Course Scheme for Under Graduate Programme
in
Instrumentation & Control Engineering

Department of Electrical & Instrumentation Engineering

Sant Longowal Institute of Engineering & Technology
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Vision of Department

Electrical and Instrumentation Engineering Department shall strive to act as a podium for the development and transfer of technical competence in academics, entrepreneurship and research in the field of Electrical and Instrumentation Engineering to meet the changing need of society.

MISSION

1 To provide modular programmes from skill development to the research level.
2 To impart education and training in innovative state-of-the-art technology in the field of Electrical and Instrumentation Engineering.
3 To promote holistic development among the students.
4 To provide extension services to rural society, industry professionals, institutions of research and higher learning in the field of Electrical and Instrumentation Engineering.
5 To interact with the industry, educational and research organizations, and alumni in the fields of curriculum development, training and research for sustainable social development and changing needs of society.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO):

The following Programme Educational Objectives are designed based on the department mission. The graduates of Instrumentation and Control Engineering should be able to demonstrate

1 skill in professional / academic career using the knowledge of mathematical, scientific and engineering principles.
2 expertise in solving real life problems, designing innovative products and systems that are techno-economically and socially sustainable.
3 sustained learning and adaptation to modern engineering tools, techniques and practices through instruction, group activity and self-study.
4 leadership and team work while working with diverse multidisciplinary / interdisciplinary groups.
5 professional ethics and commitment to organizational goals.

PROGRAM OUTCOMES

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 modeling 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.

PROGRAM SPECIFIC OUTCOMES (PSO)

1 Understand and analyze the existing techniques for measurement, instrumentation, process control and automation in real-time problems.

2 Develop innovative solutions for measurement, instrumentation, control and automation of real- time applications by utilizing the latest technological developments.

Study Scheme for Bachelor of Engineering in Instrumentation and Control (GIN)

Semester-I Group-A (GIN)							
S. No.	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**Hrs.**	**Credits**
1	BSMA-401	Engineering Mathematics I	3	1	0	4	4
2	BSPH-401	Applied Physics	3	1	0	4	4
3	ESEE-401	Elements of Electrical Engineering	2	1	0	3	3
4	ESCS-401	Elements of Computer Engineering	2	0	0	2	2
5	ESEC-401	Elements of Electronics Engineering	2	0	0	2	2
6	BSPH-402	Applied Physics Lab	0	0	2	2	1
7	ESEE-402	Elements of Electrical Engineering Lab	0	0	2	2	1
8	ESCS-402	Elements of Computer Engineering Lab	0	0	4	4	2
9	ESEC-402	Elements of Electronics Engineering Lab	0	0	2	2	1
		Total	12	03	10	25	20
Semester-II A Group-A (GIN)							
S. No.	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**Hrs.**	**Credits**
1	BSMA-402	Engineering Mathematics II	3	1	0	4	4
2	BSCH-401	Applied Chemistry	3	1	0	4	4
3	ESME-401	Elements of Mechanical Engineering	2	1	0	3	3
4	ESME-402	Workshop Technology and Practice	1	0	0	1	1
5	HSMC-401	English Communication and Soft Skills	1	0	0	1	1
6	BSCH-402	Applied Chemistry Lab	0	0	2	2	1
7	ESME-403	Elements of Mechanical Engineering Lab	0	0	2	2	1
8	ESME-404	Engineering Drawing	0	0	4	4	2
9	ESME-405	Workshop Technology and Practice Lab	0	0	4	4	2
10	HSMC-402	English Communication and Soft Skills Lab	0	0	2	2	1
11	MCCH-401	Mandatory Course-1	3	0	0	3	0
		Total	13	03	14	30	20
Semester-II B Group-A (GIN)							
1	TPIN-421	Practical Training During Summer Vacations (In-house) 02 weeks				40	1 (S/US)
2	TPIN-422	Technical Competency				40	1 (S/US)

Semester-III Group-A (GIN)							
S. No.	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**Hrs.**	**Credits**
1	BSMA-501	Numerical and Statistical Methods	3	0	0	3	3
2	PCIE-511	Electrical Circuit Analysis and Synthesis	3	1	0	4	4
3	PCIE-512	Electronic Devices and Analog Integrated Circuits	3	1	0	4	4
4	PCIE-513	Electrical and Electronic Measurement	3	1	0	4	4
5	BSBL-501	Biology for Engineers	2	0	0	2	2
6	BSMA-502	Numerical and Statistical Methods Lab	0	0	2	2	1
7	PCIE-514	Electronic Devices and Analog Integrated Circuits Lab	0	0	2	2	1
8	PCIE-515	Electrical and Electronic Measurement Lab	0	0	2	2	1
		Total	14	03	06	23	20

	Semester-IV –A Group-A (GIN)						
S. No.	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**Hrs.**	**Credits**
1	ESME-501	Engineering Mechanics	3	1	0	4	4
2	PCIE-521	Digital Electronics	3	0	0	3	3
3	PCIE-522	Sensors and Transducers	3	1	0	4	4
4	PCIE-523	Signals and Systems	3	1	0	4	4
5	HSMC-501	Principles of Management	3	0	0	3	3
6	PCIE-524	Digital Electronics Lab	0	0	2	2	1
7	PCIE-525	Sensors and Transducers Lab	0	0	2	2	1
8	MCMH-501	Mandatory Course-2	3	0	0	3	0
		Total	18	3	4	25	20

Semester-IV-B Group-A (GIN)							
1	TPID-521	Industrial Training 02 weeks				40	1 (S/US)
2	EAA-521+	Fractional credit course/Extra Academic Activity +GROUP A/B/C				40	1 (S/US)

Semester-V-A Group-A (GIN)

S No.	Sub Code	Subject Name	L	T	P	Hrs.	Credits
1	PCIE-611	Analytical and Optical Instrumentation	3	0	0	3	3
2	PCIE-612	Control Systems	3	1	0	4	4
3	OEXX-611	Open Elective-1	3	0	0	3	3
4	OEXX-612	Open Elective-2	3	0	0	3	3
5	PEIE-611	Professional Elective-1	3	0	0	3	3
6	HSMC-601	Technical Communication	2	0	0	2	2
7	PCIE-613	Control System Lab	0	0	2	2	1
8	HSMC-602	Technical Communication Lab	0	0	2	2	1
		Total	17	1	4	22	20

Semester-V-B Group-A (GIN)

1	EAA-611+	Fractional credit course/Extra Academic Activity +GROUP A/B/C				40	1(S/US)

Semester-VI-A Group-A (GIN)

S No.	Sub Code	Subject Name	L	T	P	Hrs.	Credits
1	PCIE-621	Microprocessors and Microcontrollers	3	1	0	4	4
2	PCIE-622	Industrial Instrumentation	3	0	0	3	3
3	OEXX-621	Open Elective-3	3	0	0	3	3
4	OEXX-622	Open Elective-4	3	0	0	3	3
5	PEIE-621	Professional Elective-2	3	0	0	3	3
6	HSMC-603	Engineering Economics and Entrepreneurship	3	0	0	3	3
7	PCIE-623	Microprocessors and Microcontrollers Lab	0	0	2	2	1
		Total	18	1	2	21	20

Semester-VI-B Group-A (GIN)

1	TPID-621	Industrial Training 04 weeks				40	2 (S/US)
2	EAA-622+	Fractional credit course/Extra Academic Activity +GROUP A/B/C				40	1 (S/US)

	Semester-VII Group-A (GIN)						
S No.	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**Hrs.**	**Credits**
1	PCIE-711	Process Dynamics and Control	3	1	0	4	4
2	PCIE-712	Data Communication and Networking	3	1	0	4	4
3	PEIE-711	Professional Elective-3	3	0	0	3	3
4	PEIE-712	Professional Elective-4	3	0	0	3	3
5	OEXX-711	Open Elective-5	3	0	0	3	3
6	PCIE-713	Process Dynamic and Control Lab	0	0	2	2	1
7	PRIE-711	Project Stage I and Seminar	0	0	4	4	2
		Total	15	2	6	23	20

	Semester-VIII Group-A (GIN)						
S No.	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**Hrs.**	**Credits**
1	PEIE-721	Professional Elective-5	3	0	0	3	3
2	PEIE-722	Professional Elective-6	3	0	0	3	3
3	PRIE-721	Project Stage II	0	0	12	12	6
		Total	6	0	12	18	12

OR

S No.	**Sub Code**	**Subject Name**	**L**	**T**	**P**	**Hrs.**	**Credits**
1	INID-721	Internship in Industry				40	6
2	PRIE-721	Project Stage II	0	0	12	12	6
		Total					12

List of Mandatory Courses

1. **MCCH-401 Mandatory Course – 1:** Environmental Studies
2. **MCMH-501 Mandatory Course – 2:** Indian Constitution

List of Open Electives

LIST OF OPEN ELECTIVES							
S. No.	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**Hrs.**	**Credits**
1	**OEIE-611**	**Open Elective-I**	3	0	0	3	3
a)	OEIE-611A	~~Electrical Circuits~~	3	0	0	3	3
b)	OEIE-611B	~~Electrical Engineering Materials~~	3	0	0	3	3
c)	OEIE-611C	~~Renewable Energy Sources~~	3	0	0	3	3
d)	OEIE-611D	Optical Instrumentation	3	0	0	3	3
e)	OEIE-611E	Hydraulics and Pneumatics	3	0	0	3	3
2	**OEIE-612**	**Open Elective-II**	3	0	0	3	3
a)	OEIE-612A	~~Energy Conservation Practices~~	3	0	0	3	3
b)	OEIE-612B	~~Energy Auditing and Management~~	3	0	0	3	3
c)	OEIE-612C	~~Power Plant Engineering~~	3	0	0	3	3
d)	OEIE-612D	Virtual Instrumentation	3	0	0	3	3
e)	OEIE-612E	Nuclear Instrumentation	3	0	0	3	3
3	**OEIE-621**	**Open Elective-III**	3	0	0	3	3
a)	OEIE-621A	~~Microprocessors and Applications~~	3	0	0	3	3
b)	OEIE-621B	~~Elements of Power System~~	3	0	0	3	3
c)	OEIE-621C	Biomedical Instrumentation	3	0	0	3	3
d)	OEIE-621D	Building Automation	3	0	0	3	3
e)	OEIE-621E	Image and Video Processing	3	0	0	3	3
4	**OEIE-622**	**Open Elective-IV**	3	0	0	3	3
a)	OEIE-622A	~~Control System~~	3	0	0	3	3
b)	OEIE-622B	~~Microcontrollers and Applications~~	3	0	0	3	3
c)	OEIE-622C	Industrial Safety Engineering	3	0	0	3	3
d)	OEIE-622D	Speech and Audio Processing	3	0	0	3	3
e)	OEIE-622E	Artificial Intelligence	3	0	0	3	3
5	**OEIE-711**	**Open Elective-V**	3	0	0	3	3

a)	OEIE-711A	Signals and Systems	3	0	0	3	3
b)	OEIE-711B	Sensors and Transducers	3	0	0	3	3
c)	OEIE-711C	Introduction to Soft Computing	3	0	0	3	3
d)	OEIE-711D	Process Control	3	0	0	3	3
e)	OEIE-711E	Environmental Instrumentation	3	0	0	3	3

List of Professional Electives

List of Professional Electives							
S. No.	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**Hrs.**	**Credits**
1	**PEIE-611**	**Professional Elective-1**	3	0	0	3	3
a)	PEIE-611A	Biomedical Instrumentation	3	0	0	3	3
b)	PEIE-611B	Electrical Machines	3	0	0	3	3
c)	PEIE-611C	Industrial Safety	3	0	0	3	3
2	**PEIE-621**	**Professional Elective-2**	3	0	0	3	3
a)	PEIE-621A	Biomedical Signal and Image Processing	3	0	0	3	3
b)	PEIE-621B	Power Electronics and Drives	3	0	0	3	3
c)	PEIE-621C	Telemetry and Data Acquisition	3	0	0	3	3
3	**PEIE-711**	**Professional Elective-3**	3	0	0	3	3
a)	PEIE-711A	Wind and Solar Energy Systems	3	0	0	3	3
b)	PEIE-711B	Telemedicine and Robotic-Surgery	3	0	0	3	3
c)	PEIE-711C	Non-Linear and Optimal Control	3	0	0	3	3
4	**PEIE-712**	**Professional Elective-4**	3	0	0	3	3
a)	PEIE-712A	Digital Signal Processing	3	0	0	3	3
b)	PEIE-712B	Optimization Techniques	3	0	0	3	3
c)	PEIE-712C	Virtual Instrumentation	3	0	0	3	3
5	**PEIE-721**	**Professional Elective-5**	3	0	0	3	3
a)	PEIE-721A	Robotics	3	0	0	3	3
b)	PEIE-721B	Computer Control of Processes	3	0	0	3	3
c)	PEIE-721C	Introduction to MEMs	3	0	0	3	3
6	**PEIE-722**	**Professional Elective-6**	3	0	0	3	3
a)	PEIE-722A	Advanced Microprocessors and Microcontrollers	3	0	0	3	3
b)	PEIE-722B	Power Plant Instrumentation	3	0	0	3	3
c)	PEIE-722C	Modelling and Simulation	3	0	0	3	3

