermal energy conversion systems - ocean thermal power plants - Principles of ocean wave energy conversion and tidal energy conversion - Difference between tidal and wave power generation, Economics of OTEC. Definition and classification of Geothermal resources, Utilization for electricity generation and direct heating, Wellhead power generating units. Overview of micro and mini hydel power generation.	
UNIT-V : RENEWABLE ENERGY POLICIES	**(9 Periods)**
Renewable energy policies - Feed-in tariffs, portfolio standards, policy targets, tax incentives, and biofuels mandates. International policies for climate change and energy security. Economic analysis and comparisons, Life cycle analysis, financial analysis, cost of conserved energy, and externalities. Cost assessment of supply technologies versus energy - Efficiency.	

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Rao. S. and Dr. Pamlekar B.B "**Energy Technology**" Khanna Publishers, Second Ed. 2016*
2. *Rai , G.D., "**Non-Conventional sources of Energy**", Khanna Publishers , V Ed.,2016*

REFERENCE BOOKS:

1. *Khan. B.H, "Non-Conventional Energy Resources", The McGraw Hills, Second edition, 2016.*
2. *Bansal NK, Kleeman and Meliss, M "**Renewable Energy Sources and Conversion Techniques**", Tata McGraw Hill, 1996*
3. *Roland Wengenmayr, Thomas Buhrke," Renewable energy: Sustainable energy concepts for the future", Wiley-VCH, 1st edition, 2008.*

COURSE OUTCOMES:

CO1: Understand the concept of various Non-Conventional energy resources
CO2: Familiarize the principles of operation of renewable energy technologies
CO3: Realize the need for utilizing the energy from clean and Sustainable energy resources.
CO4: Interpret advantages and disadvantages of different renewable sources of energy
CO5: Comprehend the environmental aspects and the correlation between different operational parameters
CO6: Evaluate the options and estimate the energy generation through renewable sources

COURSE ARTICULATION MATRIX:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	M	M	M	-	M	H	-	-	-	-	-	H	M	M
CO2	H	H	M	L	M	M	M	L	-	-	-	-	H	H	H
CO3	H	M	M	M	M	M	M	-	-	-	-	-	M	H	H
CO4	M	H	M	L	M	H	M	-	-	-	-	-	H	H	H
CO5	M	H	L	H	M	M	M	-	-	-	L	-	M	H	M
CO6	H	M	M	L	M	M	M	-	L	-	L	-	M	H	M
18EOE $07	H	H	M	M	-	M	M	L	L	-	L	-	H	H	H

L - Low, M - Moderate (Medium), H – High

18EOE$08	**ELECTRIC VEHICLES** *(Common to All Branches)*

Category : OE

PRE-REQUISITES: NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

* To understand the technology of Electric and Hybrid Electric Vehicles and their business perspective

UNIT-I : INTRODUCTION	**(9 Periods)**
Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance. 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. 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.	
UNIT-II : ELECTRIC TRAINS	**(9 Periods)**
Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, Switch Reluctance Motor drives- drive system efficiency.	
UNIT-III : ANALYSIS OF ENERGY STORAGE	**(9 Periods)**
Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.	
UNIT-IV : ENERGY MANAGEMENT STRATEGIES	**(9 Periods)**
Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.	
UNIT-V : BUSINESS PERSPECTIVE OF ELECTRIC VEHICLE	**(9 Periods)**
Design of a Hybrid Electric Vehicle (HEV) - Design of a Battery Electric Vehicle (BEV) Hybrid Electric Heavy Duty Vehicles, Fuel Cell Heavy Duty Vehicles. Business: E-mobility business, electrification challenges, Connected mobility and Autonomous mobility- case study: E-mobility Indian Roadmap Perspective. Policy: EVs in infrastructure system, integration of EVs in smart grid, social dimensions of EVs.	

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Mehrdad Ehsani, Yimin Gao, Sebatien Gay and Ali Emadi, "**Modern Electric, Hybrid Electric and Fuel cell vehicles: Fundamentals, Theory and Design**", CRC press, 2004.*
2. *C. Mi, M. A. Masrur and D. W. Gao, "**Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives**", John Wiley & Sons, 2011.*
3. *S. Onori, L. Serrao and G. Rizzoni, "**Hybrid Electric Vehicles: Energy Management Strategies**", Springer, 2015.*

REFERENCE BOOKS:

1. *James Larminie and John Loury, "**Electric Vehicle Technology – Explained**", John Wiley & Sons Ltd, 2003.*
2. *Sandeep Dhameja, "**Electric Vehicle Battery Systems**", Butterworth – Heinemann, 2002.*
3. *Ronald K Jurgen, "**Electric and Hybrid – Electric Vehicles**", SAE, 2002.*
4. *Ron Hodkinson and John Fenton, "**Light Weight Electric/ Hybrid Vehicle Design**", Butterworth – Heinemann, 2001.*
5. *T. Denton, **"Electric and Hybrid Vehicles"**, Routledge, 2016.*

COURSE OUTCOMES:

CO1: Understand the basics of electric vehicle components and configuration.
CO2: Analyze suitable drive scheme for developing an electric vehicle.
CO3: Able to opt a proper energy management system.
CO4: Analyze the performance of practical HEV and EV.
CO5: Understand the infrastructure for Electric Vehicles and business potential.

COURSE ARTICULATION MATRIX:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	M	M	M	-	M	M	-	-	-	-	L	M	M	-
CO2	-	M	M	M	-	M	M	-	-	-	-	L	M	M	-
CO3	-	M	M	M	-	M	M	-	-	-	-	L	M	M	-
CO4	-	M	M	M	-	M	M	-	-	-	-	L	M	M	-
CO5	-	M	M	M	-	M	M	-	-	-	-	L	M	M	-
18EOE $08	-	M	M	M	-	M	M	-	-	-	-	L	M	M	-

L - Low, M - Moderate (Medium), H – High

18EOE$09	**SMART GRID SYSTEMS** *(Common to All Branches)*

Category : OE

PRE-REQUISITES: NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

***** To comprehend the underlying techniques applied to Smart Grid

UNIT-I : BASICS OF POWER SYSTEMS	**(9 Periods)**
Basics of Power Systems: Load and Generation - Power Flow Analysis- Economic Dispatch and Unit Commitment Problems. Smart Grid: Definition – Applications- Government and Industry- Standardization	
UNIT-II : SMART GRID COMMUNICATIONS	**(9 Periods)**
Two-way Digital Communications Paradigm - Network Architectures - IP-based Systems - Power Line Communications - Advanced Metering Infrastructure	
UNIT-III : WIDE AREA MEASUREMENT	**(9 Periods)**
Sensor Networks - Phasor Measurement Units- Communications Infrastructure- Fault Detection and Self-Healing Systems -Applications and Challenges	
UNIT-IV : SECURITY AND PRIVACY	**(9 Periods)**
Cyber Security Challenges in Smart Grid - Load Altering Attacks- False Data Injection Attacks- Defense Mechanisms - Privacy Challenges- Cyber Security Standards	
UNIT-V : ECONOMICS AND MARKET OPERATIONS	**(9 Periods)**
Introduction, Reasons for restructuring / deregulation of power industry, Understanding the restructuring process - Entities involved. The market place mechanisms-Energy and Reserve Markets- Market Power - Generation Firms- Locational Marginal Prices= Financial Transmission Rights	

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

*1. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage "**Smart Grid Technologies and applications"** John Wiley Publishers Ltd., 2012.*

*2. P. Venkatesh, B.V. Manikandan, S. Charles Raja, A. Srinivasan "**Electrical Power Systems-Analysis, Security and Deregulation**" PHI Learning Private Limited, New Delhi, 2012.*

REFERENCE BOOKS:

*1. Lars T. Berger, Krzysztof Iniewski "**Smart Grid applications, Communications and Security**" John Wiley Publishers Ltd., 2012.*

*2.Yang Xiao, **"Communication and Networking in Smart Grids",** CRC Press Taylor and Francis Group, 2012.*

*3. Caitlin G. Elsworth, **"The Smart Grid and Electric Power Transmission"**, Nova Science Publishers Inc, August 2010.*

COURSE OUTCOMES:

CO1: Demonstrate the various aspects of the smart grid, including Technologies, Components, Architectures and applications
CO2: Creating a framework to operate the grid more effectively.
CO3: Evaluate the existing grid with respect to smart grid
CO4: Upgrade the existing grid to smart grid environment

COURSE ARTICULATION MATRIX:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	-	-	L	L	M	H	L	M	M	M	H	M	H	M
CO2	L	L	M	M	M	M	M	L	M	M	M	M	M	M	H
CO3	-	-	-	M	M	M	M	M	M	M	M	H	M	M	M
CO4	L	-	-	M	M	M	H	-	M	M	M	H	M	H	H
18EOE $09	L	L	M	M	M	M	H	L	M	M	M	H	M	H	H

L - Low, M - Moderate (Medium), H - High

18LOE$10	**MOBILE COMMUNICATION** *(Common to All Branches)*

PRE-REQUISITES: NIL **Category: OE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To study the concept of Mobile radio propagation, cellular system design
- To understand mobile technologies like GSM and CDMA.
- To know the mobile communication evolution of 2G, 3G and 3 GPP in detail.
- To have overview of immerging technologies application.