S. No.	Course Components	Curriculum content(% of total number of the credits of the program)	Total number of contact hours	Total number of credits
1	Basic Sciences	15	27	24
2	Engineering Sciences	15	33	24
3	Humanities and Social Sciences	6.875	13	11
4	Program Core	32.5	59	52
5	Program Electives	7.5	12	12
6	Open Electives	9.375	15	15
7	Project	3.75	12	6
8	Internship/Seminar/Industrial Training	8.125	204	13
9	Any other (Mandatory course and fractional credit course)	1.875	126	3
	Total number of Credits			160

List of courses for B.E (Minor) Program in Instrumentation and Control Engineering

		Semester III					
S No	Subject Code	Subject Name	L	T	P	Hrs	Credits
1	MDIE-511	Transducers and Signal Processing	3	1	0	4	4
		Semester IV					
S No	Subject Code	Subject Name	L	T	P	Hrs	Credits
1	MDIE-521	Data Acquisition System	3	1	0	4	4
		Semester V					
S No	Subject Code	Subject Name	L	T	P	Hrs	Credits
1	MDIE-611	Automatic Control System	3	1	0	4	4
		Semester VI					
S No	Subject Code	Subject Name	L	T	P	Hrs	Credits
1	MDIE-621	Industrial Measurements	3	1	0	4	4
		Semester VII					
S No	Subject Code	Subject Name	L	T	P	Hrs	Credits
1	MDIE-711	Industrial Automation	3	1	0	4	4

List of advanced level courses for B.E(Honors) in Instrumentation and Control Engineering

Semester V							
S No	Subject Code	Subject Name	L	T	P	Hrs	Credits
1	HDIE-611	Advanced Sensors	3	1	0	4	4
2	HDIE-612	Random and Stochastic Process	3	1	0	4	4
Semester VI							
S No	Subject Code	Subject Name	L	T	P	Hrs	Credits
1	HDIE-621	Wireless Sensor Networks	3	1	0	4	4
Semester VII							
S No	Subject Code	Subject Name	L	T	P	Hrs	Credits
1	HDIE-711	Internet Of Things and Its Applications	3	1	0	4	4
Semester VIII							
S No	Subject Code	Subject Name	L	T	P	Hrs	Credits
1	PHIE-721	Project Honors	0	0	8	8	4

SYLLABUS
of
Bachelor of
Instrumentation and Control Engineering

Subject Code : ESEE-401
Title of the course : Elements of Electrical Engineering

L	T	P	Credits	Weekly Load
2	1	0	3	3

Course Outcomes:
After successful completion of course, the students should be able to
CO 1: apply the knowledge of electrical engineering principles to solve DC and AC circuits.
CO 2: formulate and analyze electrical circuits.
CO 3: understand basic principles of electromagnetism to implement in electrical machines and transformers.
CO 4: identify and select various electrical machines according to the applications.
CO 5: apply the ethical principles for troubleshooting & installation of safety devices as per norms of engineering practice.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	1	1	1	2	3	2	2	3	1
CO2	3	3	2	2	1	1	1	1	2	3	2	1	3	1
CO3	3	1	2	3	1	1	1	1	2	2	2	1	3	1
CO4	3	1	2	1	1	1	1	1	2	2	2	3	3	1
CO5	2	2	3	1	1	1	1	1	2	3	3	2	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Basic elements:** Concepts of electric charge, current and electromotive force, potential and potential difference, conductor, semiconductor insulator and dielectric, electrical power and energy, basics of instruments used for measuring current, voltage, power and energy, methods and precautions in use of these and other instruments e.g. digital multimeters, oscilloscopes, signal generators, basics of various protection and safety devices: fuses, earthing, Miniature Circuit Breaker (MCB) and Earth Leakage Circuit Breaker (ELCB).	06
	Concepts of DC: Ohm's law, resistance, and color coding, capacitance and inductance, their ratings; effects of temperature on resistance, series and parallel connection of resistance, capacitances, Kirchoff's laws and applications, network theorems.	06
	AC fundamentals: Concept of alternating voltage and alternating current, difference between AC and DC, various terms related with AC waves, rms and average values, concept of phase difference and phasor, single phase and three phase supply, alternating voltage applied to pure resistance, pure inductance, pure capacitance and their combinations, concept of impedance and power in AC circuit.	06
	Three phase AC: Phasor representation of three phases, star and delta connections, inter-relation between phase and line values of voltage/current, power measurement in three phase system.	06
Unit-2	**Electromagnetic induction:** Concept of magnetic field, magnetic flux, reluctance, Magneto Motive Force (MMF), permeability, self and mutual induction, basic electromagnetic laws, effects on a conductor moving in a magnetic field, various losses in magnetic circuits.	06
	Electrical machines: Elementary concepts and classification of electrical machines, common features of rotating electrical machines, basic principle of a motor and a generator, need of starters and their classifications.	06
	Transformers: Transformer: Classification, principle of operation, construction, working and applications.	06

	Basic troubleshooting: Basic testing and faults diagnosis in electrical systems, various tools and their applications, replacement of different passive components : fuses, lamps and lamp holders, switches, cables, cable connectors, electromagnetic relays.	6

Recommended Books:

1. D P Kothari and I J Nagrath, "Basic Electrical Engineering", 3rd edition, Tata McGraw Hill Education, 2017.
2. D P Kothari and I J Nagrath, "Electric Machines", 5th edition, McGraw Hill Education, 2018.
3. E Hughes, "Electrical and Electronic Technology", 10th edition, Pearson Education, 2010.
4. S K Bhattacharya, Electrical Machines, 4th edition, Tata McGraw - Hill Education, 2014.
5. B L Theraja and A K Theraja, "ABC of Electrical Technology", S Chand, 2014

Subject Code : ESEE-402
Title of the course : Elements of Electrical Engineering Laboratory

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:
After successful completion of course, the students should be able to
CO 1: apply the knowledge of electrical engineering principles to solve dc and ac circuits.
CO 2: formulate and analyze electrical circuits.
CO 3: understand basic principles of electromagnetism to implement in electrical machines and transformers.
CO 4: identify and select various electrical machines according to the applications.
CO 5: apply the ethical principles for troubleshooting & installation of safety devices as per norms of engineering practice.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	2	1	1	1	1	3	2	2	3	1	1
CO2	3	3	1	2	1	1	1	1	3	2	2	3	2	1
CO3	3	3	1	2	1	1	1	1	3	2	3	3	2	2
CO4	3	3	1	2	1	1	1	1	3	2	3	3	3	3
CO5	3	1	1	2	1	1	1	1	2	2	3	3	2	1

To understand the practicability of Elements of Electrical Engineering, the list of experiments is given below to be performed (at least 10) in the laboratory.

1. Study of various passive components and measuring instruments and their connections in electrical circuits.
2. Verification of Ohm's Law.
3. Verification of Kirchhoff's current and voltage laws.
4. Verification of equivalent resistances in series and parallel connections.
5. Measurement of voltage, current, phase angle, power and power factor in RL, RC and RLC circuits.
6. Implementation of various types of earthing.
7. Study of various types of protection devices e.g. fuses, Miniature circuit Breaker (MCB) and Earth leakage circuit Breaker (ELCB).
8. Verification of Faraday's laws and Lenz's law.
9. To start the dc and ac motors with various types of starters.
10. Verification of turns ratio of transformer and find the efficiency.
11. Starting and reversing various ac and dc motors.
12. Fault diagnosis and removal in general electrical connection /apparatus.

Subject Code : TPIN-421
Title of the course : Practical Training (In House)

L	T	P	Credits	Load
-	-	-	1	Two weeks(80 hrs)

Course Outcomes:

After successful completion of industrial training, the students should be able to

CO 1: understand the use of various tools, components and instruments.

CO 2: implement work requiring individual and teamwork skill.

CO 3: correlate the theoretical concepts with the practical outputs.

CO 4: communicate their work effectively through writing.

CO/PO Mapping:(Strong(S) / Medium(M) / Weak(W) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	2	2	3	3	3	1	3	3	1
CO2	3	2	3	3	3	3	3	2	2	3	1	3	3	1
CO3	3	3	2	3	2	2	2	2	1	3	1	3	3	3
CO4	1	1	1	1	1	1	1	1	1	3	1	3	1	3

Objective of the programme is to

1. enrich the students with a basic understanding of the Instrumentation and Control Engineering.
2. familiarize and provide “hands on” training experience with the requisite tools, components and instruments likely to be used.
3. get students well versed with various practical aspects.
4. introduce the way of troubleshooting various engineering faults related to respective fields.
5. make the students able to present work in written, oral or formal presentation formats.

Subject Code : PCIE-511

Title of the course : Electrical Circuit Analysis and Synthesis

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

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

CO 1: be familiar with the fundamental concepts of network analysis.

CO 2: know about the network theorems and two port network descriptions.

CO 3: determine system stability using network stability criteria.

CO 4: be familiar with the fundamental concepts of synthesis of two-port passive networks.

CO 5: learn various characteristics of attenuators and filters.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	1	1	1	1	1	1	3	3	1
CO2	3	2	2	1	2	1	1	1	3	1	1	2	3	1
CO3	3	3	3	3	3	1	1	1	3	2	1	2	3	1
CO4	3	2	3	2	1	1	1	1	2	2	1	3	3	1
CO5	3	2	3	2	3	1	1	1	2	1	1	2	3	1

Unit	Main Topics and Course Outline	Hour(s)
Unit-1	**Graph theory:** Graph of a network, definitions, tree, co tree, link, basic loop and basic cut set, incidence matrix, cut set matrix, tie set matrix duality, loop and node methods of analysis.	08
	Network theorems (Applications to ac networks): Super-position theorem, Thevenin's theorem, Norton's theorem, maximum power transfer theorem, reciprocity theorem. Millman's theorem, compensation theorem, Tellegen's theorem.	06
	Network functions: Concept of complex frequency, transform impedances network functions of one port and two port networks, concept of poles and zeros, properties of driving point and transfer functions, time response and stability from pole zero plot, frequency response and Bode plots..	10
Unit-2	**Two port networks:** Characterization of LTI two port networks ZY, ABCD and h parameters, reciprocity and symmetry, inter-relationships between the parameters, inter-connections of two port networks, ladder and lattice networks. T & Π representation of networks	09
	Network synthesis: Positive real function; definition and properties; properties of LC, RC and RL driving point functions, synthesis of LC, RC and RL driving point emittance functions using Foster and Cauer first and second forms.	08
	Filters: Image parameters and characteristics impedance, passive and active filter fundamentals, low pass, high pass, band pass, band elimination filters.	07

Recommended Books:

1. A Chakrabarti, "Circuit Theory", 7th edition, Dhanpat Rai Co., 2018.
2. C K Alexander and M N O Sadiku, "Fundamentals of Electric Circuits" ,5th edition, McGraw-Hill,2013.
3. D R Choudhary, "Networks and Systems", 2nd edition, New Age International, 2013.
4. V K Aatre, "Network Theory and Filter Design", 3rd edition, New Age International, 2014.
5. A A Nimje and D P Kothari, "Electrical Circuit Analysis and Synthesis", New Age International ,2017.

Subject Code : PCIE-512
Title of the course : Electronic Devices and Analog Integrated Circuits

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

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

CO 1: be familiar with the structure of basic electronic devices.

CO 2: be exposed to the operation of electronic devices.

CO 3: implement applications of electronic devices.

CO 4: be familiar with the operational amplifier characteristics and applications.

CO 5: be familiar with the multivibrators.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1	1	2	2	1	1	2	1	1	3	1
CO2	3	3	2	3	3	2	2	1	2	2	2	2	3	1
CO3	2	3	2	2	2	2	2	1	2	2	1	2	3	1
CO4	3	2	2	2	2	2	1	2	2	2	3	1	3	1
CO5	2	3	3	3	2	2	3	1	2	2	2	2	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**PN Junction Devices:** PN junction diode: structure, operation, V-I characteristics, rectifiers: half wave and full wave rectifier, special purpose diodes: Zener diode, tunnel diode and varactor diode, photodiode, Zener diode characteristics, Zener as regulator.	08
	Bipolar Junction Transistor: Transistors-construction, operation, characteristics, parameters, transistor as an amplifier at low frequency, hybrid model and Re model of BJT, analysis of amplifier using hybrid model and re model, amplifier types-CE, CB, CC, DC operating point, biasing circuits fixed bias, emitter bias, voltage divider bias, bias stabilization.	10
	FET and MOSFET: Introduction to FET, MOSFET, their construction, operation and characteristics.	06
Unit-2	**Feedback Amplifier and Oscillators**: Feedback concept, advantages of negative feedback, voltage / current, series, shunt feedback, positive feedback, criterion for oscillations, phase shift, Wien bridge, Hartley, Colpitts and Crystal oscillators.	08
	Introduction to op-amps: Op-amp analysis, ideal op-amp building blocks, open loop op-amp configurations, practical op-amp, offset voltage, input bias and offset current, CMRR., applications of op-amps.	10
	Specialized ICs: 555 Timer-Monostable multivibrator, astable multivibrator, PLL(phase locked loop).	06

Recommended Books-

1. R L Boylested and L Nashelsky, "Electronic Devices and Circuit Theory", 11th edition Pearson, 2015.
2. A S Sedra and K C Smith, "Microelectronic Circuits: theory and Applications", 7th edition, Oxford University Press, 2017.
3. R A Gayakwad, "Op-amps and Linear Integrated Circuits", 4th edition, Pearson India, 2015.
4. M H Rashid, "Micro Electronic Circuits Analysis and Design", 2nd edition, Cengage, 2012.
5. T L Floyd, "Electron Devices", 9th edition, Pearson Asia, 2015.
6. M Jacob , CH Christos and S Jit , "Electronic Devices and Circuits" ,3rd edition, Tata McGraw-Hill,2010.