UNIT I WIRELESS COMMUNICATION	**(9 periods)**
Cellular systems- Frequency Management and Channel Assignment- types of handoff and their characteristics, dropped call rates & their evaluation -MAC – SDMA – FDMA – TDMA – CDMA – Cellular Wireless Networks.	
UNIT II WIRELESS NETWORKS	**(9 periods)**
Wireless LAN – IEEE 802.11 Standards – Architecture – Services – Mobile Ad hoc Networks- WiFi and WiMAX - Wireless Local Loop.	
UNIT III MOBILE COMMUNICATION SYSTEMS	**(9 periods)**
GSM-architecture-Location tracking and call setup- Mobility management- Handover-Security-GSM SMS – International roaming for GSM- call recording functions-subscriber and service data mgt – Mobile Number portability -VoIP service for Mobile Networks – GPRS – Architecture-GPRS procedures-attach and detach procedures-PDP context procedure-combined RA/LA update procedures-Billing	
UNIT IV MOBILE NETWORK AND TRANSPORT LAYERS	**(9 periods)**
Mobile IP – Dynamic Host Configuration Protocol-Mobile Ad Hoc Routing Protocols– Multicast routing-TCP over Wireless Networks – Indirect TCP – Snooping TCP – Mobile TCP – Fast Retransmit / Fast Recovery – Transmission/Timeout Freezing-Selective Retransmission – Transaction Oriented TCP- TCP over 2.5 / 3G wireless Networks.	
UNIT V APPLICATION LAYER	**(9 periods)**
WAP Model- Mobile Location based services -WAP Gateway –WAP protocols – WAP user agent profile- caching model-wireless bearers for WAP - WML – WMLScripts - WTA - iMode - SyncML.	

Contact periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

*1. John Schiller, "**Mobile Communications**", Second Edition, Pearson Education, 2003.*
*2. William Stallings, "**Wireless Communications and Networks**", Pearson Education, 2002.*

REFERENCES BOOKS:

*1. Kaveh Pahlavan, Prasanth Krishnamoorthy, "**Principles of Wireless Networks**", First Edition, Pearson Education, 2003.*

*2. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, "**Principles of Mobile Computing**", Springer, 2003.*

*3. C.K.Toh, "**AdHoc Mobile Wireless Networks**", First Edition, Pearson Education, 2002.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand GSM, CDMA concepts and architecture, frame structure, system capacity, services provided.

CO2: Study of evolution of mobile communication generations 2G, 2.5G, 3G with their characteristics and limitations.

COURSE ARTICULATION MATRIX:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	M	-	-	-	-	-	-	-	-	L	M	L	-
CO2	M	M	M	-	-	-	-	-	-	-	-	L	M	L	-
18LOE $10	M	M	M	-	-	-	-	-	-	-	-	L	M	L	-

L - Low, M - Moderate (Medium), H - High

18LOE$11	**INTRODUCTION TO VLSI SYSTEM DESIGN** *(Common to All Branches)*

Category: OE

PRE-REQUISITES: NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To introduce various aspects of CMOS logic design in combinational and sequential circuit to design CMOS VLSI system components

UNIT I: CMOS LOGIC DESIGN	**(9 Periods)**
Inverter- CMOS Logic Gates: Compound Gates – Pass Transistors and Transmission Gates – Tristated – Multiplexers –CMOS Fabrication and Layout: Fabrication Process – Layout Design rule – Gate Layouts – Stick Diagrams – Design Partitioning	
UNIT II: MOS TRANSISTOR THEORY	**(9 Periods)**
Introduction – Long Channel I-V Characteristics – C-V Characteristics – Non-ideal I-V Effects – DC Transfer Characteristics – CMOS Technologies – Sources of Power Dissipation - Dynamic Power – Static Power.	
UNIT III: COMBINATIONAL CIRCUIT DESIGN	**(9 Periods)**
Circuit Families: Static CMOS – Ratioed Circuits – Cascode Voltage Switch Logic – Dynamic Circuits – Pass Transistor Circuits. Silicon-on-Insulator Circuit Design – Subthreshold Cirucit Design	
UNIT IV: SEQUENTIAL CIRCUIT DESIGN	**(9 Periods)**
Sequential static circuits – Circuit design of latched and flip-flops – Sequencing dynamic circuits – Synchronizers – Wave pipelining - VLSI clocking: CMOS clocking styles - Pipelined systems - Clock generation and distribution.	
UNIT V: DESIGN OF VLSI SYSTEMS	**(9 Periods)**
System Specifications – Structural Gate Level Modeling – Switch Level Modeling – Behavioral and RTL Modeling - Addition/subtraction – Comparators –counters —Multiplexers - Binary Decoders – Comparators – Priority Encoders – Latches - Flip-Flops and Registers – SRAM – DRAM – ROM.	

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *N. Weste and David Money Harris, "**CMOS VLSI Design**", Fourth Edition, Pearson Education,2011.*
2. *Uyemura, John P, "**Introduction to VLSI Circuits and Systems**", Wiley & Sons, 8th Reprint 2009*

REFERENCE BOOKS:

1. *Jan M. Rabaey, "**Digital Integrated Circuits: A Design Perspective**", PHI, Second Edition, 2012.*
2. *R. Jacob Baker, "**CMOS: Circuit Design, Layout, and Simulation**", Wiley-IEEE, Revised Second Edition, 2008.*
3. *Pucknell, "**Basic VLSI Design**", Prentice Hall, 2006.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Realize the CMOS logic design

CO2: Acquire knowledge on combinational and sequential circuit design of CMOS logic

CO3: Use VLSI clocking styles and realize CMOS VLSI system components

COURSE ARTICULATION MATRIX:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
CO2	M	M	M	-	-	-	-	-	-	-	-	L	M	L	L
CO3	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
18LOE $11	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L

L - Low, M - Moderate (Medium), H - High

18LOE$12	**MICROCONTROLLER AND APPLICATIONS** *(Common to All Branches)*

Category: OE

PRE-REQUISITES: NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- Describe the architecture of 8051 microcontroller.
- Develop assembly program for 8051.
- Apply the instruction set of 8051 to get effective programs.
- Design system in block level using microcontroller, memory devices, buses and other peripheral devices.
- Solve real life problem using microcontroller based systems.

UNIT I: MICROCONTROLLER	**(9 Periods)**
Microcontroller Features – On chip oscillator, List of Special Function Registers (SFRs), On chip program memory, on chip data memory, I/O Ports, Watch Dog Timer, Architecture of 8051, Instruction set - Addressing modes.	
UNIT II: ASSEMBLY LANGUAGE PROGRAMMING	**(9 Periods)**
8051 Assembly Language Programming, Branch Instruction Programming -I/O Port Programming – Arithmetic and Logic Instruction Programming-code conversion programming	
UNIT III: PROGRAMMING IN C AND INTERFACING-I	**(9 Periods)**
Timers & Counters programming - Serial Port Programming - Interrupts Programming .8255 Interfacing and Programming- External Memory Interfacing - LCD interfacing, LED Interfacing	
UNIT IV: INTERFACING-II	**(9 Periods)**
Keyboard Interfacing - ADC, DAC interfacing –Temperature Transducer-Pressure and Displacement Transducer-Light Sensor - Optocoupler - Relays.	
UNIT V: APPLICATIONS OF MICROCONTROLLERS	**(9 Periods)**
Stepper Motor interface-Temperature Monitoring and Control System-Speed Control of a DC Motor - Digital Thermometer-Digital Frequency Meter.	

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1.Mohammad Ali Mazidi, Janice Gillispie Mazidi ***"The 8051 Microcontroller and Embedded Systems (Using assembly and C)"*** *Pearson education/ Prentice Hall of India Pvt. Ltd., 2007.*

2. Ajit Pal, *"Microcontrollers : Principles and Applications"****, Prentice-Hall of India Pvt.Ltd; 1 edition (August 2011).***

REFERENCE BOOKS:

1. *Krishna Kanth,* ***"Microprocessor and Microcontroller Archotecture,Programming and System Design using 8085, 8086, 8051"****, Prentice Hall of India, 2011.*
2. *Kenneth J.Ayala,* ***"The 8051 Microcontroller"*** *3rd edition,Thompson Delmar Learning,2007, New Delhi.*
3. *Jacob Fraden,* ***"Handbook of Modern Sensors: Physics, Design and Applications"****, 3rd ed, Springer, 2010.*
4. *Michael J. Pont,* ***"Embedded C"*** *Pearson Education India, 1st edition (*2007*);*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Describe the architectures of controller

CO2: Develop Assembly program applying Digital logic and mathematics using 8051 instruction set

CO3: Design microcontroller based system within realistic constraint like user specification, availability of components etc

CO4: Interface real world sensors

CO5: Solve real life problem and construct a complete system as a solution

COURSE ARTICULATION MATRIX:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
CO2	M	M	M	-	-	-	-	-	-	-	-	L	M	L	L
CO3	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
CO4	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L
CO5	M	M	M	-	-	-	-	-	-	-	-	L	M	L	L
18LOE $12	M	M	M	-	-	-	-	-	-	-	-	L	H	L	L

L - Low, M - Moderate (Medium), H - High

18POE$13	**RAPID PROTOTYPING** *(Common to All Branches)*

Category: OE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

* To educate students with fundamental and advanced knowledge in the field of Rapid Prototyping technology and the associated Aerospace, Architecture, Art, Medical and Industrial applications.

UNIT- I	**INTRODUCTION**	**(9 Periods)**
Need - Development of RP systems – Applications in Product Development - Virtual Prototyping- Rapid Tooling – Rapid Manufacturing - Classification of RP processes – Benefits - Applications		
UNIT- II	**REVERSE ENGINEERING AND CAD MODELING**	**(9 Periods)**
Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wireframe, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for RP- Case studies.		
UNIT- III	**LIQUID BASED AND SOLID BASED RAPID PROTOTYPING SYSTEMS**	**(9 Periods)**
Classification – Liquid based systems - Stereo lithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications. Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and application. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.		
UNIT- IV	**POWDER BASED RAPID PROTOTYPING SYSTEMS**	**(9 Periods)**
Selective Laser Sintering (SLS): Principle, process, indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications – case Studies, Selective Laser Melting and Electron Beam Melting		
UNIT- V	**OTHER RAPID PROTOTYPING SYSTEMS**	**(9 Periods)**
Three dimensional Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, Demerits, Applications and case studies. Shape Deposition Manufacturing (SDM), Ballastic Particle Manufacturing (BPM), Bio Additive Manufacturing.		