Subject Code : PCIE-513
Title of the course : Electrical and Electronic Measurement

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

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

CO 1: acquire knowledge of the characteristics of measuring instruments and their classification.

CO 2: be conversant in construction, working of measuring instruments and their proficient use.

CO 3: acquire knowledge various methods of electrical parameters measurement.

CO 4: be competent to handle various instruments for the measurement of electrical quantities.

CO 5: demonstrate Cathode Ray Oscilloscope (CRO) as signal generator and analyzer.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	1	2	1	1	1	1	1	1	3	1
CO2	3	3	3	2	2	2	2	1	2	2	2	1	3	1
CO3	2	3	3	2	2	2	2	1	1	1	1	1	3	1
CO4	2	1	2	2	2	2	2	2	2	2	2	2	3	1
CO5	2	1	2	2	2	2	1	2	2	2	2	1	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Analog instruments:** Analog instruments, classification of analog instruments, principles of operation, operating forces, constructional details of PMMC (Permanent Magnet Moving Coil), moving iron, electrodynamometer and electrostatic types of instruments, ohmmeters-series and shunt type, rectifier type instruments, advantages, disadvantages and their comparison, extension of instrument range.	06
	Measurement of power and energy: Power in AC and DC circuits, electrodynamometer wattmeter, measurement of power in single and three phase circuits, power factor measurement, energy meter for AC circuits, single phase induction type watt hour meter, poly phase energy meters.	06
	Instrument transformer: Introduction, current and potential transformer, relationships, characteristics, constructional details, reduction of errors and their comparison, AC and DC current probes.	06
	Bridges and potentiometer: Wheatstone bridge, measurements of resistance, general form of ac bridge, measurement of self-inductance, capacitance, mutual inductance and frequency, sources of error and their minimization, potentiometer (AC and DC).	06
Unit-2	**Electronic measurements:** Introduction, electronic voltmeter, VIVM (vacuum tube voltmeter) Transistor voltmeter, BJT, (bipolar junction transistor) FET (Field Effect Transistor) and MOSFET (Metal-Oxide Semiconductor FET) voltmeters, electronic multi- meters, vector voltmeter, vector impedance meter, current measurements using electronic instruments, LCR meter.	06
	Cathode ray oscilloscope: Introduction, CRO block diagram, CRT (Cathode Ray Tube) circuits and observation of waveform on CRO, measurement of voltage, current, phase and frequency.	06

	Instruments for generation and analysis of waveforms: Signal generators, function generator, wave analyzer, harmonic distortion analyzer, spectrum analyzer, spectrum analysis, Q-Meter.	06
	Frequency and time interval measurement: Frequency measurement, period measurement, errors in measurement, universal counters and extension of the range of counters, Synchroscope.	06

Recommended Books-

1. A K Sawhney, "A Course on Electrical and Electronic Measurements and Instrumentation", Dhanpat Rai, 2016.
2. D A Bell, "Electronic Instrumentation and Measurement", 3rd edition, Oxford University Press, 2013.
3. J B Gupta, "A Course in Electronic and Electrical Measurements and Instrumentation", S K Kataria and Sons, 2012.
4. H S Kalsi, "Electronic Instrumentation", 3rd edition, Tata McGraw Hill, 2017.
5. C S Rangan, G R Sharma and V S Mani, "Instrumentation Devices and Systems", 2nd edition ,Tata McGraw Hill, 2017.

Subject Code : PCIE-514

Title of the course : Electronic Devices and Analog Integrated Circuits Lab

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:

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

CO 1: acquire knowledge of the characteristics of Junction Diode, Zener Diode, BJT.

CO 2: able to do the proficient use of semiconductor devices.

CO 3: acquire knowledge of working of oscillators.

CO 4: be competent to design circuits for various applications of Op-amp.

CO 5: able to develop multivibrators.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcome(PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	3	2	2	2	3	1	3	1	3	2
CO2	3	2	3	2	3	2	3	1	3	2	3	1	3	1
CO3	2	2	3	2	2	2	2	1	3	2	3	1	3	1
CO4	2	2	3	2	2	2	3	2	2	2	3	2	3	1
CO5	3	2	3	2	2	2	3	2	2	2	3	2	3	1

To understand the practicability of Electronic Devices and Analog Integrated Circuits**,** the list of experiments is given below to be performed (at least 10) in the laboratory.

1. To study the characteristics of PN junction diode.
2. To study the characteristics of Zener diode
3. To design the circuit of half wave rectifier.
4. To design the circuit of full wave rectifier.
5. To design a circuit showing the working of BJT as a switch.
6. To plot a load line for a CE amplifier and show effect of input signal on Q-point.
7. To demonstrate use of a BJT in a CE amplifier circuit configuration and study its frequency response.
8. To demonstrate working of a Wein Bridge Oscillator.
9. To design a circuit for Op-amp working as differentiator.
10. To design a circuit for Op-amp working as integrator.
11. To design a circuit for Op-amp working as a square wave generator.
12. To design a circuit for Op-amp working as a comparator.
13. To design a circuit for monostable multivibrator using 555 timers.
14. To design a circuit for astable multivibrator using 555 timers.

Subject Code : PCIE-515

Title of the course : Electrical and Electronic Measurement Lab

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:

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

CO 1: acquire knowledge of the characteristics of measuring instruments and their classification.

CO 2: be conversant in construction, working of measuring instruments and their proficient use.

CO 3: acquire knowledge various methods of electrical parameters measurement.

CO 4: be competent to handle various instruments for the measurement of electrical quantities.

CO 5: demonstrate Cathode Ray Oscilloscope (CRO) and signal generator and analyzer.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	3	2	1	2	1	1	2	1	3	2
CO2	3	3	3	2	3	2	2	2	1	2	2	1	3	2
CO3	2	3	3	2	2	2	2	1	1	1	2	2	3	2
CO4	2	2	3	2	2	2	3	2	2	2	2	2	3	2
CO5	2	3	3	3	2	1	1	1	2	2	2	2	3	2

To understand the practicability of Electrical and Electronic Measurements, the list of experiments is given below to be performed (at least 10) in the laboratory.

1. Study of principle of operation of various types of electromechanical measuring instruments.
2. a) To measure high value of DC current by a low range DC ammeter and shunt.
   b) To measure high value of DC voltage by a low range DC voltmeter and multiplier
3. a) To measure high value of AC current by a low range AC ammeter and current transformer.
   b) To measure high value of AC voltage by low range voltmeter and potential transformer measurement of resistance using Wheatstone bridge.
4. To measure active and reactive power in 3 phase balanced load by one wattmeter method.
5. To measure the active power in three phase balanced and unbalanced load by two wattmeter method and observe the effect of power factor variation on wattmeter reading.
6. To calibrate and use the induction energy meter.
7. Measurement of resistance using Kelvin's bridge.
8. Measurement of self-inductance using Anderson's bridge.
9. Measurement of capacitance using Schering bridge.
10. Plotting of hysteresis loop for a magnetic material using flux meter.
11. Measurement of frequency using Wein's bridge.
12. To study the connections and use of current and potential transformers and to find out ratio error.
13. Determination of frequency and phase angle using CRO.
14. Measurement of unknown voltage using potentiometer.
15. To find 'Q' of an inductance coil and verify its value using Q- meter.
16. Calibration of AC voltmeter and AC ammeter.
17. Measurement of form factor of a rectified sine wave and determine source of error if r.m.s. value is measured by a multi-meter.

Subject Code : PCIE-521
Title of the course : Digital Electronics

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: exercise various number systems, binary operation and error correction.

CO 2: interpret Boolean algebra, encoders, decoders and code conversion.

CO 3: know about working of latch, flip-flops, registers, counters and their types.

CO 4: be conversant in basics of VHDL and design sequential circuit using VHDL.

CO 5: know about digital ICs, logic families, memories and programmable logic arrays.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSO)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	1	1	1	1	2	3	2	2	3	1
CO2	3	3	2	2	1	1	2	2	2	3	3	3	3	1
CO3	3	3	3	2	1	1	2	1	3	3	1	3	3	1
CO4	3	3	3	2	2	1	2	2	3	3	1	3	3	1
CO5	3	3	3	2	2	1	2	1	3	3	1	2	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Number system & codes:** Review of number systems, binary number systems, octal number system, hexadecimal number system, signed & unsigned numbers, 1‘s & 2‘s complement of a number, different types of codes & their conversions, binary operations- addition, subtraction, multiplication, division.	08
	Combinational logic: Concept of positive & negative logic, introduction to Boolean variables, logical functions using Karnaugh map &Quine-Macluskey methods, multiplexers, demultiplexers, encoders, decoders, adders, subtractors, parity generators, parity checkers, code converter.	08
	Sequential logic concepts and components: Flip flops - SR, JK, D and T flip flops level triggering and edge triggering, shift registers, type of registers, circuit diagrams, synchronous& asynchronous counters, excitation tables, design with state equation state diagram counters, up & down counters, ring counters & mod, counters. Introduction to finite state machines.	08
Unit-2	**Introduction to VHDL:** Overview of digital design with Very-High-Speed Integrated Circuits (VHSIC), VHSIC Hardware Description Language (VHDL), HDL format and syntax, entity, data representation in VHDL, truth table using VHDL, decision control structure and sequential circuit using VHDL.	08
	Digital logic families: Introduction, characteristics of digital ICs, integrated injection logic, direct coupled transistor, transistor-transistor logic, emitter coupled logic, MOS & CMOS logic, and high threshold logic families.	08
	Semiconductor memories and Programmable logic devices.: Introduction, memory organization, classification & characteristics of memories, sequential memories, read only memories, read & write memories, content addressable memories, programmable array logic and programmable logic arrays, complex programmable logic devices (CPLDS), field programmable gate array (FPGA).	08

Recommended Books-

1. T L Floyd, "Digital Fundamentals", 11th edition, Pearson Education, 2017.
2. R P Jain, "Modern digital Electronics", 4th edition, Tata McGraw Hill, 2009.
3. A Kumar, "Fundamentals of Digital Circuits", 4th edition, Prentice Hall of India, 2016.
4. D P Leach, A P Malvino and G Saha, "Digital Principles and Applications", 8th edition, Tata McGraw Hill, 2014.
5. M Mano, "Digital Logic and Computer Design", Pearson, 2016.
6. R J Tocci, N S Widmer, G L Moss., "Digital Systems", 12th edition, Pearson, 2018.
7. D P Kothari and J S Dhillon , "Digital Circuit and Design", Pearson, 2015.

Subject Code : PCIE-522

Title of the course : Sensors and Transducers

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

After successful completion of course, the students will be

CO 1: exposed to various sensors and transducers for measuring mechanical quantities.
CO 2: familiar with the specifications of sensors and transducers.
CO 3: able to design signal conditioning circuits for various sensors and transducers.
CO 4: exposed to advancements in sensor technology.
CO 5: able to identify or use a transducer for a specific measurement application.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSO)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	2	2	2	1	1	2	1	3	1
CO2	3	2	3	2	3	2	2	2	1	1	2	1	3	1
CO3	2	3	3	3	2	2	3	2	2	1	3	2	3	1
CO4	2	3	3	3	2	2	3	3	2	2	3	2	3	1
CO5	3	3	3	2	3	3	2	2	3	2	2	2	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**General concepts:** Terminology of measurement systems, transducer, its classification, general input-output configuration, static and dynamic characteristics of a measurement system, statistical analysis of measurement data.	12
	Resistive transducers: Potentiometers, metal and semiconductor strain gauges and signal conditioning circuits, strain gauge applications: load and torque measurement, digital displacement sensors.	12
Unit-2	**Inductive transducers:** Self and mutual inductance, capacitive transducers, eddy current transducers, proximity sensors, tacho-generators and stroboscope.	08
	Piezoelectric transducers: Their signal conditioning, seismic transducer and its dynamic response, photoelectric transducers, Hall effect sensors, magnetostrictive transducers.	08
	Introduction to semiconductor sensor: Materials, scaling issues and basics of micro fabrication, smart sensors.	08

Recommended Books-

1. D A Bell, "Electronic Instrumentation and measurement", 3rd edition, Oxford University Press,2013.
2. J B Gupta, "A Course in Electronic and Electrical Measurements & Instrumentation", S K Kataria and Sons,2014.
3. S M Sze, "Semiconductors sensors", John Wiley & Sons Inc.,2008.
4. D Patranabis, "Sensors and Transducers", Prentice Hall, 2nd edition, 2003.
5. D C Nakra and K K Chaudhary, "Instrumentation measurement and analysis",4th edition, Tata McGraw Hill, 2016.
6. A K Sawhney , "A course on electrical and electronic measurements and Instrumentation", Dhanpat Rai, 2016.