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Chua Chee Kai and Leong Kah Fai* ***"Rapid Prototyping: Principles and Applications in Manufacturing",*** *John Wiley AND Sons, 1997*
2. *Paul F. Jacobs* ***"Stereo-lithography and other RP & M Technologies",*** *from Rapid Prototyping to Rapid Tooling, SME/ASME,1996*

REFERENCE BOOKS:

1. *Gibson, I., Rosen, D.W. and Stucker, B* ***"Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing",*** *Springer, 2010.*
2. *Chua, C.K., Leong K.F. and Lim C.S* ***"Rapid prototyping: Principles and applications",*** *second edition, World Scientific Publishers, 2010.*
3. *Gebhardt, A* ***"Rapid prototyping",*** *Hanser Gardener Publications, 2003.*
4. *Liou, L.W. and Liou, F.W* ***"Rapid Prototyping and Engineering applications: A tool box for prototype development",*** *CRC Press, 2011.*
5. *Hilton, P.D. and Jacobs, P.F* ***"Rapid Tooling: Technologies and Industrial Applications",*** *CRC press, 2005*

COURSE OUTCOMES:

On completion of this course, students will be able to

CO1: Appreciate the importance of computers and modern tools in manufacturing to reduce cost and matching the societal needs.

CO2: Create and analyze 2D and 3D models using CAD modeling software and integrating with manufacturing systems.

CO3: Understand the variety of Additive Manufacturing (AM) technologies apply to their potential to support design and manufacturing, case studies relevant to mass customized manufacturing.

CO4: Apply knowledge on latest techniques of manufacturing in their field of career

CO5: To monitor and control shop floor with the aid of computers

COURSE ARTICULATION MATRIX

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1			L				M						L	L	
CO2			M											M	L
CO3			L										M	L	
CO4			M		H	M	L						M	H	L
CO5		M				L					M		L	H	
18POE$13		M	M		M	L	L				L		M	M	L

L- Low, M – Moderate (Medium), H – High

18POE$14	**MANAGERIAL ECONOMICS** *(Common to All Branches)*

Category: OE

L	T	P	C
3	0	0	3

PRE-REQUISITES: NIL

COURSE OBJECTIVES:

- To introduce the fundamental economic principles necessary for production managers.

UNIT- I	**FUNDAMENTALS OF MANAGERIAL ECONOMICS**	**(9 Periods)**
Goals and Constraints - The Nature and Importance of Profits - Understanding Incentives - Economic rationality, Scarcity and opportunity cost -Marginal and Incremental Analysis.		
UNIT- II	**DEMAND ANALYSIS**	**(9 Periods)**
Demand and Supply -Market Equilibrium - Price Elasticity of Demand - Price Elasticity, Total Revenue, and Marginal Revenue - Factors Affecting Price Elasticity - Cross Price Elasticity - Income Elasticity of Demand - Other Elasticities, Elasticities for Nonlinear Demand Functions - Elasticity of Supply.		
UNIT- III	**DEMAND THEORIES**	**(9 Periods)**
Choice and Utility Theory - Law of Diminishing marginal utility - Consumer Equilibrium - Consumer Surplus - Price effect, Substitution Effect and Income Effect.		
UNIT- IV	**THEORY OF PRODUCTION AND COST**	**(9 Periods)**
The Production Function - Profit-Maximizing Input Usage - Isoquants and Isocosts - Cost Minimization and Optimal Input Substitution - The Cost Function - Breakeven analysis, Contribution analysis - Long-run Costs and Economies of Scale - Multiple Cost Functions and Economies of Scope - Learning curve.		
UNIT- V	**THEORY OF MARKET AND PRICING**	**(9 Periods)**
The Nature of Industry - Perfect Competition – Monopoly - Monopolistic Competition – Oligopoly - Product pricing.		

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1. *Thomas and Maurice **"Managerial Economics: Concept and Applications",** McGraw-Hill, 2005*
2. *Maheshwari.Y **"Managerial Economics",** Prentice Hall of India, 2012*

REFERENCE BOOKS:

1. *D.N. Dwivedi, **"Managerial Economics",** Vikas Publishing house, 2015*
2. *Christopher R Thomas, S Charles Maurice, **"Managerial economics",** Mcgraw Hill, 2014*

COURSE OUTCOMES:

On completion of this course, students will be able to

CO1: Explain fundamentals of managerial economics.

CO2: Discuss the dynamics of market forces.

CO3: Explain about various theories of demand.

CO4: Discuss about the cost concepts related to production.

CO5: Describe about the theory of market and pricing method.

COURSE ARTICULATION MATRIX

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	L	L							L	M	M	L			L
CO2	L	L	L							M	M	L			L
CO3	L									L	M	L			L
CO4	L									L	L	L			L
CO5	L	M	M	L						L	M	L			L
18POE$14	L	L	L	L						L	M	L			L

L- Low, M – Moderate (Medium), H - High

18POE$15	**HYDRAULICS AND PNEUMATICS** *(Common to All Branches)*

PRE-REQUISITES: NIL **Category: OE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To make the students to design the hydraulic and pneumatic circuits for different applications.

UNIT- I	**BASIC PRINCIPLES**	**(9 Periods)**
Hydraulic Principles; Hydraulic Fluids; Hydraulic pumps – Classification, Characteristics, Pump Selection; Hydraulic actuators; Hydraulic valves – Pressure, Flow, Direction Controls, Applications, Symbols.		
UNIT- II	**HYDRAULIC CIRCUITS**	**(9 Periods)**
Hydraulic circuits – Reciprocating, Quick Return, Sequencing, Synchronizing, Regenerative circuit, Double pump hydraulic system; Safety Circuits.		
UNIT- III	**POWER GADGETS IN HYDRAULICS**	**(9 Periods)**
Accumulators – Classification, Circuits; Pressure Intensifier and Circuit; Mechanical-hydraulic servo system; Selection of components. Installation and Maintenance of Hydraulic power pack; Troubleshooting of fluid power circuits.		
UNIT- IV	**PNEUMATIC SYSTEMS**	**(9 Periods)**
Pneumatic Fundamentals; Control Elements; Logic Circuits; Position sensing, Pressure sensing; Electrical controls: Various switches; Electro Pneumatic and Electro Hydraulic Circuits.		
UNIT- V	**DESIGN AND SELECTION OF PNEUMATIC CIRCUITS**	**(9 Periods)**
Design of Pneumatic circuits – Classic, Cascade, Step counter; PLC and Microprocessors – Uses; Selection criteria for Pneumatic components; Installation and Maintenance of Pneumatic power pack; Fault finding; Case studies.		

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1. *Anthony Esposito,* ***"Fluid Power with Applications",*** *Pearson Education India, 7th edition, 2013.*
2. *Andrew Parr,* ***"Hydraulics and Pneumatics:A Technician's and Engineer's Guide",*** *Butterworth-Heinemann, 3rd edition, 2011.*

REFERENCE BOOKS:

1. *DudleyA Pease and John J Pippenger* ***"Basic Fluid Power",*** *Prentice Hall PTR, 2nd edition 1987.*
2. *John J Pippenger and Tyler G Hicks* ***"Industrial Hydraulics",*** *McGraw Hill,2nd edition, 1970.*
3. *J. Michael, Pinches and HohnG.Ashby* ***"Power Hydraulics",*** *Prentice Hall, 1989.*

COURSE OUTCOMES:

On completion of this course, students will be able to

CO1: Describe the principle of fluid power
CO2: Describe the components of hydraulics
CO3: Design the hydraulic circuits for automation
CO4: Describe the components of pneumatics
CO5: Design the pneumatic circuits for automation

COURSE ARTICULATION MATRIX

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	H										M			
CO2	M											M			
CO3	M	H										M			
CO4	M											M			
CO5	M											M			
18POE$15	M	H										M			

L- Low, M – Moderate (Medium), H - High

18NOE$16	**MEASUREMENT AND CONTROL** *(Common to All Branches)*

PRE-REQUISITES: NIL **Category: OE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To learn about the working of different analog and digital instruments.

UNIT I – INTRODUCTION TO MEASUREMENTS	**(9Periods)**
Significance of measurements – Methods of measurements – Classification of Instruments – Functions of Instruments and Measurement System – Elements of measurement system – Errors in measurement — Calibration of instruments: Methods & analysis – Introduction to Transducer & types.	
UNIT II – STRAIN AND DISPLACEMENT MEASUREMENT	**(9Periods)**
Factors affecting strain measurements – Types of strain gauges – theory of operation – strain gauge materials – strain gauge circuits and applications of strain gauges. Resistive potentiometer (Linear, circular and helical) – L.V.D.T., R.V.D.T. and their characteristics – variable inductance and capacitance transducers – Piezo electrical transducers – Hall Effect devices and Proximity sensors.	
UNIT III – PRESSURE AND TEMPERATURE MEASUREMENT	**(9Periods)**
Mechanical devices like Diaphragm, Bellows, and Bourdon tube for pressure measurement – Variable inductance and capacitance transducers – Piezo electric transducers – L.V.D.T. for measurement of pressure. Resistance type temperature sensors – RTD & Thermistor – Thermocouples & Thermopiles, Laws of thermocouple – Radiation methods of temperature measurement.	
UNIT IV – FLOW AND LEVEL MEASUREMENT	**(9Periods)**
Differential pressure meters like Orifice plate, Venturi tube, flow nozzle, Pitot tube, Rotameter, Turbine flow meter, Electromagnetic flow meter and Ultrasonic flow meter. Resistive, inductive and capacitive techniques for level measurement – Ultrasonic methods – Air purge system (Bubbler method).	
UNIT V – AUTOMATIC CONTROL SYSTEM	**(9Periods)**
Elements of control systems – concept of open loop and closed loop systems – Controllers – Brief idea of proportional, derivative and integral – Pneumatic Controller – Hydraulic Controller.	