Subject Code : PCIE-523
Title of the course : Signals and Systems

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:
After successful completion of course, the students should be able to
CO 1: interpret signals, convolution and learn various properties.
CO 2: to gain knowledge to reduce noise, interference and their reduction methods.
CO 3: be conversant in Fourier series, Fourier transform along with their basic properties
CO 4: analyze sampling, restructuring, sampling theorem, aliasing, digital signal processing.
CO 5: study Laplace and Z-transform, their basic properties, region of convergence, inverse Laplace and Z-transform, rational system functions.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	2	2	2	1	1	2	1	3	1
CO2	3	2	3	2	3	2	2	2	1	1	2	1	3	1
CO3	2	3	3	3	2	2	3	2	2	1	3	2	3	1
CO4	2	3	3	3	2	2	3	3	2	2	3	2	3	1
CO5	3	3	3	2	3	3	2	2	3	2	2	2	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction to Signals and Systems:** Introduction to signals and systems, system properties, convolution of signals, linear shift invariant systems and their properties, correlation, effects of noise and interference on the measurement system, noise sources and coupling mechanism, method of reducing effects, reliability , choice and economics of the measurement system.	12
	Introduction to transforms: Introduction to transforms, Fourier series and Fourier transform, convergence of Fourier transform, properties of Fourier transform.	12
Unit-2	**Sampling and reconstruction of the signal:** Sampling theorem, sampling/reconstruction of signals, realistic sampling, aliasing, introduction to digital signal processing, advantages and disadvantages of digital signal processing over analog signal processing.	12
	Laplace and Z-transforms: Introduction to Laplace transform and Z-transform, region of convergence, properties of Laplace and Z transform, inverse Laplace and Z transforms, rational system functions.	12

Recommended Books:

1. AV Oppenheim, A S Willsky and S H Nawab, "Signals and Systems", Pearson,2nd edition, 2015.
2. J G Proakis and D G Manolakis, "Digital Signal Processing: Principles, Algorithms, and Applications", 4th edition, Pearson, 2007.
3. H P Hsu, "Signals and Systems", Schaum's series, 2nd edition, Tata McGraw Hill Education, 2017.
4. S Haykin and B V Veen, "Signals and Systems", 2nd edition, John Wiley and Sons, 2007.
5. E W Kamen and B Heck, "Fundamentals of Signals and Systems",3rd edition, Pearson Education, 2006.

Subject Code : PCIE-524
Title of the course : Digital Electronics Lab

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:

After successful completion of course, the students should be able to
CO 1: exercise and verify truth tables of TTL gates, universal gates.
CO 2: design and verify truth tables of Half and Full adder, subtractor circuits.
CO 3: verify truth tables of Multiplexers 74150 and De multiplexer 74154.
CO 4: design and verify truth tables of S-R (NOR/NAND gates based), J-K and D flip flops.
CO 5: operate counters and design 4-bit shift register, modulo-4 counter using J K flip flops.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	2	2	2	1	1	2	1	3	1
CO2	3	2	3	2	3	2	2	2	1	1	2	1	3	1
CO3	2	3	3	3	2	2	3	2	2	1	3	2	3	1
CO4	2	3	3	3	2	2	3	3	2	2	3	2	3	1
CO5	3	3	3	2	3	3	2	2	3	2	2	2	3	1

To understand the practicability of Digital Electronics, the list of experiments is given below to be performed (at least 10) in the laboratory.

1. Verification of the truth tables of TTL gates.
2. Verify the NAND and NOR gates as universal logic gates.
3. Design and verification of the truth tables of half and full adder circuits.
4. Design and verification of the truth tables of half and full subtractor circuits.
5. Verification of the truth table of the multiplexer 74150.
6. Verification of the truth table of the de-multiplexer 74154.
7. Design and test of an S-R flip-flop using NOR/NAND gates.
8. Verify the truth table of a J-K flip-flop (7476).
9. Verify the truth table of a D flip-flop (7474).
10. Operate the counters 7490, 7493.
11. Design of 4-bit shift register (shift right).
12. Design of modulo-4 counter using J K flip flop.

Subject Code : PCIE-525
Title of the course : Sensors and Transducers Lab.

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:

After successful completion of course, the students should be able to
CO 1: know about the basic principles of various transducers.
CO 2: impart knowledge in static and dynamic characteristics of sensors.
CO 3: the design of signal conditioning circuits for transducers.
CO 4: differentiate between ideal and real characteristics of transducers.
CO 5: handle loading effects.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	2	2	2	1	1	2	1	3	1
CO2	3	2	3	2	3	2	2	2	1	1	2	1	3	1
CO3	2	3	3	3	2	2	3	2	2	1	3	2	3	1
CO4	2	3	3	3	2	2	3	3	2	2	3	2	3	1
CO5	3	3	3	2	3	3	2	2	3	2	2	2	3	1

To understand the practicability of Sensors and Transducers, the list of experiments is given below to be performed in the laboratory.

1. Characteristics of (resistive and thermo emf) temperature sensor.
2. Measurement of displacement using LVDT.
3. Characteristics of piezoelectric measurement system.
4. Characteristics of Hall effect sensor.
5. Measurement of strain using strain gauges.
6. Measurement of torque using strain gauges.
7. Measurement using proximity sensors.
8. Characteristics of capacitive measurement systems.
9. Loading effects of potentiometer.
10. Design of Opto-coupler using photoelectric transducers.
11. Characteristics of micro pressure and micro accelerometer sensing device.
12. Study of speed measuring devices and gyroscope.

Subject Code : TPID-521
Title of the course : Industrial Training

L	T	P	Credits	Load
-	-	-	1	(02 Weeks)80hrs

Course Outcomes:

After successful completion of industrial training, the students should be able to

CO 1: implement the project requiring individual and teamwork skills.

CO 2: correlate the theoretical concepts with the real life industrial environment.

CO 3: gather and analyze the scientific information.

CO 4: communicate their work effectively through writing and presentation.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	2	2	3	3	3	1	3	3	1
CO2	3	2	3	3	3	3	3	2	2	3	1	3	3	1
CO3	3	3	2	3	2	2	2	2	1	3	1	3	3	3
CO4	1	1	1	1	1	1	1	1	1	3	1	3	1	3

Objective of the programme is to

1. enrich the students with a basic understanding of the Instrumentation Engineering, towards developing a holistic perspective to understand various practical issues and latest trends in the field.
2. familiarize and provide “hands on” training experience with the requisite simulation, design, and analytical tools and techniques.
3. achieve a long-term goal of transforming themselves into a brilliant blend of theoretician and practicing engineer.
4. introduce the way of troubleshooting various engineering faults related to respective fields.
5. make the students able to present work in written, oral or formal presentation formats.

Subject Code : PCIE-611
Title of the Course : Analytical and Optical Instrumentation

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: differentiate between analytical and other measuring instruments and apply concept of sampling.

CO 2: apply the principle of spectrometry and chromatography in industrial application.

CO 3: learn the concept of electron microscopy, SEM and TEM and their applications.

CO 4: demonstrate the application of potentiometry and gas analyzer.

CO 5: know about the data presentation and statistical analysis of analytical instruments.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	3	2	2	1	1	2	1	1	3	1
CO2	3	2	1	2	2	3	1	2	2	2	2	1	3	1
CO3	3	2	2	2	2	2	1	2	1	1	1	2	3	1
CO4	3	1	1	2	2	2	1	1	2	2	2	1	3	1
CO5	3	3	2	2	1	2	1	1	1	2	1	2	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction:** Difference between analytical and other instruments, sampling, sampling system for liquids and gases, sampling components, automatic and faithful sampling. Summarization of International and National standards related to this course.	06
	Spectrometry: Electromagnetic radiation, radiation sources, optical sources and detectors, Beer's Lamberts law, UV, IR and Visible spectrophotometer, flame photometer, atomic absorption spectrometer: basic principle, block diagram and related instrumentation, basic principle, block diagram and related instrumentation of X-ray analyzers, NMR spectrometry, mass spectrometry and its types.	12
	Chromatography: Basic principle and types of chromatography, block diagram and related instrumentation of gas and liquid chromatography.	06
Unit-2	**Electron microscopy:** Introduction, types of electron microscopy: Scanning electron microscope (SEM) and Transmission Electron Microscopy (TEM), difference between optical microscopy, SEM and TEM.	06
	Gas analyzer: Types: paramagnetic oxygen analyzer, IR gas analyzer, thermal conductive gas analyzer, analyzer based on gas density.	06
	Potentiometry: Electro chemical cell, Ion sensitive Electrodes, Solid state sensors, gas sensing electrode, bio catalytic membrane electrode.	06
	Data presentation and analysis: Analytical data presentation, error analysis.	06

Recommended Books:

1. R S Khandpur, "Handbook of Analytical Instruments", 3rd edition, McGraw-Hill Education, 2015.
2. R P Khare, "Analysis Instrumentation: An Introduction", CBS Publisher, 2019.
3. D Patranabis, "Principles of Industrial Instrumentation", 2nd edition, Tata McGraw-Hill Education, 2001.
4. H H Willard., L L Jr. Merritt, J A Dean and F A Jr. Settle, "Instrumental Methods of Analysis", 7th edition, CBS Publishers, 2004.
5. B G Liptak, "Analytical Instrumentation," CRC Press ,1994.

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Subject Code : PCIE-612
Title of the course : Control Systems

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

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

CO 1: acquire the basic knowledge of control engineering.
CO 2: analyze the mathematical model of a system and determine the response of different order systems for standard input inputs.
CO 3: do steady state and transient analysis of a system for standard input inputs.
CO 4: analyze the stability analysis of a system.
CO 5: be competent to design compensating networks.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSO)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	2	3	1	3	2	2	2	3	1
CO2	3	3	2	3	3	3	2	1	2	1	3	1	3	1
CO3	3	2	3	2	2	2	3	2	3	3	2	2	3	1
CO4	2	2	2	2	3	3	2	3	2	3	3	1	3	1
CO5	3	3	3	2	2	2	2	2	3	3	1	2	3	1

Unit	Main Topics and Course Outline	Hour(s)
Unit-1	**Introductory concept:** Plant, systems, servomechanism, regulating systems, disturbances, open loop control system, closed loop control system, linear and non-linear systems, time variant and invariant, continuous and sampled-data control systems, concept of feedback, block diagrams.	08
	Modelling: Formulation of equation of linear electrical, mechanical, thermal, pneumatic and hydraulic system, electrical mechanical analogies, transfer function, concept of state variable modelling, block diagram representation, block diagram simplification for linear systems, signal flow graphs, Mason gain rules.	08
	Time domain analysis: Typical test-input signals, transient and steady state response of the first order systems, second order systems and higher order systems, transient response analysis, steady state error and coefficients, pole zero location and stability, Routh-Hurwitz criterion.	08
Unit -2	**Root locus analysis:** Introduction, general rules for constructing Root Loci, root-locus plots, positive feedback systems, conditionally stable systems, root loci for systems with transport lag.	06
	Frequency domain analysis: Introduction, Bode diagrams, plotting Bode diagrams, polar plots, drawing Nyquist plots, log-magnitude- versus-phase plots, Nyquist stability criterion, stability analysis, relative stability, closed-loop frequency response of unity-feedback systems.	06

	Introduction to Compensation: Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness of control systems, root-loci method of feedback controller design, design specifications in frequency domain, frequency domain methods of design, application of proportional, integral and derivative controllers, lead and lag compensation in designs, necessity of compensation, series and parallel compensation.	06
	State variable Analysis: Concepts of state variables, state space model, diagonalization of state matrix, solution of state equations, eigenvalues and stability analysis, concept of controllability and observability. Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	06

Recommended Books –

1. B C Kuo, "Automatic Control System", 9th edition, Wiley, 2014.
2. J J Distefano, A R Stuberud and I J Williams, "Schaum's Outlines of Theory and Problems of Feedback and Control Systems", 2nd edition, Tata McGraw Hill,2007.
3. I J Nagrath and M Gopal, "Control System Engineering", 6th edition, New Age International Publishers, 2017.
4. K Ogata, "Modern Control Engineering", 5th edition, Pearson Education India, 2015.
5. R C Dorf and RH Bishop, "Modern Control System", 12th edition, Pearson Education India, 2013.

6.

Subject Code : PCIE-613

Title of the course : Control Systems Lab

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:

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

CO 1: acquire the basic knowledge of control engineering.

CO 2: analyze the mathematical model of a system and determine the response of different order systems for standard input inputs.

CO 3: solve the steady state and transient analysis of a system for standard input inputs.

CO 4: analyze the stability analysis of a system.

CO 5: be competent to analyze closed loop control design problems and design compensating networks.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSO)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	2	3	1	3	2	2	2	3	1
CO2	3	3	2	3	3	3	2	1	2	1	3	1	3	1
CO3	3	2	3	2	2	2	3	2	3	3	2	2	3	1
CO4	2	2	2	2	3	3	2	3	2	3	3	1	3	1
CO5	3	3	3	2	2	2	2	2	3	3	1	2	3	1

To understand the practicability of Control Engineering, the list of experiments is given below to be performed (at least 10) in the laboratory

1. To determine response of first order and second order systems for step input for various values of constant 'K' using linear simulator unit and compare theoretical and practical results.
2. To analyze P, PI and PID temperature controller for an oven and compare their performance.
3. To study and calibrate temperature using resistance temperature detector (RTD)
4. To design Lag, Lead and Lag-Lead compensators using Bode plot.
5. To study DC position control system
6. To test synchro-transmitter and receiver and obtain output V/S input characteristics
7. To determine speed-torque characteristics of an AC servomotor.
8. To analyze performance of servo voltage stabilizer at various loads using load bank.
9. To study behavior of separately excited dc motor in open loop and closed loop conditions at various loads.
10. To test PID Controller for simulation proves like transportation lag.
11. To determine time domain response of a second order system for step input and obtain performance parameters.
12. To convert transfer function of a system into state space form and vice-versa.
13. To plot root locus diagram of an open loop, transfer function and determine range of gain 'k' for stability.
14. To plot a Bode diagram of an open loop transfer function.
15. To draw a Nyquist plot of an open loop transfer functions and examine the stability of the closed loop system.

Subject Code : PCIE-621

Title of the course : Microprocessors and Microcontrollers

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

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

CO 1: acquire the knowledge about history, architecture of 8, 16, 32 & 64-bit Microprocessor.

CO 2: know about 8085 microprocessor, architecture and timing diagrams.

CO 3: develop the programming applications of microprocessors.

CO 4: interfacing of peripheral devices with 8085.

CO 5: be conversant in 8051 microcontrollers, its architecture and program.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSO)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	3	2	1	1	1	1	3	2	3	1
CO2	3	3	3	2	1	1	1	1	2	2	2	2	3	1
CO3	3	3	2	3	2	1	1	1	1	2	3	2	3	1
CO4	3	2	3	2	1	1	1	2	1	2	1	2	3	1
CO5	3	2	3	2	3	3	2	2	2	3	2	3	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction to microprocessors:** Types of computers, microprocessor evolution and types, CPU operation and terminology, idea of 8- bit, 16-bit, 32-bit and 64- bit microprocessors from Intel, Motorola and Zilog and their comparisons.	08
	Introduction to 8-bit microprocessor: 8085 microprocessor architecture and pin diagram of 8085, ALU timing and control unit, registers, data and address bus, timing and control signals, fetch and execute operations, instruction format, addressing techniques, classification of instructions instruction and data flow, system timing diagram, transition state diagram, system configuration for 8085.	08
	The 8085 Programming: Instruction types, classification of instructions, addressing modes, instruction format, over view of instruction set, writing assembly language programs, data manipulations, fixed point arithmetic, data conversion, sorting numeric data, look-up table and time delays, concepts of stack, interrupts, interrupt service subroutine.	08
Unit-2	**Interfacing Memory with 8085:** Memory interfacing, I/O interfacing – memory mapped and peripheral mapped I/O, data transfer schemes, programmed, interrupt driven and Direct memory Access (DMA) data transfers, block diagram representation, control word formats, modes.	08
	Peripheral Devices: Interfacing of 8255A PPI, 8251 USART, 8254 programmable interval timer, 8259A programmable interrupt controller and 8279 with 8085, block diagram representation, control word formats, modes, simple programs.	08
	Introduction to Embedded Systems: The 8051 architecture, introduction, 8051 micro-controller hardware, input/ output, pins, ports and circuits, external memory, counters and timers, serial data input/ output, interrupts. Projects related to this course should be given to students (in groups) in order to promote team work and ethical values.	08

Recommended Books-

1. B Ram., "Fundamentals of Microprocessors and Microcontrollers", Dhanpat Rai Publications, 2012.
2. B B Bray, "The INTEL Microprocessors 8086/88, 80186, 286, 386, 486, Pentium Pro Processors, Architecture, Programming and Interfacing", 8th edition, Pearson education India,2008.
3. D V Hall, "Microprocessors and its Interfacing", 3rd edition, McGraw Hill Education, 2017.
4. R Gaonkar,"Microprocessor Architecture, Programming and Applications with the 8085",6th edition Penram International,2013.
5. A K Ray and K Bhurchandi, "Advanced Microprocessors and Peripherals",3rd edition, McGraw Hill Education,2017.
6. K J Ayala, "The 8051 Microcontroller-Architecture, Programming and Application",2nd edition, Penram International,2007.
7. M Mahalakshmi, "8051 Microcontroller Architecture, Programming and Application", Laxmi Publications, 2012.
8. M A Mazidi and J G Mazidi , "The 8051 Micro-controller & Embedded System", 2nd edition, Pearson Education, 2008.

Subject Code : PCIE-622
Title of the course : Industrial Instrumentation

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: acquire the knowledge of purpose and scope of instrumentation in Industrial processes.

CO 2: become competent to handle different types of temperature measuring instruments like thermistor, thermocouple etc. and their application in various Industrial processes.

CO 3: become conversant in construction and working various pressure measuring instruments.

CO 4: become conversant in construction and working various flow and level measurement devices used for industrial purposes.

CO 5: know about the calibration of various industrial instruments.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	3	3	3	2	2	2	2	2	3	1
CO2	2	3	2	3	3	3	3	2	2	1	2	1	3	1
CO3	3	3	3	2	3	2	2	2	2	2	1	2	3	1
CO4	3	2	2	2	3	2	2	2	2	1	2	2	3	1
CO5	3	3	3	2	2	3	3	3	1	2	1	2	3	1

Unit	Main Topics and Course Outline	Hour(s)
Unit-1	**Temperature measurement:** Temperature scale and conversion, principle of vapour, gas, liquid filled thermometers, bimetallic thermometer, pressure spring thermometer, thermocouple and its configuration, extension wires, resistance temperature detector & compensation techniques, thermistor, pyrometry, Stefan Boltzmann's law, black body radiation, optical radiation pyrometers, radiation thermometers, pneumatic and electrical temperature transmitters, digital thermometers. Summarization of International and National standards related to this course.	12
	Pressure measurement: Introduction to static and dynamic pressure, differential pressure elements, U tube manometer, inclined manometer, ring balanced type manometer, elastic transducers like ordinary and diaphragm, bourdon tube, bellows, capsules, differential pressure transducers, pneumatic and electrical pressure transmitters, pressure switches and strain gauge pressure pickups, methods for measurement of vacuum Pirani gauge, Mclead gauge, Knudsen gauge, very high pressure measurement, calibration of pressure instruments.	12
Unit-2	**Measurement of flow rate:** Classification of fluid flow, variable head meters for incompressible and compressible, Differential pressure meter (primary elements)-theory, construction and applications of orifice plate, venturimeter, flow nozzle, pitot tube, Dall tube, variable area type flow meters, pressure taps, manometers, differential pressure measurement magnetic meter, turbine meter, vortex meter, mass flow meter. Ultrasonic Meter, thermal flow meter, positive displacement meters, calibration of flow meters.	12
	Field Measurements: Level measurement: float type level indication, differential pressure method, electrical type level gauges using resistive and capacitive probes and ultrasonic level sensor, other variables measurement**:** mass, weight, force, torque and shaft power measurement.	12

	Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	

Recommended Books-

1. B G Liptak, "Instrument Engineers Handbook", Vol- 1, 4th edition, CRC Press, 2003.
2. D Patranabis, "Principles of Industrial Instrumentation", 3rd edition, McGraw-Hill, 2010.
3. E O Doebelin and D N Manik "Measurement Systems: Application and Design", 6th edition, McGraw-Hill, 2017.
4. R. K. Jain, "Mechanical and Industrial Measurements", 12th edition, Khanna Publishers, 2013.
5. C S Rangan, G R Sharma and V S Mani, "Instrumentation Devices and Systems", 2nd edition, Tata McGraw Hill,2017.

Subject Code : PCIE-623
Title of the course : Microprocessors and Microcontrollers Lab.

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:
After successful completion of course, the students should be able to
CO 1: create program for addition, subtraction of numbers in decimal, hexadecimal and BCD system.
CO 2: write program to perform multiplication, division of 8-bit numbers, obtain largest, smallest number from an array and arrange data in ascending, descending order.
CO 3: write a program to convert hexadecimal number into ASCII number and vice versa.
CO 4: develop a program to initiate and check transmission, reception of 8251, interfacing of 8253 timer and verify operation of 8253 in six modes.
CO 5: create interfacing of DAC with 8085 for generation of square, saw tooth and triangular waves, implement serial communication through RS-232 C port.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	3	2	1	1	1	1	3	2	3	1
CO2	3	3	3	2	1	1	1	1	2	2	2	2	3	2
CO3	3	3	2	3	2	1	1	1	1	2	3	2	3	2
CO4	3	2	3	2	1	1	1	1	1	2	1	2	3	2
CO5	3	2	3	2	3	3	2	2	2	3	2	3	3	2

To understand the practicability of Microprocessor and Microcontrollers, the list of experiments is given below to be performed in the laboratory:

1. Write a program using 8085 microprocessor for decimal, hexadecimal addition and subtraction of two numbers.
2. Write a program using 8085 microprocessor for addition and subtraction of two BCD numbers.
3. To perform multiplication and division of two 8-bit numbers using 8085.
4. To find the largest and smallest number in an array of data using 8085 instruction set.
5. To write a program to arrange an array of data in ascending and descending order.
6. To convert given hexadecimal number into its equivalent ASCII number and vice versa using 8085instruction set.
7. To write a program to initiate 8251 and to check the transmission and reception of character.
8. To interface 8253 programmable interval timer to 8085 and verify the operation of 8253 in six different modes.
9. To interface DAC with 8085 to demonstrate the generation of square, saw tooth and triangular wave.
10. Serial communication between two 8085 through RS-232 C port.

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Subject Code : TPID-621
Title of the course : Industrial Training

L	T	P	Credits	Load
-	-	-	2	4 weeks(160 hrs)

Course Outcomes:

After successful completion of industrial training, the students should be able to

CO 1: implement the project requiring individual and teamwork skills.

CO 2: correlate the theoretical concepts with the real-life industrial environment.

CO 3: gather and analyze the scientific information.

CO 4: communicate their work effectively through writing and presentation.

CO/PO Mapping:(Strong(S) / Medium(M) / Weak(W) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	2	2	3	3	3	1	3	3	1
CO2	3	2	3	3	3	3	3	2	2	3	1	3	3	1
CO3	3	3	2	3	2	2	2	2	1	3	1	3	3	3
CO4	1	1	1	1	1	1	1	1	1	3	1	3	1	3

Objective of the programme is to

1. enrich the students with a basic understanding of the Instrumentation and Control Engineering, towards developing a holistic perspective to understand various practical issues and latest trends in the field.
2. familiarize and provide “hands on” training experience with the requisite simulation, design, and analytical tools and technique.
3. achieve a long-term goal of transforming themselves into a brilliant blend of theoretician and practicing engineer.
4. introduce the way of troubleshooting various engineering faults related to respective fields.
5. make the students able to present work in written, oral or formal presentation formats.

6.

Subject Code : PCIE-711
Title of the course : Process Dynamics and Control

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

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

CO 1: analyze and formulate mathematical model of process element.

CO 2: design closed loop system with various types of controllers.

CO 3: demonstrate the working of various control valves and their selection criteria.

CO 4: understand the operation and tuning of Proportional (P), Integral (I), Derivative (D), and composite mode of controllers.

CO 5: acquire knowledge of feedback, feed forward, ratio, cascade control configurations and industrial Safety.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	1	2	1	3	1	1	2	2	3	1
CO2	3	3	3	3	1	2	1	1	1	1	2	3	3	1
CO3	3	3	3	3	2	2	1	1	2	1	2	3	3	1
CO4	3	3	2	3	3	2	1	2	1	1	2	3	3	1
CO5	3	2	2	3	2	2	1	1	1	1	2	3	3	1

Unit	Main Topics and Course Outline	Hour(s)
Unit-1	**Introduction to process control:** Introduction, basic components, process control block diagram, mechanical, process variables, introduction to the modelling of the various liquid, gaseous and thermal elements, examples like tank level control, heat exchanger control, mixing process control, distillation control etc. Summarization of International and National standards related to this course	06
	Controller principles: Continuous and discontinuous controller modes, two position mode, multi position mode, floating control mode, proportional, integral and derivative control mode and composite controller modes, PI, PD, and PID, criterions and method for the tuning of controllers.	10
	Final control: Final control operation, signal conversion (analog and digital electrical signals),actuators (electrical, pneumatic and hydraulic), control valve classification and types, selection criteria for control valves.	08
Unit-2	**Multiple loop control schemes:** On-off controllers, cascade and feed forward controllers, split range controllers, ratio controls, single loop, multi loop and self-tuning controllers, Set point control (SPC), Direct digital control (DDC).	06
	Controller hardware: Electronic, pneumatic and hydraulic controller's implementation, single and composite modes of controllers.	06
	Multi-loop interaction: Introduction, features and examples of MIMO Process, design of cross controllers, relative gain array and selection of control loop.	06
	Industrial safety: Fire prevention and control, handling of fire accidents, electrical safety, environmental safety, various safety equipment and their constructional features, maintenance and repair of safety equipment, safety in high pressure operations, safety management, safety provisions in the factory act, laws related to the industrial safety, measurement of safety performance, safety audit.	06

	Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	

Recommended Books-

1. G Stephanopoulos, "Chemical Process Control", Pearson Education, 2015.
2. S Bhanot, "Process Control: Principles and Applications", Oxford University Press, 2008.
3. K Kant, "Computer- Based Industrial Control", 2nd edition, Prentice Hall India, 2010.
4. C D Johnson, "Process Control Instrumentation Technology", 8th edition, Pearson Education,2015.
5. B G Liptak, "Process Control: Instrument Engineer,' Handbook", 3rd edition, Butterworth Heinemann, 1995.
6. B W Bequette, "Process Control: Modeling, Design and Simulation", Prentice Hall, 2003.
7. D E Seaborg, D A Mellichamp and T F Edgar, "Process Dynamics and Control", 3rd edition, John Wiley & Sons, 2010.
8. F G Shinskey, "Process Control Systems: Application, Design and Tuning", 4th edition, McGraw Hill Higher Education, 1996.
9. G K Mcmillan and D M Considine, "Process/Industrial Instruments and Controls Handbook", 5th edition, McGraw Hill Professional, 1999.
10. P Harriott, "Process Control", McGraw Hill Education, 2001.