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS

1. *A.K. Sawhney, Puneet Sawhney **"A Course in Electronic and Electrical Measurements and Instrumentation"** S.K.Kataria & Sons, Delhi, 2014.*
2. *E. D. Doeblin, **"Measurement Systems: Application and Design",** McGraw – Hill Publication, 6th Edition 2017.*

REFERENCE BOOKS

1. *S. K. Singh,* ***"Industrial Instrumentation & Control"****, 3rd Edition, McGraw Hill, 2016.*
2. *A.K. Sawhney, Puneet Sawhney* ***"A Course in mechanical measurements and Instrumentation & Control"****, Dhanapat Rai & Co, 2012.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Explain the construction and working of instruments used for various measurements.
CO 2: Describe the methods of measurement, classification of transducers and to analyze error.
CO 3: Elaborate the basic concept of control system.
CO 4: Analyze the characteristics of various measuring instruments
CO 5: Suggest suitable instruments for a particular application

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	M	H	M	H	M	L	H	M	H	H	H	M	H
CO2	H	M	M	M	H	H	H	M	H	L	H	H	H	H	M
CO3	H	H	M	H	M	H	M	L	H	M	H	H	H	H	H
CO4	H	H	M	H	M	H	M	L	H	M	H	H	H	M	H
CO5	H	H	M	H	M	H	M	L	H	M	H	H	H	M	M
18NOE$16	H	H	M	H	M	H	M	L	H	M	H	H	M	H	M

L-Low, M-Moderate(medium), H-High

18NOE$17	**INDUSTRIAL AUTOMATION** *(Common to All Branches)*

PRE-REQUISITES: NIL **Category: OE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To elaborate the basic concept of automation and the components required for automation

UNIT I – INTRODUCTION TO AUTOMATION	**(9 Periods)**
Automation overview – requirement of automation systems – architecture of industrial automation system – power supplies and isolators –relays – switches –transducers – sensors –seal-in circuits – industrial bus systems : modbus and profibus.	
UNIT II – AUTOMATION COMPONENTS	**(9 Periods)**
Sensors for temperature – pressure – force – displacement - speed – flow- level – humidity and pH measurement. Actuators – process control valves – power electronic drives DIAC- TRIAC – power MOSFET – IGBT. Introduction to DC and AC servo drives for motion control	
UNIT III – PROGRAMMABLE LOGIC CONTROLLERS	**(9 Periods)**
PLC Hardware – PLC programming – ladder diagram – sequential flow chart – PLC communication and networking – PLC selection – PLC installation – Advantages – Application of PLC to process control industries and Robotics.	
UNIT IV – DISTRIBUTED CONTROL SYSTEM (DCS)	**(9 Periods)**
Overview of DCS – DCS hardware – DCS software configuration – DCS communication – DCS supervisory computer tasks – DCS integration with PLC and Computers	
UNIT V – SCADA	**(9 Periods)**
Introduction - Supervisory Control and Data Acquisition Systems (SCADA) – SCADA HMI Essentials – SCADA Components – SCADA Configuration and Software – HMI hardware and software.	

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1. *John.W. Webb Ronald A Reis, **"Programmable Logic Controllers - Principles and Applications",** Prentice Hall Inc., 5th Edition, 2003.*
2. *M. P. Lukcas, **"Distributed Control Systems",** Van Nostrand Reinhold Co., 1986.*

REFERENCE BOOKS :

1. *Bela G Liptak, **"Process software and digital networks – Volume 3",** 4th Edition, CRC press, 2012.*
2. *Romily Bowden, **"HART application guide and the OSI communication foundation",** 1999*
3. *Frank D. Petruzella, **"Programmable Logic Controllers",** 5th Edition, McGraw Hill, 2016.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Elaborate the basic architecture of automation systems

CO 2 : Describe the various sensors and actuators involved in industrial automation

CO 3: Construct ladder logic diagram using PLC basic functions, timer and counter functions for simple applications

CO 4: Illustrate the functionary components and supervisory control of DCS with relevant diagrams

CO 5: Describe the basics of SCADA technology

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	H	H	M	M	L	L	L	H	L	M	L	L	H	L	L
CO2	H	H	H	H	L	L	L	H	L	M	L	L	H	L	L
CO3	H	H	M	M	L	L	M	H	L	M	L	L	H	L	L
CO4	H	H	H	H	L	L	L	H	L	M	L	L	H	L	L
CO5	H	H	M	M	M	L	L	H	L	M	L	L	H	L	L
18NOE$17	H	H	M	M	L	L	L	H	L	M	L	L	H	L	L

L-Low, M-Moderate(medium), H-High

18NOE$18	**VIRTUAL INSTRUMENTATION** *(Common to All Branches)*

PRE-REQUISITES: NIL **Category: OE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

- To confer applications of virtual instrumentation in various fields.

UNIT I – INTRODUCTION	**(9 Periods)**
Virtual Instrumentation and LabVIEW - Evolution of LabVIEW - Difference between LabView and conventional languages - Sequencing and data flow - Graphical programming.	
UNIT II – LabVIEW ENVIRONMENT	**(9 Periods)**
Front panel - Block diagram - Icon and Connector - Control Palette - Function Palette-Tools Palette - Creating, editing, wiring, debugging and saving VIs - sub-VIs - creating sub-VIs - simple examples-Looping: For loop, while loop-Shift registers - case and sequence; structures, formula nodes.	
UNIT III – PROGRAMMING TECHNIQUES	**(9 Periods)**
Arrays - clusters, charts and graphs, - local and global variables - property node, string and file I/O.	
UNIT IV – DATA ACQUISITION AND INSTRUMENT CONTROL	**(9 Periods)**
DAQ – Components - Buffers: Buffered and non buffered I/O - Triggering - Analog I/O-Digital I/O - Counters and timers-Instrument control: VISA, GPIB, VXI and PXI	
UNIT V – ADVANCED Lab VIEW AND APPLICATIONS	**(9 Periods)**
Connectivity in LabVIEW: an introduction - IVI - Labwindows/CVI. Applications of Lab VIEW: process control, physical, biomedical, Image acquisition and processing.	

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS

1. *Sanjay Gupta and Joseph John, **"Virtual Instrumentation using LabVIEW"** Tata McGraw-Hill, Second edition 2010*
2. *Gary Johnson, Richard Jennings **"Lab view graphical programming",** Tata McGraw Hill, 2011.*

REFERENCE BOOKS

1. *Lisa K Wells and Jeffrey Travels, **"Labview for everyone",** Prentice Hall, 3rd Edition 2009.*
2. *S. Gupta, J.P. Gupta, **"PC interfacing for data acquisition and process control",** 2nd Ed., Instrument Society of America, 2011*
3. *Jovitha Jerome, **"Virtual Instrumentation Using LabVIEW"** PHI Learning Pvt. Ltd 1st Edition, 2010*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO 1: Recognize the importance and applications of virtual instrumentation.

CO 2: Develop ability for programming in LabVIEW using various data structures, program structures, plotting the graphs and charts for system monitoring, processing and controlling.

CO 3: Realize the basics of interfacing and programming using related hardware.

CO 4: condition the acquired signal from the transducer to standard data formats

CO 5: Develop real time applications using LabVIEW

COURSE ARTICULATION MATRIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	H	M	M	L	L	L	H	L	M	M	M	H	M	M
CO2		H	H	H	L	L	L	H	L	M	M	M	H	M	M
CO3		H	M	M	L	L	M	H	L	M	M	M	H	M	M
CO4		H	H	H	L	L	L	H	L	M	M	M	H	M	M
CO5		H	M	M	M	L	L	H	L	M	M	M	H	M	M
18NOE$18	M	H	M	M	L	L	L	H	L	M	M	M	H	M	M

L-Low, M-Moderate(medium), H-High

18SOE$19	**PROGRAMMING IN JAVA** *(Common to All Branches)*

PRE-REQUISITES: NIL **Category: OE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

Upon completion of this course the students will be familiar with:

- Basic programming constructs in java to develop simple object oriented programs.
- Exception handling, multi-threading and I/O programming
- Development of GUI applications
- Manipulation of images.
- Network Programming

UNIT – I : FUNDAMENTALS OF JAVA PROGRAMMING	**(9 Periods)**
History and Evolution of Java- Overview of java– Operators- Control Structures– Methods- Classes and Objects– Inheritance- Packages and Interfaces- Exception Handling.	
UNIT – II : THREADS , I/O AND STRING HANDLING	**(9 Periods)**
Multi threaded Programming– Enumeration- Auto boxing– Annotations- String Handling- Input/Output: Exploring java.io.	
UNIT – III : APPLETS AND EVENT HANDLING	**(9 Periods)**
Applet class- Event Handling. Introducing the AWT: working with windows- graphics and text- Using AWT controls- Layout Manager - menus.	
UNIT – IV : IMAGING AND DATABASE CONNECTIVITY	**(9 Periods)**
Imaging: Creating- loading and displaying- Image observer- Double buffering- Media tracker- Image producer– consumer– filters– animation- Java Database Connectivity.	
UNIT – V : NETWORKING	**(9 Periods)**
Networking – Remote Method Invocation – Java Beans –Java servlets	

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1. *Herbert Schildt, **"Java, The Complete Reference** ", Tata McGrawHill, Eighth Edition, 2011.*

REFERENCE BOOKS:

1. *Deitel .H.M and Deitel.P.J, **"Java: How to Program",** Pearson Education Asia, Eighth Edition 2010.*
2. *Lay.S&Horstmann Gary Cornell, **"Core Java Vol I",** Seventh Edition, The Sun Microsystems & press Java Series, 2005.*
3. *Lay.S&Horstmann Gary Cornell, **"Core Java Vol II",** Eighth Edition, The Sun Microsystems & press Java Series, 2008.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Write simple java programs using fundamental concepts of java like control structures, inheritance, packages, interfaces and exception handling. [**Usage]**

CO2: Write java program using multithreading and string handling. [**Usage]**

CO3: Develop GUI based applications using Applets. [**Usage]**

CO4: Write java programs to display and manipulation of graphical images. [**Usage]**

CO5: Establish database connectivity.[**Familiarity]**

CO6: Develop client server programs using RMI and servlets. [**Usage]**

COURSE ARTICULATION MATRIX:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	M	M	H		H	M	M				H	M	M	H	H	H
CO2	M	M	H		H	M	M				H	M	M	H	H	H
CO3	M	M	H		H	M	M				H	M	M	H	H	H
CO4	M	M	H		H	M	M				H	M	M	H	H	H
CO5	M	M	H		H	M	M				H	M	M	H	H	H
CO6	M	M	H		H	M	M				H	M	M	H	H	H
18SOE$19	M	M	H		H	M	M				H	M	M	H	H	H

L - Low, M - Moderate (Medium), H - High

18SOE$20	**CYBER SECURITY** *(Common to All Branches)*

PRE-REQUISITES: NIL **Category: OE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

Upon completion of this course, the students will be familiar with:

- Cybercrime and cyber offenses
- Cybercrime using mobile devices.
- Tools and methods used in cybercrime.
- Legal perspectives of cybercrime.
- Fundamentals of computer forensics.

UNIT – I : INTRODUCTION TO CYBERCRIME AND CYBEROFFENSES	**(9 Periods)**
Cybercrime and Information Security - Classifications of Cybercrimes - The Legal Perspectives - Cybercrime and the Indian ITA 2000 - A Global Perspective on Cybercrimes - Plan of Attacks - Social Engineering – Cyberstalking - Cybercafe and Cybercrimes – Botnets - Attack Vector.	
UNIT – II : CYBERCRIME: MOBILE AND WIRELESS DEVICES	**(9 Periods)**
Proliferation of Mobile and Wireless Devices - Trends in Mobility - Credit Card Frauds in Mobile and Wireless Computing Era – Security challenges posed by mobile devices – registry setting for mobile devices – authentication service security – attacks on mobile/cell phones – Organizational measures for handling mobiles.	
UNIT – III : TOOLS AND METHODS USED IN CYBERCRIME	**(9 Periods)**
Proxy Servers and Anonymizers – Phishing - Password Cracking – Keyloggers – Spywares -Virus and Worms - Trojan Horses and Backdoors – Steganography - DoS and DDoS Attacks - SQL Injection - Attacks on Wireless Networks.	
UNIT – IV : CYBERCRIMES AND CYBERSECURITY: THE LEGAL PERSPECTIVES	**(9 Periods)**
Cyberlaws- The Indian Context - The Indian IT Act - Challenges to Indian Law and Cybercrime Scenario in India - Consequences of Not Addressing the Weakness in Information Technology Act - Digital Signatures and the Indian IT Act - Amendments to the Indian IT Act - Cybercrime and Punishment.	
UNIT – V : UNDERSTANDING COMPUTER FORENSICS	**(9 Periods)**
Digital Forensics - Forensics Analysis of E-Mail - Network Forensics - Forensics and Steganography - Forensics and Social Networking Sites - Challenges in Computer Forensics - Data Privacy Issues – Forensics Auditing – Antiforensics.	

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1. *Nina Godbole and Sunit Belapur,* ***"Cyber Security Understanding Cyber Crimes, Compute Forensics and Legal Perspectives"****, Wiley India Publications, April, 2011.*

REFERENCE BOOKS:

1. *Robert Jones,* ***"Internet Forensics: Using Digital Evidence to Solve Computer Crime",*** *O"Reilly Media, October, 2005.*
2. *Chad Steel, "****Windows Forensics: The field guide for conducting corporate computer investigations****", Wiley India Publications, December, 2006.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the fundamental concepts of cybercrime and cyberoffenses. **[Familiarity]**

CO2: Describe the cybercrimes occurred in mobile and wireless devices. **[Familiarity]**

CO3: Elaborate the methods used in cybercrime. **[Familiarity]**

CO4: Explain the laws for cybercrime and its respective punishments. **[Familiarity]**

CO5: Explain the forensics Analysis of E-Mail, Network and Social Networking Sites **[Familiarity]**

COURSE ARTICULATION MATRIX:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	M	M	M	M	L	H	L	M				H	H	L	M	M
CO2	M	M	M	M	M	H	M	M				M	H	H	M	M
CO3	H	L	L	L	L	H	H	L				H	H	H	L	L
CO4	H	M	M	M	M	H	H	H				M	H	H	L	L
CO5	H	M	M	M	M	L	H	L				H	H	H	M	M
18SOE$20	H	M	M	M	M	H	H	M				H	H	H	M	M

L - Low, M - Moderate (Medium), H - High

18SOE$21	**NETWORK ESSENTIALS** *(Common to All Branches)*

PRE-REQUISITES: NIL **Category: OE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

Upon completion of this course, the students will be familiar with,

- Basic taxonomy and terminology of the computer networking
- Wireless networking
- Addressing and Routing
- Routing protocols
- Troubleshooting and security issues.

UNIT – I : INTRODUCTION	**(9 Periods)**
Introduction to Computer Networks - Goals and advantages of Computer Networks - Network Topologies – Basic networking devices – Protocols – the need for a layered architecture - The OSI Model and the TCP/IP reference model – the Ethernet LAN – Home Networking – Assembling an office LAN – Testing and Troubleshooting a LAN – Physical layer cabling: Twisted pair and Fiber optics.	
UNIT – II : WIRELESS NETWORKING	**(9 Periods)**
Importance of Wireless Networking – IEEE 802.11 Wireless LANs – Bluetooth- WIMAX – RFIDs – Securing the Wireless LANs – Configuring a Point to Multipoint Wireless LAN – Interconnecting network LANs – Switch, Bridges and Routers. Interconnecting LANs with the router, Configuring the network interface-Auto negotiation.	
UNIT – III : ADDRESSING AND ROUTING FUNDAMENTALS	**(9 Periods)**
IPv4 and IPv6 addressing – Subnet masks – CIDR blocks – configuration of a router – Console port connection - user EXEC mode – Privileged EXEC mode - Configuration of a switch – Static VLAN configuration - Spanning Tree protocol – Network Management – Power over Ethernet.	
UNIT – IV : ROUTING PROTOCOLS	**(9 Periods)**
Static Vs Dynamic Routing Protocols – Distance vector Routing – Link State Routing – Hybrid Routing – Configuring RIP - Network Services – DHCP, DNS - Analyzing Internet Traffic.	
UNIT – V : TROUBLESHOOTING AND NETWORK SECURITY	**(9 Periods)**
Analyzing Computer Networks – FTP data packets – Analyzing Campus Network data traffic – Troubleshooting the router and switch interface, Troubleshooting fiber optics – Intrusion – DOS – Security software and hardware.	

Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods

TEXT BOOKS:

1. *Jeffrey S.Beasley Piyasat Nilkaew **"Network Essentials"** 3rd Edition, Pearson, 2012*
2. *Larry L. Peterson and Bruce S. Davie **"Computer Networks, A Systems Approach"** 5th edition, Morgan Kaufmann Publishers Inc, 2011.*

REFERENCE BOOKS:

1. *Behrouz A.Ferouzan, **"Data Communications and Networking"**, 5th edition, Tata McGraw-Hill, 2012.*
2. *Andrew S. Tanenbaum, **"Computer networks"**, PHI, 5th edition 2011.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Identify topologies and types of Computer Networks and enumerate the layers of the OSI model and TCP/IP and Explain the functions of each layer **[Familiarity]**

CO2: Explain the significance of wireless networks and configure a Wireless LAN **[Assessment]**

CO3: Describe basic routing algorithms and network services. **[Familiarity]**

CO4: Troubleshoot the router and switch interface **[Usage]**

CO5: Analyze Campus Network data traffic **[Usage]**

COURSE ARTICULATION MATRIX:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	M	M	H	H	H	L	L	H	H	H	H	H	M	H	H	M
CO2	L	L	L	L	H	L	L	H	L	L	L	H	M	H	H	M
CO3	L	H	M	M	H	L	L	H	H	M	L	H	L	H	H	L
CO4	H	H	H	M	H	L	L	H	H	H	M	H	M	H	H	M
CO5	H	H	H	M	H	L	L	H	H	M	L	H	M	H	H	M
18SOE$21	M	H	H	M	H	L	L	H	H	L	M	H	M	H	H	M

L - Low, M - Moderate (Medium), H - High

18IOE$22	**PROGRAMMING IN PYTHON** *(Common to All Branches)*

PRE-REQUISITES: NIL **Category: OE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

Upon completion of this course, the students will be familiar with,

- Data types and variables declaration.
- Control statements, Functions and the use of basic programming.
- List, dictionary and operations used in python.
- File and Exception handling.
- Object oriented programming and GUI development.