Subject Code : PCIE-712
Title of the course : Data Communication and Networking

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:
After successful completion of course, the students should be able to
CO 1: analyze data communication networks, internet protocols, standards, layered tasks & addressing.
CO 2: design wireless sensor networks for a given application.
CO 3: know about emerging research areas in the field of sensor networks.
CO 4: know about internet of things and its hardware and software components.
CO 5: interface I/O devices, sensors & communication modules.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	3	2	2	3	3	3	3	3	3	3
CO2	3	3	2	2	2	2	3	3	2	3	3	3	3	3
CO3	2	3	3	3	2	3	3	2	3	3	3	3	3	3
CO4	3	3	2	2	3	3	2	2	2	3	2	2	3	3
CO5	2	3	2	2	3	2	2	2	1	2	2	3	3	3

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction and network models:** An Introduction to data communication and networks, internet, Protocols and standards, layered tasks, Open System Interconnection (OSI) model, layers in OSI model, Transmission Control Protocol / Internet Protocol (TCP/IP protocol) suite, addressing. Summarization of International and National standards related to this course.	08
	Description of seven layers: Description of various OSI seven layers, data link control, multiple access, Ethernet, wireless LAN-IEEE 802.11, Bluetooth, need for the network layer, IPv4 and IPv6 addresses, process to process delivery, user datagram protocol (UDP), electronic mail and file transfer, www and http.	08
	WSN (Wireless Sensor Networks): Networks, unique constraints and challenges, advantage of sensor networks, types of WSN, Mobile Ad-hoc Networks (MANETs) and wireless sensor networks, enabling technologies for WSN, issues and challenges in WSN.	08
Unit-2	**Routing and dissemination protocols**: MAC protocols: classification of MAC protocols, dissemination protocol for large sensor network, quality of a sensor network; real-time traffic support and security protocols, WSN to internet communication, and internet to WSN communication.	12
	Introduction to Internet of Things: Overview of internet of things- the edge, cloud and the application development, anatomy of the thing, industrial internet of things (IoT - Industry 4.0), real time diagnostics, design and development for IoT, understanding system design for IoT, design model for IoT. Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	12

Recommended Books-

1. D E Comer, " Internet working with TCP/IP volume 1", 6th edition,Pearson Education India , 2015.
2. W Dargie , C Poellabauer, "Fundamentals of Wireless Sensor Networks Theory and Practice", Wiley, 2014.
3. S Soloman, "Sensors Handbook" 2nd edition, McGraw Hill Education, 2010.
4. L Darnell, "The Internet of Things (A Look at Real World Use Cases and Concerns)", Kindle Edition, 2016.
5. J Biron and J Follett, "Foundational Elements of an IoT Solution – The Edge, The Cloud and Application Development", O'Reilly Media, Inc.,2016.

Subject Code : PCIE-713
Title of the course : Process Dynamics and Control Lab

L	T	P	Credits	Weekly Load
0	0	2	1	2

Course Outcomes:
After successful completion of course, the students should be able to
CO 1: design proportional (P), proportional plus integral (PI). proportional plus derivative (PD) and proportional plus integral plus derivative (PID) controller.
CO 2: to perform tuning of P, PI, PID controller and analyze pressure transmitter.
CO 3: demonstrate the working of feedback control and I/P converter.
CO 4: analyze operation of feedback temperature and feedback pressure control system.
CO 5: analyze characteristics of ratio, cascade and feed forward control.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	2	1	3	1	1	2	2	3	1
CO2	3	3	3	3	1	1	1	1	1	1	2	3	3	1
CO3	3	1	3	3	2	2	1	1	2	1	2	3	3	1
CO4	3	1	2	2	3	3	1	2	1	1	2	3	3	1
CO5	3	2	2	2	2	2	1	1	1	1	2	3	3	1

To understand the practicability of Process Dynamics and Control, the list of experiments is given below to be performed (at least 10) in the laboratory.

1. Design of proportional controller.
2. Design of proportional plus integral controller.
3. Design of proportional plus derivative controller.
4. Design of proportional plus integral plus derivative controller
5. Characteristics of feed-back control.
6. Study of I/P Converter output to control valve displacement.
7. Study of feedback pressure control plant with DCS panel.
8. Study of feedback temperature control system.
9. Tuning of P controller.
10. Tuning of PI controller.
11. Tuning of PID controller.
12. Study of pressure transmitter.
13. Characteristics of ratio control.
14. Characteristics of cascade control.
15. Characteristics of feed-forward control.

Subject Code : PRIE-711
Title of the course : Project Stage I and Seminar

L	T	P	Credits	Weekly Load
0	0	4	2	4

Course Outcomes:

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

CO 1: communicate their work effectively through writing and presentation.
CO 2: use research based knowledge in the latest area of technology.
CO 3: engage in independent and life-long learning.
CO 4: implement the project requiring individual and teamwork skills.
CO 5: carry out design calculations and implementations in the area of project.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	1	1	1	1	1	1	3	1	3	1	3
CO2	3	3	2	3	2	2	2	2	1	3	3	3	3	3
CO3	2	2	2	2	2	2	2	3	3	2	2	3	3	3
CO4	3	2	2	2	2	2	2	3	3	3	1	3	3	1
CO5	3	2	3	3	3	3	3	2	2	3	1	3	3	1

Objectives of the programme is to

1. familiarize the students with the outside professional environment.
2. make the students able to use the resources for the given problem/assignment.
3. update the students with modern trends of Instrumentation and control engineering.
4. develop own opinions, particularly on issues, based on critical and reasonable approach to the information available.
5. make the students able to present work in written, oral or formal presentation formats.

Subject Code : INID-721
Title of the course : Internship in Industry

L	T	P	Credits	Load
-	-	-	6	4 months(640 hrs)

Course Outcomes:

After successful completion of industrial training, the students should be able to

CO 1: correlate the theoretical concepts with the real-life industrial environment.

CO 2: implement strategies like time management, multi-tasking in an industrial setup.

CO 3: gather and analyze the scientific information.

CO 4: communicate their work effectively through writing and presentation.

CO/PO Mapping:(Strong(S) / Medium(M) / Weak(W) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	3	3	3	3	2	2	3	1	3	3	1
CO2	3	2	2	2	2	2	2	3	3	3	1	3	3	1
CO3	3	3	2	3	2	2	2	2	1	3	1	3	3	3
CO4	1	1	1	1	1	1	1	1	1	3	1	3	1	3

Objective of the programme is to

1. provide possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job.
2. familiarize and provide “hands on” training experience with the requisite simulation, design, and analytical tools and technique.
3. achieve a long-term goal of transforming themselves into a brilliant blend of theoretician and practicing engineer.
4. understand the social, economic and administrative considerations that influence the working environment of industrial organizations.
5. make the students able to present work in written, oral or formal presentation formats.

Subject Code : PRIE-721

Title of the course : Project Stage II

L	T	P	Credits	Weekly Load
0	0	12	6	12

Course Outcomes:

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

CO 1: implement the project requiring individual and teamwork skills.

CO 2: update recent knowledge in the area of project.

CO 3: carry out design calculations and implementations in the area of project.

CO 4: communicate their work effectively through writing and presentation.

CO 5: handle professional responsibilities and respect for ethics.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	2	2	3	3	3	1	3	3	1
CO2	3	3	2	3	2	2	2	2	1	3	3	3	3	3
CO3	3	2	3	3	3	3	3	2	2	3	1	3	3	1
CO4	1	1	1	1	1	1	1	1	1	3	1	3	1	3
CO5	2	2	2	2	2	2	2	3	3	2	2	3	3	3

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

The assignment normally includes:

1. survey and study of published literature on the assigned topic.
2. working out a preliminary approach to the problem relating to the assigned topic.
3. conducting preliminary analysis/modelling/simulation/experiment/design/feasibility.
4. preparing a written report on the study conducted for presentation to the department.
5. final seminar, as oral presentation before a departmental committee including external expert.

Subject Code : OEIE-611A
Title of the course : Electrical Circuits

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:
After successful completion of course, the students should be able to
CO1: apply network theorems for the analysis of electrical circuits.
CO2: obtain the transient and steady-state response of electrical circuits.
CO3: analyze circuits in the sinusoidal steady-state (single-phase and three-phase).
CO4: analyze two port circuit behavior.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	2	2	1	1	1	2	2	3	2
CO2	3	2	2	2	2	2	1	2	1	2	2	1	3	2
CO3	3	3	2	2	1	2	2	2	2	1	1	2	3	2
CO4	2	2	1	1	3	2	2	1	1	1	2	2	3	3

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Network theorems:** Superposition theorem, Thevenin theorem, Norton theorem, maximum power transfer theorem, reciprocity theorem, compensation theorem, analysis with dependent current and voltage sources, node and mesh analysis, concept of duality and dual networks.	08
	Solution of first and second order networks: Solution of first and second order differential equations for series and parallel R-L, R-C, RLC circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient state response.	08
	Sinusoidal steady state analysis: Representation of sine function as rotating phasor, phasor diagrams, impedances and admittances, AC circuit analysis, effective, RMS values, average power and complex power, three-phase circuits, mutual coupled circuits, dot convention in coupled circuits, ideal transformer.	08
Unit-2	**Electrical circuit analysis using Laplace transforms:** Review of Laplace transform, analysis of electrical circuits using Laplace transform for standard inputs, convolution integral, inverse Laplace transform, transformed network with initial conditions, transfer function representation, poles and zeros, frequency response (magnitude and phase plots), series and parallel resonances.	12
	Two Port network and network functions: Two port networks, terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections of two port networks. Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	12

Recommended Books:

1. M E Van Valkenburg and T S Rathore, "Network Analysis", 3rd edition, Pearson Education, 2019.
2. D R Choudhury, "Networks and Systems", 2nd edition, New Age International,2013.
3. C K Alexander and M N O Sadiku, "Fundamentals of Electric Circuits", 5th edition, McGraw Hill Education,2013.
4. A Chakrabarti, "Circuit Theory Analysis and Synthesis", 7th edition, Dhanpat Rai and Co., 2018.
5. V K Aatre, "Network Theory and Filter Design", 3rd edition, New Age International, 2014.
6. A A Nimje and D P Kothari, "Electrical Circuit Analysis and Synthesis", New Age International ,2017.
7. W H Hayt, J E Kemmerly and S M Durbin, "Engineering Circuit Analysis", 9th edition, McGraw Hill Education, 2018.

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Subject Code : OEIE-611B
Title of the course : Electrical Engineering Materials

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:
After successful completion of course, the students should be able to
CO 1: acquire an in depth knowledge about the conducting materials.
CO 2: acquire of knowledge of properties of dielectric and insulator materials.
CO 3: understand the selection of magnetic materials for electrical devices.
CO 4: recognize the material for economically and eco-friendly fabrication of electrical equipment.
CO 5: acquire the knowledge of materials for special applications in electrical equipment.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	1	2	3	1	1	1	1	3	3	1
CO2	2	1	1	1	1	2	3	1	1	1	1	3	3	1
CO3	2	1	1	1	1	2	3	1	1	1	1	3	3	1
CO4	2	1	1	1	1	2	3	1	1	1	1	3	3	1
CO5	2	1	1	1	1	2	3	1	1	1	1	3	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Conducting materials:** Review of metallic conduction on the basis of free electron theory. Fermi-Dirac distribution, variation of conductivity with temperature and composition, materials for electric resistors, general electric properties; material for brushes of electrical machines, lamp filaments, fuses and solder.	08
	Insulating materials: Inorganic materials (mica, glass, porcelain, asbestos), organic materials (paper, rubber, cotton silk fiber, wood, plastics and Bakelite), resins and varnishes, liquid insulators (transformer oil) gaseous insulators (air, SF6 and nitrogen) and ageing of insulators.	08
	Dielectric: Dielectric, polarization under static fields- electronic ionic and dipolar polarizations, behavior of dielectrics in alternating fields, factors influencing dielectric strength and capacitor materials, insulating materials, complex dielectric constant, dipolar relaxation and dielectric loss.	08
Unit-2	**Magnetic materials**: Classification of magnetic materials, origin of permanent magnetic dipoles, ferromagnetism, hard and soft magnetic materials, magneto materials used in electrical machines, instruments and relays.	08
	Semiconductors magnetic materials: Mechanism of conduction in semiconductors, density of carriers in intrinsic semiconductors, the energy gap, types of semiconductors. Hall effect, compound semiconductors, basic ideas of amorphous and organic semiconductors.	08
	Materials for special applications: Materials for solar cells, fuel cells and battery. materials for coatings for enhanced solar thermal energy collection and solar selective coatings, cold mirror coatings, heat mirror coatings, antireflection coatings, sintered alloys for breaker and switch contacts.	08

Recommended Books-

1. S O Kasap and S Kasap, "Principles of electrical engineering materials and devices" McGraw Hill College, 2000.
2. B P Pokharel and N R Karki, " Electrical Engineering Materials", Alpha Science International, 2007.
3. C S Indulkar and S Thiruvengadam, "An Introduction to Electrical Engineering Materials", 4th edition, S. Chand, and Company, 2006.
4. R K Shukla and A Singh, "Electrical Engineering Materials", McGraw Hill, 2014.
5. G K Banerjee, "Electrical and Electronics Engineering material", Prentice Hall India,2014.