UNIT – I : INTRODUCTION	**(9 Periods)**
Introduction to Python - Setting up Python in OS – Python IDLE(write- edit- run- and save programs) – Strings - Numbers – Variables – simple I/O - Getting user input– Using String method– Converting values.	
UNIT – II : CONTROL STATEMENTS AND FUNCTIONS	**(9 Periods)**
Control statements – Random number generator- Branching and loops – Range functions- Functions –User defined functions- passing parameters- return function- working with global variables and constants.	
UNIT – III : LISTS AND DICTIONARIES	**(9 Periods)**
Lists – create- index- slice a list- Add and delete elements from a list- Append- Sort and reverse a list- nested sequences- Dictionaries – Create- add- delete from a Dictionary- Operations associated with pairs of data.	
UNIT – IV : FILES AND EXCEPTIONS	**(9 Periods)**
Files – Read from text files- Write to text files- Read and write more complex data- Exceptions – Intercept and handle errors during program's execution.	
UNIT – V : OBJECT ORIENTED PROGRAMMING AND GUI	**(9 Periods)**
Object oriented programming – Create objects of different classes in the same program- objects communication- complex object creation- derive new classes- existing class extension- override method- GUI – GUI toolkit- create and fill frames- create buttons- text entries and text boxes- create check buttons and radio buttons - case study – create a web page using GUI functionality.	

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Y. Daniel Liang,* ***"Introduction to Programming Using Python",*** *Pearson, 2013.*
2. *David I.Schneider,* ***"Introduction to programming using python",*** *person, 2015.*

REFERENCE BOOKS:

1. *Michael Dawson,* ***"Python Programming for the Absolute Beginner",*** *Premier Press, 2003.*
2. *Charles Dierbach,* ***"Introduction to Computer Science Using Python: A Computational Problem-Solving Focus",*** *Wiley Publications, 2012.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to,

CO1: Use various data types. **[Understand]**

CO2: Use control statements and functions. **[Understand]**

CO3: Analyze the arrangement of data elements in Lists and Dictionary structures. **[Analyze]**

CO4: Handle exceptions and perform file operations**. [Understand]**

CO5: Develop application using object oriented programming and GUI. **[Analyze]**

COURSE ARTICULATION MATRIX:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L		L	L		L	L			L		L	L
CO2	M	L		L	L		L	L			L		L	L
CO3	M	M	L	M	L		L	L			L		M	L
CO4	M	M	L	M	L		M	M			L		M	L
CO5	M	M	L	M	L		M	M			M	L	M	L
18IOE $22	M	M	L	M	L		M	M			L	L	M	L

L - Low, M - Moderate (Medium), H – High

18IOE$23	**BIG DATA SCIENCE** *(Common to All Branches)*

PRE-REQUISITES: NIL **Category: OE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

Upon completion of this course, the students will be familiar with,

- Big Data and its characteristics.
- Technologies used for Big Data Storage and Analysis.
- Mining larger data streams.
- Concepts related to Link analysis and handle frequent data sets.

UNIT – I : THE FUNDAMENTALS OF BIG DATA	**(9 Periods)**
Understanding Big Data-Concepts and Technology-Big Data Characteristics-Types of data-Case Study-Business Motivation and Drivers for Big Data Adoption- Planning Considerations-Enterprise Technologies and Big Data Business Intelligence- OLTP-OLAP-Extract Transform Load-Data Warehouses-Data Mart-Traditional and Big Data BI-Case Study.	
UNIT – II : BIG DATA STORAGE AND PROCESSING	**(9 Periods)**
Big Data Storage Concepts- Clusters-File systems and Distributed File Systems-NoSQL- Sharding - Replication -Sharding and Replication-CAP Theorem-ACID-BASE-Case Study- Big Data Processing Concepts- Parallel Data Processing-Distributed Data Processing-Hadoop-Processing Workloads-Cluster-Processing in Batch mode-Processing in RealTime mode-Case study	
UNIT – III : BIG DATA STORAGE AND ANALYSIS TECHNOLOGY	**(9 Periods)**
Big Data Storage Technology: On-Disk Storage devices-NoSQL Databases-In-Memory Storage Devices-Case study, Big Data Analysis Techniques: Quantitative Analysis-Qualitative Analysis-Data Mining-Statistical Analysis-Machine Learning-Semantic Analysis-Visual Analysis-Case Study.	
UNIT – IV : MINING DATA STREAMS	**(9 Periods)**
The stream data model – Sampling data streams – counting distinct elements in a stream – Estimating moments. Finding similar items – Applications of nearest neighbor search – shingling of documents - similarity preservation – locality sensitive hashing- distance measures – methods for high degree similarity.	
UNIT – V : LINK ANALYSIS AND FREQUENT ITEMSETS	**(9 Periods)**
Link analysis – Page rank – Efficient computation of a page rank – topic sensitive page rank – link spam –Frequent datasets – the market basket model – Apriori algorithm – handling larger datasets in main memory –limited pass algorithm – counting frequent items in a stream.	

Contact Periods:

Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Thomas Erl, WajidKhattak, and Paul Buhler,* ***"Big Data Fundamentals Concepts, Drivers & Techniques",*** *Prentice Hall,2015.*
2. *AnandRajaraman and Jeffrey David Ullman,* ***"Mining of Massive Datasets",*** *Cambridge University Press, 2012.*

REFERENCE BOOKS:

1. *Paul Zikopoulos, Chris Eaton, Paul Zikopoulos,* ***"Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data",*** *McGraw Hill, 2011.*
2. *Frank J Ohlhorst,* ***"Big Data Analytics: Turning Big Data into Big Money",*** *Wiley and SAS Business Series, 2012.*
3. *Bill Franks,* ***"Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics",*** *Wiley and SAS Business Series, 2012.*
4. *Paul Zikopoulos, Dirk deRoos, Krishnan Parasuraman, Thomas Deutsch , James Giles, David Corrigan,* ***"Harness the Power of Big data – The big data platform",*** *McGraw Hill, 2012.*
5. *Colleen Mccue,* ***"Data Mining and Predictive Analysis: Intelligence Gathering and Crime Analysis",*** *Elsevier, 2007*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to,

CO1: Understand the Big Data and usage in Enterprise Technologies. **[Understand]**
CO2: Store and Process Big Data using suitable Processing Methods. **[Understand]**
CO3: Handle Big Data using appropriate analysis Techniques. **[Analyze]**
CO4: Mine larger data streams using suitable algorithms. **[Understand]**
CO5: Rank pages and handle large data sets efficiently. **[Analyze]**

COURSE ARTICULATION MATRIX:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L	M	L	H	L							M	L
CO2	M				H			L				L	M	L
CO3		H			H							L	M	L
CO4	M	H	M		M							L	M	L
CO5	L	M	H									L	M	L
18IOE $23	M	H	M	L	H	L		L				L	M	L

L - Low, M - Moderate (Medium), H - High

18IOE$24	**OBJECT ORIENTED PROGRAMMING USING C++** *(Common to All Branches)*

PRE-REQUISITES: NIL **Category: OE**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

Upon completion of this course, the students will be familiar with,

- Fundamentals of object oriented programming
- Classes and objects
- Concepts of overloading and type conversions
- Inheritance and Polymorphisms
- Files, templates and exception handling

UNIT – I : PRINCIPLES OF OBJECT ORIENTED PROGRAMMING	**(9 Periods)**
Basic concepts- benefits – applications of object oriented programming – beginning with C++ - tokens – expressions and control structures – C++ stream classes – Formatted and Unformatted I/O operations. Managing output with manipulators.	
UNIT – II : CLASSES AND OBJECTS	**(9 Periods)**
Introduction – specifying class – defining member functions – memory allocation constructors and destructors - parameterized, copy, default, dynamic and multiple constructors – destructors.	
UNIT – III : FUNCTIONS AND TYPE CONVERSIONS	**(9 Periods)**
Introduction – function prototyping call by reference – return by reference – inline function – recursion – friend function – function overloading – operator overloading – manipulation of strings using operators – type conversions.	
UNIT – IV : INHERITANCE AND POLYMORPHISM	**(9 Periods)**
Defining derived classes – single, multiple, multilevel, hierarchical and hybrid inheritance – virtual base classes – abstract base classes – nesting of classes - pointers – pointers to objects – this pointer – pointers to derived classes – virtual functions – pure virtual functions virtual constructors and destructors.	
UNIT – V : FILES AND TEMPLATES	**(9 Periods)**
Classes for file stream operations – opening and closing a file – detecting EOF – open file modes – file pointers and their manipulations – sequential I/O operations – updating and error handling of file. Class and function template – template with multiple parameters – overloading, member function and non-type template arguments-Exception handling.	

Contact Periods:
Lecture: 45 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**

TEXT BOOKS:

1. *Lafort Robert,* ***"Object oriented profframming in C++",*** *4th Edition.*
2. *E.Balagurusamy,* ***"Object oriented Programming with C++",*** *McGraw Hill Education Ltd, 7th Edition 2017.*

REFERENCE BOOKS:

1. *R.Rajaram, **"Object Oriented Programming and C++",** New Age International 2nd edition, 2013.*
2. *K.R. Venugopal, Rajkumar, T. Ravishankar, **"Mastering C++",** Tata McGraw Hill Education, 2nd edition, 2013.*
3. *Yashavant P. Kanetkar, **"Let us C++",** BPB Publications, 2nd edition 2003.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to,

CO1: Understand the principles of object oriented programming. **[Understand]**
CO2: Develop programs using classes and objects. **[Analyze]**
CO3: Use functions and type conversions in programs. **[Understand]**
CO4: Apply inheritance and polymorphism to develop applications. **[Analyze]**
CO5: Use files, templates and handle exceptions. **[Understand]**

COURSE ARTICULATION MATRIX:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	H	H	M			M						M	L
CO2	M	H	H	H			M						H	L
CO3	M	H	H	H			M						H	L
CO4	M	H	H	H			M						H	L
CO5	M	H	H	H			M						H	L
18IOE $24	M	H	H	H			M						H	L

L - Low, M - Moderate (Medium), H - High

18BOE$25	**COMPUTATIONAL BIOLOGY** *(Common to All Branches)*

Category: OE

PRE-REQUISITES: NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- Understand the basic concepts and role of computation in biological analysis
- Familiarize with sequence alignment methods
- Understand the machine learning tools used for biological analysis