Subject Code : OEIE-611C
Title of the course : Renewable Energy Resources

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO1: acquire knowledge on fundamentals of solar energy and its storage methods.
CO2: study the methods of collection of solar energy.
CO3: analyze the performance characteristics of wind energy.
CO4: understand and demonstrate the principles of various renewable energy resources.
CO5: apply various energy harvesting techniques.

CO/PO Mapping:(Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2	3	2	2	3	3	3	2	3	1
CO2	3	2	2	2	2	3	2	2	3	2	3	1	3	1
CO3	3	3	3	2	2	2	2	2	2	1	2	2	3	1
CO4	3	2	2	2	2	2	3	2	2	2	2	2	3	1
CO5	3	2	2	2	2	2	2	2	3	2	2	1	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Principles of Solar Radiation:** Role and potential of new and renewable source, the solar energy option, environmental impact of solar power, physics of the sun, the solar constant, extra-terrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data.	08
	Solar Energy Collection: Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.	06
	Solar Energy Storage and Applications: Different methods, sensible, latent heat and stratified storage, solar ponds. solar applications- solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion.	06
	Wind Energy: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria.	04
Unit-2	**Bio-Mass:** Principles of bio-conversion, anaerobic/aerobic digestion, types of bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C. engine operation and economic aspects.	10
	Geothermal Energy: Resources, types of wells, methods of harnessing the energy, potential in India.	06
	Ocean Energy: OTEC, principles utilization, setting of OTEC plants, thermodynamic cycles. tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics.	08

Recommended Books-

1. D P Kothari, K C Singal and R Rajan, "Renewable Energy Sources and Emerging Technologies", 2nd edition, Prentice Hall India,2011.
2. G.D Rai, "Non-Conventional Energy Sources", Khanna Publishers, 2004.
3. S N Singh, "Non-Conventional Energy Resources", Pearson Education India,2015
4. J Twidell and T Wier, "Renewable Energy Resources", 3rd edition, CRC Press (Taylor & Francis),2015.
5. G N Tiwari and M K Ghosal, "Fundamental of Renewable Energy Resources", Alpha Science International, 2007.
6. S P Sukhatme and J K Nayak, "Solar Energy",4th edition, McGraw Hill Education,2017.

Subject Code : OEIE-611D

Title of the course : Optical Instrumentation

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: explain the basics of optical sources and detectors.
CO 2: impart knowledge on optical fiber and fiber optic sensors.
CO 3: impart knowledge on the characteristics of optical sources and detectors.
CO 4: understand the transmission characteristics of optical fiber channel.
CO 5: give some industrial applications of fiber optic sensors and lasers.

CO/PO Mapping:(Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	2	1	2	1	1	3	1	2	3	1
CO2	3	2	3	3	3	3	3	2	3	2	3	3	3	3
CO3	3	2	1	2	2	1	2	1	2	3	1	2	3	2
CO4	3	3	3	3	3	3	3	3	3	2	3	3	3	3
CO5	3	2	3	3	3	3	3	2	3	2	3	3	3	3

Theory

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction:** Characteristics of optical radiation, luminescence.	06
	Optoelectronic sources: LED – LED power and efficiency, structures- planar, dome, ELED, SLED, super luminescent LEDS, characteristics and applications. LASERS – structures- gain guided and index guided lasers, types- semiconductor- homo and hetero junction lasers. Non-semiconductor lasers - gas, liquid and solid. Single frequency Lasers, characteristics, Q switching and mode locking, cavity dumping.	10
	Optoelectronic detectors: General characteristics of photodetectors, Photodiode, junction photodiodes – heterojunction diode and PIN diode, APD, Special detectors- Schottky barrier diode, photo- transistor and photo-thyristor, solar cells.	08
Unit-2	**Optical fibre:** Fundamentals, types, transmission characteristics. Fibres splicing, connector and couplers. optocouplers and optrodes.	04
	Industrial applications of fibre-optic sensors: measurement of temperature, pressure, flow and level.	08
	Industrial applications of LASERS: measurement of distance, length, velocity, acceleration, current and voltage. **Other applications of Laser:** Material processing like Laser heating, melting, scribing, splicing, welding and trimming of materials, removal and vaporization, calculation of power requirements. Laser gyroscope.	12

Recommended Books

1. Djafar K. Mynbaev, Lowell.L.Scheiner, " Fiber-Optic Communications Technology", Pearson Education Pte. Ltd., 1st Edition, 2008.
2. R. P. Khare, " Fibre Optics and Optoelectronics", Oxford Press, 1st Edition, 2004.
3. John M. Senior, "Optical Fiber Communication", Pearson Education, 3rd Edition, 2009.
4. Wilson and Hawkes, "Opto Electronics - An Introduction", Prentice Hall, New Delhi, 3rd Edition, 2003.
5. Bhattacharya P, "Semiconductor Optoelectronics", Prentice Hall, New Delhi, 2nd Edition, 2002.
6. Culshaw B. and Dakin J.(Eds.), "Optical Fibre Sensors Vol I, II and III", Artech House, 1989.
7. Fukuda, "Optical Semiconductor Devices", John Wiley, 1st Edition, 2005.
8. Kasap, "Optoelectronics and Photonics: Principles and practices", Pearson Education, 2nd Edition 2012.

Subject Code : OEIE-611E

Title of the course : Hydraulics and Pneumatics

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: acquire knowledge about working of hydraulic and pneumatic systems. **CO 2:** identify the controlling components of hydraulic and pneumatic systems. **CO 3:** select and prepare a distribution system for compressed air.
CO 4: compile the design of hydraulic and pneumatic systems and analyze them.
CO 5: demonstrate the need of pressure and time dependent controls.

CO/PO Mapping:(Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	2	1	2	1	1	3	1	2	3	1
CO2	3	2	3	3	3	3	3	2	3	2	3	3	3	3
CO3	3	2	1	2	2	1	2	1	2	3	1	2	3	2
CO4	3	3	3	3	3	3	3	3	3	2	3	3	3	3
CO5	3	2	3	3	3	3	3	2	3	2	3	3	3	3

Theory

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction to Hydraulic Power:** Pascal's law and problems on Pascal's Law, continuity equations, Introduction to conversion of units, Structure of Hydraulic Control System. The Source of Hydraulic Power: Pumps Pumping theory, pump classification, gear pumps, vane pumps, piston pumps, pump performance, pump selection. Variable displacement pumps. Hydraulic Actuators: Linear Hydraulic Actuators (cylinders), Mechanics of Hydraulic Cylinder loading.	08
	Hydraulic Motors: Hydraulic Rotary Actuators, Gear motors, vane motors, piston motors, Hydraulic motor theoretical torque, power and flow rate, hydraulic motor performance. Control Components in Hydraulic Systems: Directional Control Valves – Symbolic representation, Constructional features, pressure control valves – direct and pilot operated types, flow control valves.	08
	Hydraulic Circuit Design and Analysis: Control of single and double – acting hydraulic cylinder, regenerative circuit, pump unloading circuit, counter balance valve application, hydraulic cylinder sequencing circuits. Cylinder synchronizing circuits, speed control of hydraulic cylinder, speed control of hydraulic motors, Accumulators. Maintenance of Hydraulic Systems: Hydraulic oils; desirable properties, general type of fluids, sealing devices, reservoir system, filters and strainers, problem caused by gases in hydraulic fluids, wear of moving parts due to solid particle contamination, temperature control, trouble shooting.	08
Unit- 2	**Introduction to Pneumatic Control:** Choice of working medium, characteristics of compressed air. Structure of pneumatic control system. Compressed air: Production of compressed air – compressors, preparation of compressed air- Driers, filters, regulators, lubricators, distribution of compressed air. Pneumatic Actuators: Linear cylinders – types, conventional type of cylinder working, end position cushioning, seals, mounting arrangements applications.	12

	Directional Control Valves: Symbolic representation as per ISO 1219 and ISO 5599. Design and constructional aspects, poppet valves, slide valves spool valve, suspended seat type slide valve. Simple pneumatic control: Direct and indirect actuation pneumatic cylinders, use of memory valve. Flow control valves and speed control of cylinders supply air throttling and exhaust air throttling, use of quick exhaust valve. Signal Processing Elements: Use of Logic gates – OR and AND gates pneumatic applications, practical examples involving the use of logic gates, Pressure dependent controls: types construction, practical applications, time dependent controls: principle, construction, practical applications.	12

Recommended Books-

1. Anthony Esposito, "Fluid Power with applications", Pearson education, Inc., 5th Edition, 2000.
2. Andrew Parr, "Pneumatics and Hydraulics", Jaico Publishing Co. 2000.
3. Dr. Niranjan Murthy and Dr. R. K. Hegde, "Hydraulics and Pneumatics", Sapna Publications, 2013.
4. Majumdar S.R., "Oil Hydraulics Systems - Principles and Maintenance", Tata McGraw-Hill, 2001.
5. Majumdar, S.R., "Pneumatic Systems – Principles and Maintenance", Tata McGraw Hill, 2007.
6. Srinivasan. R, "Hydraulic and Pneumatic Control", Tata McGraw - Hill Education, 2nd Edition, 2012.
7. Shanmugasundaram K, "Hydraulic and Pneumatic controls", Chand & Co, 2006.

Subject Code : OEIE-612A
Title of the course : Energy Conservation and Practice

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:
After successful completion of course, the students should be able to
CO1: acquire an in depth knowledge about the energy management and auditing.
CO2: recognize how energy can be conserved and managed in industries.
CO3: acquire a comprehensive idea on tariffs in transmission &distribution systems.
CO4: be conversant in utilization and effects of energy on environment.
CO5: be competent to handle the energy auditing procedure.

CO/PO Mapping:(Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
Cos	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	2	2	1	1	2	1	1	2	2	1
CO2	3	3	2	2	1	3	1	2	3	2	1	3	3	2
CO3	2	3	2	3	3	3	1	2	3	2	1	3	3	2
CO4	3	3	2	2	2	3	1	2	3	2	2	3	3	3
CO5	3	3	2	1	1	3	1	2	2	1	2	2	2	2

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Energy Conservation:** Introduction, principles of energy conservation, motivation for energy conservation, energy conservation planning, energy conservation in industries, energy conservation in electrical generation, transmission and distribution, energy conservation in household and commercial sectors, energy conservation in transport, energy conservation in agriculture, energy conservation legislation.	08
	Energy efficiency in electrical utilities: Electrical system, motor, harmonics, diesel generator, centrifugal pumps, fans and blowers, air compressor, lighting system, energy consumption and energy saving potentials, design considerations.	08
	Energy efficiency in thermal utilities: Steam engineering in thermal plants, steam traps and various energy conservation measures; boilers: losses and efficiency calculation methods, controls, furnaces: heat balance in furnaces, furnace efficiency calculations, energy conservation opportunities in furnaces, insulation and refractories.	08
Unit-2	**Cogeneration:** Definition and scope, topping and bottoming cycles, benefits, industries suitable for cogeneration, agricultural uses of waste heat, use of power plant reject heat for waste water treatment, integrated energy system, potential of cogeneration in India.	08
	Energy and Sustainable Development: Introduction, energy problems, energy use trends in developing countries, prospects of changes in energy supply, agenda for sustainable development.	08
	Environmental Aspects of Electric Energy Generation: Environment and its quality, man's right to modify environment, energy and environment, air pollution, stack emissions, cooling tower impacts, aquatic impacts, nuclear plant impacts, hydro-plant impacts, social and economic impacts.	08

Recommended Books-

1. C B Smith and K E Parmenter, "Energy Management Principles: Applications Benefits Savings", 2nd edition, Elsevier,2015.
2. S Doty and W C Turner, "Energy Management Handbook",8th edition, Fairmont, 2012.
3. C L Wadhwa, "Generation Distribution and Utilization of Electrical Energy",4th edition, New Age International,2017.
4. S S Thipse "Energy Conservation and Management", Narosa ,2014.
5. G Thomson, "Environment energy and Sustainable Development", Syrawood, 2016.

Subject Code : OEIE-612B
Title of the course : Energy Auditing and Management

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:
After successful completion of course, the students should be able to
CO1: acquire an in depth knowledge about the energy management and auditing
CO2: recognize how energy can be conserved and managed in industries.
CO3: acquire a comprehensive idea on tariffs in transmission and distribution systems.
CO4: be conversant in utilization and effects of energy on environment.
CO5: be competent to handle the energy auditing procedure.