UNIT – I : BASICS OF BIOLOGY	**(9 Periods)**
Biomolecules of life: Structure and Composition of DNA, RNA & Protein. Protein Structure basics-Primary, Secondary and tertiary Structure of protein.	
UNIT – II : BIOLOGICAL DATABASES	**(9 Periods)**
Concept of Relational database, Data archiving, Data mining, Primary databases-NCBI, EMBL, DDBJ; Structure databases-PDB	
UNIT – III : SEQUENCE ANALYSIS	**(9 Periods)**
Pairwise alignment tools-Dot matrix analysis, Dynamic programming-Smith Waterman and Needleman Wunsch algorithm ,Heuristic methods- BLAST,FASTA; Multiple sequence alignment methods-Progressive alignment (Clustal)	
UNIT – IV : STRUCTURE ANALYSIS AND DRUG DESIGN	**(9 Periods)**
Protein secondary prediction-Chou fasman method, GOR method; Tertiary structure prediction-Homology modelling, Introduction to Computer aided drug design.	
UNIT – V : MACHINE LEARNING	**(9 Periods)**
Genetic Algorithm, Neural networks, Artificial Intelligence, Hidden markov model -application in bioinformatics	

Contact Periods:

Lecture: 45 Periods **Tutorial: 00 Periods** **Practical: 00 Periods** **Total: 45 Periods**

TEXT BOOKS:

*1.David W. Mount , **"Bioinformatics: Sequence and Genome Analysis"** , Cold Spring Harbor Laboratory Press, Second Edition, 2004*

*2. Arthur M. Lesk, **"Introduction to Bioinformatics"**, Oxford University Press, 2008.*

*3.Pierre Baldi, Soren Brunak. , **"Bioinformatics: The machine learning approach"**, MIT Press, 2001*

REFERENCE BOOKS:

*1. Andreas D. Baxevanis, **"Bioinformatics, A Practical Guide to the Analysis of Genes and Proteins"**, Third edition; Wiley-Interscience, 2004.*

*2. Baxevanis A.D. and Oullette, B.F., **"A Practical Guide to the Analysis of Genes and Proteins"**, 2nd ed., John Wiley, 2002*

*3. David L. Nelson, Michael M. Cox., **"Lehninger: Principles of Biochemistry"**, Sixth edition, Freeman, W. H. & Co. Publisher, 2012.*

COURSE OUTCOMES:

Upon completion of the course the students will be able to

CO1: Understand the basic structure of Biological macromolecules

CO2: Acquire the knowledge of biological databases and its importance.

CO3: Perform pair wise and multiple sequence alignment

CO4: Predict the secondary and tertiary structure of proteins.

CO5: Understand the machine learning approaches in computational biology

COURSE ARTICULATION MATRIX:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M	L	L		L			M				L	
CO2	M	L	L	L					L			L	L	L
CO3	L		L			M			L			L	L	
CO4	M	M	L	M	M								M	
CO5		M		H	H	M	L		M				H	H
18BOE $25	M	M	L	M	M	M	L		M			L	M	H

L - Low, M-Moderate (Medium), H- High

18BOE$26	**BIOLOGY FOR ENGINEERS** *(Common to All Branches)*

PRE-REQUISITES: NIL

Category: OE

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To understand the basic functions of the cell and their mechanisms in transport process.
- To get familiarize human anatomy and physiology.
- To learn about microbes, immune system and biomolecules.
- To know the concepts of applied biology.

UNIT – I : BASICS OF CELL BIOLOGY	**(9 Periods)**
An overview of cells – origin and evolution of cells-cell theory-classification of cells – prokaryotic cells and eukaryotic cells; Structure of prokaryotic and eukaryotic cells and their organelles-comparison of prokaryotic and eukaryotic cells; Transport across membranes – diffusion - active and passive diffusion.	
UNIT – II : BASICS OF MICROBIOLOGY	**(9 Periods)**
Classification of microorganism-microscopic examination of microorganisms; Structural organization and multiplication of bacteria-viruses-algae and fungi; Microorganism used for the production of penicillin-alcohol and vitamin B-12.	
UNIT – III : HUMAN ANATOMY AND PHYSIOLOGY	**(9 Periods)**
Basics of human anatomy-tissues of the human body-epithelial-connective-nervous and muscular; Nervous system-Respiratory System-Circulatory system and Digestive system.	
UNIT – IV : BIO MOLECULES AND IMMUNE SYSTEM	**(9 Periods)**
Introduction to Biochemistry-classification-structure and properties of carbohydrates-proteins- lipids and nucleic acids; Innate and acquired immunity; Types of immune responses.	
UNIT – V : APPLIED BIOLOGY FOR ENGINEERS	**(9 Periods)**
Overview of biosensors - glucometer applications-medicine; Microarray analysis to diagnose the cancer; Microbial production of biofuels; Applications of stem cells.	

Contact Periods:
Lecture: 45 Periods **Tutorial: 00 Periods** **Practical: 00 Periods** **Total: 45 Periods**

TEXT BOOKS:

*1. Darnell J, Lodish H, Baltimore D. **"Molecular Cell Biology"**, W.H.Freeman; 8th Edition, 2016.*

*2. Pelczar MJ, Chan ECS and Krein NR, **"Microbiology"**, Tata McGraw Hill, 5thEdition, New Delhi.2001.*

*3. Wulf Cruger and Anneliese Cruger, **"A Textbook of Industrial Microbiology"**, Panima Publishing Corporation, 2nd Edition, 2000.*

REFERENCE BOOKS:

1. *David L. Nelson and Michael M Cox, **"Lehninger's Principles of Biochemistry"**, Macmillan Worth Publisher, 4th edition, 2004.*
2. *Brain R.Eggins , **"Chemical Sensors and Biosensors"**, John Wiley & Sons, 2002.*
3. *Anton Moser, **"Bioprocess Technology, Kinetics and Reactors"**, Springer, Berlin (Verlag),1st edition, 1998*
4. *Kuby J, **"Immunology"**, WH Freeman & Co., 7th edition, 2013.*

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the functions of cell and their structural organization
CO2: Describe the mechanisms and role of cell in immune system
CO3: Get familiarized biomolecules and human anatomy system
CO4: Illustrate the applications of microbes in industrial process
CO5: Apply the engineering concepts in biology

COURSE ARTICULATION MATRIX:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	L	-	-	-	-	-	-	-	-	-	H	M
CO2	L	M	-	L	-	-	L	M	-	-	-	-	M	M
CO3	L	M	L	L	-	-	-	L	M	-	-	L	H	H
CO4	L	L	L	L	M	-	-	-	L	-	-	-	M	H
CO5	-	-	-	-	-	-	-	-	-	-	-	-	H	H
18BOE $26	L	M	L	L	M	-	L	M	M	-	-	L	H	H

L - Low, M-Moderate (Medium), H- High

18BOE$27	**FUNDAMENTALS OF BIOENGINEERING** *(Common to All Branches)*

Category: OE

PRE-REQUISITES: NIL

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To make the students aware of the overall industrial bioprocess.
- To understand the basic configuration and parts of a fermentor.
- To study the production of primary and secondary metabolites.
- To understand the production of modern biotechnology products.

UNIT I: INTRODUCTION TO INDUSTRIAL BIOPROCESS	**(9 Periods)**
Fermentation - Bacterial, Fungal and Yeast, Biochemistry of fermentation. Traditional and Modern Biotechnology - A brief survey of organisms, processes, products. Basic concepts of Upstream and Downstream processing in Bioprocess.	
UNIT II : FERMENTATION INDUSTRY	**(9 Periods)**
Overview of fermentation industry, Basic configuration of Fermentor and ancillaries, main parameters to be monitored and controlled in fermentation processes. Types of fermentation – Solid state, submerged, batch, continuous, fed batch fermentation methods.	
UNIT III : PRODUCTION OF PRIMARY METABOLITES	**(9 Periods)**
A brief outline of processes for the production of some commercially important organic acids - Citric acid, lactic acid ,acetic acid; amino acids - glutamic acid, phenylalanine; ethanol.	
UNIT IV: PRODUCTION OF SECONDARY METABOLITES	**(9 Periods)**
Study of production processes for various classes of secondary metabolites: Antibiotics: beta lactams – penicillin and cephalosporin; aminoglycosides – streptomycin; macrolides - erythromycin, vitamin - B9, B12.	
UNIT V: PRODUCTS THROUGH MODERN BIOTECHNIQUES	**(9 Periods)**
Production of industrial enzymes - proteases, amylases, lipases; Production of single cell protein from wastes; biopreservatives – Bacterosin; biopolymers - xanthan gum and PHA. Industrial uses of enzymes in detergents, beverage and food.	

Contact Periods:
Lecture: 45 Periods **Tutorial: 00 Periods** **Practical: 00 Periods** **Total: 45 Periods**

TEXT BOOKS

1. *Peter F. Stanbur., Stephen J. Hall., A. Whitake., **"Principles of Fermentation Technology"**, Science & Technology Books. 2007.*
2. *Presscott, S.C., Cecil G., Dun, **"Industrial Microbiology"**, Agrobios (India), 2005.*
3. *Casida, L.E., **"Industrial Microbiology"**, New Age International (P) Ltd, 1968.*

REFERENCE BOOK

1. *Crueger, W., Anneliese Cruege.,**"Biotechnology: A Textbook of Industrial Microbiology"**, Panima Publishing Corporation, Edition 2, 2003.*
2. *Sathyanarayana, U., **"Biotechnology"**, Books and Allied (P) Ltd. Kolkata, 2005.*
3. *Ratledge C., Kristiansen B., **"Basic Biotechnology"**, Cambridge University Press, second Edition, 2001.*
4. *Michael J. Waites., **"Industrial Microbiology: An Introduction"**, Blackwell Publishing,2001.*

COURSE OUTCOMES:

Upon completion of the course in Bioprocess Principles graduates will be able to

CO1: Understand the basics of industrial bioprocess.

CO2: Explain the principle of a fermentation process and the chronological development of fermentation industry.

CO3: Understand the basic configuration of a fermentor and its ancillaries.

CO4: Learn the production of various primary and secondary metabolites.

CO5: Understand the production of biotechnological products.

COURSE ARTICULATION MATRIX:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	H	H	-	-	-	-	-	-	-	-	-	M	-
CO2	H	M	-	-	-	-	-	-	-	-	-	-	-	-
CO3	H	H	H	M	M	M	-	L	H	-	-	-	-	H
CO4	H	L	L	-	-	L	-	L	-	-	-	-	-	H
CO5	H	M	H	L	M	-	-	L	-	-	-	-	-	H
18BOE $27	H	M	H	M	M	M	-	L	H	-	-	-	M	H

L- Low , M-Moderate(Medium), H- High

18NVA$01	MATLAB PROGRAMMING

PRE-REQUISITES: NIL

Category: VA

L	T	P	C
1	0	0	1

COURSE OBJECTIVE

* To familiarize with the main features of the MATLAB integrated design environment and its user interfaces.

UNIT - I	BASIC STRUCTURE AND FEATURES OF MATLAB	(5 Periods)
Command window, figure window; editor window and help window- arithmetic operations with scalars, order of precedence- MATLAB as a calculator, display formats, math built-in functions, scalar variables, assignment operator; predefined variables - useful commands for managing variables - applications in problem solving.		
UNIT - II	**CREATING ARRAYS**	**(5 Periods)**
One dimensional and two dimensional array addressing; built-in functions for handling arrays, mathematical operations with matrices, strings and strings as variables; generation of random numbers; examples of MATLAB applications.		
UNIT - III	**SCRIPT FILES and PLOTS**	**(5 Periods)**
Creating and saving a script file, current directory; output commands. Plot command; line specifier's plot of a given data; plot of a function; plotting multiple graphs in the same plot.		
Contact Periods **Lecture : 15 Periods Tutorial : 0 Periods Practical : 0 Periods Total : 15 Periods**		

TEXT BOOKS:

1. *Gilat Amos, **"MATLAB: An Introduction with Applications",** John Wiley & Sons, Inc (Wiley Student Edition), 2008*

REFERENCE BOOKS:

1. *Herniter, E. Marc,**"Programming in MATLAB",** Brooks/Cole, Thomson Learning*

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1: Enable how to approach for solving Engineering problems using simulation tools.

CO2: Prepare to use MATLAB in their project works.

CO3: Provide a foundation in use of this software for real time applications.

COURSE ARTICULATION MARTIX:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	H	H	H	M	L	H	H	M	M	H	H	H	H
CO2	M	L	H	H	H	M	L	H	M	H	H	M	H	H	M
CO3	L	M	H	H	H	M	L	H	M	M	M	H	H	M	H
18NVA$01	M	M	H	H	M	M	L	H	M	M	H	M	H	M	H

L- Low, M-Moderate (Medium), H-High

18NVA$02	**PCB DESIGN AND FABRICATION** *(Common to EEE & EIE Branches)*

PRE-REQUISITES: NIL **Category: VA**

L	T	P	C
1	0	0	1

COURSE OBJECTIVES:

- To acquire knowledge on Circuit board designing in assembling and testing of PCB based electronics circuits and become familiar with the simulation software

COURSE CONTENT:

1. Introduction to PCB Designing
2. Scope of PCB Designing
3. Hardware on Breadboard
4. Software Description
5. Design circuit on PCB software (Proteus, Express PCB, ARES)
6. Schematic Layout
7. Board creation
8. Fabrication Process.
9. Design of single sided PCB

Contact Periods:

Lecture: 15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods

TEXT BOOKS:

1. *R.S.Khandpur, **" Printed Circuit Boards: Design, Fabrication, Assembly and Testing",** Tata McGraw –Hill Education, 2005.*
2. *Jan Axelson, **" Making Printed Circuit Boards",** TAB Books, 1993.*

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1: Familiarize PCB Circuit Terminology

CO2: design a circuit and create a schematic Capture

CO3: Become proficient with computer for drawing Schematic and PCB Layout

CO4: To Create New part and to Fabricate a Prototype PCB

COURSE ARTICULATION MARTIX:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	H	H	L	L	M	H	H	L	H	M	H	M	H
CO2	M	M	H	H	H	M	L	H	H	M	M	H	H	H	H
CO3	M	L	H	H	H	M	L	H	M	H	H	M	H	H	M
CO4	L	M	H	H	H	M	L	H	M	M	M	H	H	M	H
18NVA$02	M	M	H	H	M	M	L	H	M	M	H	M	H	M	H

L- Low, M-Moderate (Medium), H-High

18NVA$03	CALIBRATION OF INSTRUMENTS

PRE-REQUISITES: NIL

Category: VA

L	T	P	C
1	0	0	1

COURSE OBJECTIVE

- To familiarize with the main features of the instrument Calibration.

UNIT - I
MEASUREMENT UNCERTAINTY: Background – random and systematic errors – type A and type B uncertainty – sensitivity coefficients – uncertainty evaluation. **CALIBRATION**: Introduction - meaning – objectives - necessity of calibration - basic calibration process – various components of a calibration system.
UNIT - II
STANDARDS AND STANDARDIZATION: Working standards, check standards and international standards - levels of standard accuracies, accuracy ratio between levels of calibration pyramid - Requirements of traceability - metrology standardization documents.
UNIT III
CALIBRATION TECHNIQUES: Introduction – Calibration Curve Method, Standard Additions Method, Internal Standard Method, Comparative technique - choosing calibration method – determining calibration intervals. (3) **CALIBRATION SETUPS**: Electrical calibration – Temperature calibration – Pressure and Flow calibration – demonstrations.
Contact Periods **Lecture : 15 Periods Tutorial : 0 Periods Practical : 0 Periods Total : 15 Periods**

TEXT BOOKS:

1. *Stephanie Bell,* ***"A Beginner`s Guide to Uncertainty of Measurement, Measurement Good Practice Guide No. 11 (Issue 2)",*** *National Physical Laboratory, UK, 1999.*
2. *Allan. S. Moris,* ***"Measurement and Calibration for Quality Assurance",*** *Prentice Hall, 1991.*
3. *Mike Cable,* ***"Calibration: A Technicians Guide",*** *ISA Publisher, 2005.*

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1: Have a better understanding of the technology and methods associated with verification and Calibration.

CO2: Select proper measuring instrument and know requirement of calibration, errors in measurement etc.

CO3: Expand their skills through on-the-job training, as well as practical experience gained on the plant.

COURSE ARTICULATION MARTIX:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	M	M	H	H	L	L	M	H	H	L	H	M	H	M	H
CO2	M	M	H	H	H	M	L	H	H	M	M	H	H	H	H
CO3	M	L	H	H	H	M	L	H	M	H	H	M	H	H	M
18NVA$03	M	M	H	H	M	M	L	H	M	M	H	M	H	M	H

L- Low, M-Moderate (Medium), H-High

18NVA$04	SAFETY PRACTICES AND MANAGEMENT IN PROCESS INDUSTRIES

PRE-REQUISITES: NIL

Category: VA

L	T	P	C
1	0	0	1

COURSE OBJECTIVE

- To familiarize with the main features of safety practices and management in process industries.

UNIT - I	**SAFETY AND HEALTH MANAGEMENT SYSTEM**
Key elements of a safety and Health Management System- Policy & commitment, Planning, Implementation and Operation, Measuring Performance, Auditing and Reviewing performance Initial Safety and health Management System Review, Safety and health Management System model, safety and Health policy	
UNIT - II	**RISK ASSESSMENT AND CONTROL**
Legal Basis for risk Assessment, key stages of Risk assessment and control- use trained Risk assessors, preparation and Inventory, Identify the hazards, assess the risk , identify Appropriate Action , Risk assessment records and control . A simple Risk estimation example – Hazards, remedial measures, Motivation of employees, Insurance coverage of Industrial plant & personnel.	
UNIT III	**RULES AND REGULATION OF SAFETY DEPARTMENT**
Stages in plant life and unsafe condition in factories, maintenance & safety, basics safety programming, safety department, Rules and regulation of safety department, Responsibility of management for safety in plant, safe guarding the public, Responsibility of government, social organization and public authorities. Safety activities of the ILO (International Labour Organization)	
Contact Periods	
Lecture : 15 Periods **Tutorial : 0 Periods** **Practical : 0 Periods** **Total : 15 Periods**	

REFERENCES

1. *S.P.Mahajan,* ***"Pollution control in process industries",*** *1st Edition, Tata McGraw Hill Publishing Company, New Delhi, 1993.*
2. *Krishnan N.V.* ***"Safety Management in Industry",*** *1st Edition,Jaico Publishing House, Bombay,1997.*

COURSE OUTCOMES:

Upon completion of the course, the students will be able to

CO1: Evaluate the safety performance of an organization
CO2: Gain the knowledge about the risk assessment and control
CO3: Familiarize the rules and regulations of safety department

COURSE ARTICULATION MATRIX:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO.1	L	M	L	L	-	-	-	L	M	-	-	L	L	L	M
CO 2	L	L	L	L	M	-	-	-	L	-	-	-	L	L	M
CO 3	-	-	-	-	-	-	-	-	-	-	-	-	L	H	M
18NVA$04	L	M	L	L	M	-	-	M	L	-	-	L	L	L	M

L- Low, M-Moderate (Medium), H-High