CO/PO Mapping:(Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	1	2	1	1	2	1	2	3	2	1
CO2	3	2	2	1	3	3	2	1	2	1	3	3	3	1
CO3	2	1	2	1	2	3	2	2	2	2	3	3	3	1
CO4	3	2	2	2	2	3	3	3	2	1	3	3	3	1
CO5	3	3	3	1	3	3	2	2	3	2	3	2	2	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Energy audit methodology and recent trends:** General philosophy, need of energy audit, economics of implementation of energy optimization projects, it's constraints, barriers and limitations, report-writing, preparations and presentations of energy audit reports, post monitoring of energy conservation projects, MIS, case-studies / report studies of energy audits, guidelines for writing energy audit report, data presentation in report, findings recommendations, impact of renewable energy on energy audit recommendations, energy cost and recent electricity board tariffs, energy conservation by improving load factor, power factor, demand factor, plant utilization factor. Summarization of International and National standards related to this course.	12
	System audit of utilities: Boilers: performance evaluation, loss analysis, water treatment and its impact on boiler losses, furnaces, its types and classifications, applications, pumps, its types and application, unit's assessment, energy saving in pumps & pumping systems, energy saving in compressors & compressed air systems, cooling towers, its types and performance assessment & limitations. **Energy audit instruments:** Instruments for audit and monitoring energy and energy savings, types and accuracy, Indian Electricity Act 1956, Distribution Code and Electricity Bill Act 2003.	12
Unit-2	**Electrical distribution and utilization:** Electrical systems, transformers loss reductions, parallel operations, transmission & distribution losses, power factor improvements, Demand Side management (DSM), load management, harmonics & its improvements, energy efficient motors and soft starters, automatic power factor controllers, variable speed drives, electronic lighting ballasts for lighting, LED lighting, trends and approaches.	12
	Energy management: Need of energy management, definition and objective of energy management, general principles of energy management, energy management skills, energy management strategy in respect of electrical power plants. Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	12

Recommended Books-

1. U Desideri and F Asdrubali, "Handbook of Energy Efficiency of Buildings: A Life Cycle Approach", Butterworth-Heinemann, 2018.
2. S Doty and W C Turner, "Energy Management Handbook",8th edition, Fairmont, 2012.
3. S Desai, "Handbook of Energy Audit", McGraw Hill, 2017.
4. C L Wadhwa, "Generation Distribution and Utilization of Electrical Energy",4th edition, New Age International,2017.
5. C B Smith and K E Parmenter, "Energy Management Principles: Applications Benefits Savings", 2nd edition, Elsevier,2015

Subject Code : OEIE-612C

Title of the course : Power Plant Engineering

L	T	P	Credits	Weekly Load

3	0	0	3	3

Course Outcomes:

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

CO 1: get an overview on power generation through various methods.
CO 2: use the important power plant measurements and devices.
CO 3: handle basic boiler control techniques.
CO 4: handle the turbine control techniques.
CO 5: handle parameters to be monitored and controlled in a thermal power plant.

CO/PO Mapping:(Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	2	2	1	2	1	2	2	3	1
CO2	3	3	2	2	1	1	2	1	1	2	1	1	3	1
CO3	3	2	1	3	3	3	3	2	2	3	3	2	3	1
CO4	3	2	2	2	2	2	1	2	2	2	2	2	3	1
CO5	3	3	2	2	1	2	2	2	1	2	1	1	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Overview of power generation:** Survey of methods of power generation: hydro, thermal, nuclear, solar and wind power, importance of instrumentation in power generation, thermal power plant, building blocks, combined cycle system, combined heat and power system, sub critical and supercritical boilers. Summarization of International and National standards related to this course.	12
	Measurements in power plants: 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.	12
Unit-2	**Boiler control I:** Combustion of fuel and excess air, firing rate demand, steam temperature control of deaerator, drum level control, single, two and three element control, furnace draft control, implosion, flue gas dew point control, trimming of combustion air, soot blowing.	09
	Boiler control II: Burners for liquid and solid fuels, burner management, furnace safety interlocks, coal pulverize control, combustion control for liquid and solid fuel fired boilers, air/fuel ratio control, fluidized bed boiler, cyclone furnace.	09
	Control of turbine: types of steam turbines, impulse and reaction turbines, compounding, turbine governing system, speed and load control, transient speed rise, free governor mode operation, automatic load frequency control, turbine oil system, oil pressure drop relay, oil cooling system, turbine run up system.	06

Recommended Books:

1. D Lindsely, J Grist and D Parker, “Thermal Power Plant Control and Instrumentation: The control

of boilers and HRSGs (Energy Engineering)",2nd edition, Institution of Engineering and Technology, 2018.
2. E B Woodruff, H B Lammers and T F Lammers, "Steam Plant Operation",9th edition, McGraw Hill Education, 2011.
3. R K Rajput., "A Text Book of Power Plant Engineering." 5thedition, Lakshmi Publications, 2013.
4. B G Liptak, "Instrumentation in Process Industries", Chilton Book Company, 2005.
5. P K Nag, "Power Plant Engineering", McGraw-Hill Education, 4th edition, 2014.
6. P Tamilmani," Power Plant Instrumentation", Sams Publishers, 2018.
7. K Krishnaswamy and M P Bala., "Power Plant Instrumentation", 2nd edition, Prentice Hall India, 2013

Subject Code : OEIE-612D
Title of the course : Virtual Instrumentation

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: exercise basics of digital image generation, processing, sampling and quantization.

CO 2: know about image transforms techniques and image enhancement techniques.

CO 3: become conversant in 2-D system, spectral density function, estimation and information theory.

CO 4: analyze image restoration including models, filters and digital processing.

CO 5: develop process of image segmentation, image data compression and associated techniques.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1	2	1	2	2	1	2	1	2	3	1
CO2	3	3	2	2	3	1	1	2	2	3	2	2	3	1
CO3	2	2	2	3	2	1	2	2	2	3	2	2	3	1
CO4	2	2	2	2	3	2	2	2	2	2	3	3	3	1
CO5	2	2	3	3	3	1	3	2	2	3	3	3	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction to Virtual Instrumentation:** Historical perspective, classification of different instruments / instrumentation system, definition and architecture of virtual instrumentation system, salient features and application area of virtual instrumentation.	06
	Data flow and programming techniques: Graphical programming in data flow, comparison with conventional programming, popular data flow and VI software packages, building a VI front panel and block diagram, sub VI.	08
	Programming techniques: For and while loops, case and sequence structure, formula nodes, local and global variables, array and clusters, charts and graphs, string and file I/O, event driven programming.	10
Unit-2	**Data acquisition basics:** ADC, DAC, I/O, counters and timer, PC hardware structure, timing, interrupts, DMA, software and hardware installation, configuring data acquisition hardware using the drives in application software, use of DAQ library functions for different analog and digital input/output operations.	06
	Common instrument interfaces: RS 232, RS485, GBIP, use of library functions to communicate with different instruments, introduction to VISA.	06
	Applications of VI: Measurement of max, min, peak-peak voltage, time period of a signal, power spectrum and logging Fourier transform, correlation methods, windowing and filtering.	06
	Networking in Labview: Labview as a network client server, publishing vis on web, projects related to this course should be given to students (in groups) in order to promote team work and ethical values.	06

Recommended Books:

1. Sanjay Gupta, "Virtual Instrumentation Using Labview", 2nd edition, McGraw Hioll Education,2017.
2. J Travis and J Kring, "LabVIEW for Everyone", 3rd edition, Prentice Hall India,2006.
3. R Jennings and F D A Queva, "Lab view Graphical Programming", 5th edition, McGraw-Hill Education, 2019.
4. P A Blume, **"**LabVIEW Style Book", Prentice Hall India,2017.
5. J Jarome, "Virtual Instrumentation using Labview, Prentice Hall India,2010.
6. R Bitter, T Mohiuddin and M Nawrocki, Labview Advanced Programming Techniques2nd edition,CRC Press,2017.

Subject Code : OEIE-612 E
Title of the course : Nuclear Instrumentation

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: interpret the working of nuclear system, its basics and radiation detection techniques.
CO 2: understand electronic and counting system, various analyzers and Energy Resolution.
CO 3: be conversant in nuclear instrumentation system in industries.
CO 4: analyze application of nuclear instruments in medicine and health care.
CO 5: know various safety aspect, shielding and emergency schemes.

CO/PO Mapping:(Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	2	1	2	1	1	3	1	2	3	1
CO2	3	2	3	3	3	3	3	2	3	2	3	3	3	3
CO3	3	2	1	2	2	1	2	1	2	3	1	2	3	2
CO4	3	3	3	3	3	3	3	3	3	2	3	3	3	3
CO5	3	2	3	3	3	3	3	2	3	2	3	3	3	3

Theory:

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction:** Introduction to properties of Nuclear system and Radiation, Interaction of radiation with matter, General Properties of Nucleus, Radioactivity, Nature of Nuclear Radiations, Characteristic properties of radioactive radiations, Properties of Alpha, Beta, and Gamma rays, Natural and artificial radio-activity. Radioactivity Laws, Half-life period, radioactive series, Isotopes and Isobars, Various effects- photoelectric, Compton scattering and pair production, stopping power and range of charged nuclear particles.	08
	Radiation detectors: Techniques for weak signal detection, Detectors for Alpha, beta and gamma rays, Detector classification. Ionization chamber, Regions of multiplicative operation, Proportional counter, Geiger Muller counter-volt ampere characteristics, Designing features, Scintillation detectors (Photomultiplier tube-types, dark currents, scintillators, pulse resolving power), efficiency of detection, Signal To Noise Ratio (SNR) improvement, Solid state detectors (Lithium ion drifted -Si-Li, Ge-Li, Diffused junction, surface barrier)	10
	Electronics and counting systems: Pre-amp., main amplifiers, Discriminators, Scalars and count rate meters, Pulse shaping, pulse stretchers, Coincidence circuits, photon counting system block diagram, factors influencing resolution of gamma energy spectrum, Energy resolution in radiation detectors, single and multichannel analyzers (MCA), pulse height analyzers (PHA).	06
Unit-2	**Applications in industry:** Basic Nuclear Instrumentation system- block diagram, Nuclear Instrumentation for laboratory. Personal monitors like Thermo Luminescence Detectors (TLD), Dosimeters, Tele-detectors, which are used to assess the radiation exposure to the radiation plant workers. Nuclear Instrumentation for power reactor. Nuclear Instrumentation for Toxic fluid tank level measurement, Underground Piping Leak detection, weighing, thickness gauges, water content measurement etc. Agriculture applications like food irradiation.	10
	Applications in medicines: Gamma camera- design, block diagram, medical usage. Radiation uptake studies- block diagram and design features. Nuclear Instrumentation for health care, Radiation Personnel Health Monitors like neutron monitors, Gamma Monitors, Tritium monitors, Iodine monitors and PARA (particulate activity radiation alarms).	08

	Safety: Hazards of ionization radiation, physiological effect of radiation, Dose and Risk, Radiological Protection-Shielding material and effectiveness. Operational safety instruments, Emergency schemes, affluent disposal, Applications to medical diagnosis and treatment.	06

Recommended Books-

1. G F Knoll, "Radiation Detection & Measurement.", 2nd edition, John Wiley & Sons,1998.
2. Gaur and Gupta, " Engineering Physics*"*.,Danpat Rai & Sons, 2001.
3. Irvin Kaplan, "Nuclear Physics*"*,Narosa, 1987.
4. M N Avdhamule and P G Kshirsagar ". Engineering Physics", S. Chand & Co., 2001.
5. P W Nicholson, "Nuclear Electronics*"*, John Wiley, 1998.
6. S S Kapoor and V S Ramamurthy, "Nuclear Radiation Detectors", Wiley Eastern Limited, 1986

Subject Code : OEIE-621A
Title of the course : Microprocessors and Applications

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:
After successful completion of course, the students should be able to
CO 1: acquire the knowledge about history, architecture of 8, 16, 32 & 64-bit microprocessor.
CO 2: know about 8085 microprocessor, architecture and timing diagrams.
CO 3: develop the programming applications of microprocessors.
CO 4: interfacing of peripheral devices with 8085.
CO 5: familiar with 8259 interrupt controller, 8254 timers /counter, A/D and D/A converter

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	3	2	1	1	1	1	3	2	3	1
CO2	3	3	3	2	1	1	1	1	2	2	2	2	3	1
CO3	3	3	2	3	2	1	1	1	1	2	3	2	3	1
CO4	3	2	3	2	1	1	1	2	1	2	1	2	3	1
CO5	3	2	3	2	3	3	2	2	2	3	2	3	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction to microprocessors:** Types of computers, microprocessor evolution and types, CPU operation and terminology, idea of 8- bit, 16-bit, 32-bit and 64- bit Microprocessors from Intel, Motorola and Zilog and their comparisons.	08
	Introduction to 8-bit microprocessor: 8085 Microprocessor architecture and pin diagram of 8085, ALU timing and control unit, registers, data and address bus, timing and control signals, fetch and execute operations, instruction format, addressing techniques, classification of instructions instruction and data flow, system timing diagram, transition state diagram, system configuration for 8085.	08
	8085 Programming: Instruction types, classification of instructions, addressing modes, instruction format, over view of instruction set, writing assembly language programs, data manipulations, fixed point arithmetic, data conversion, sorting numeric data, look-up table and time delays, concepts of stack, interrupts, interrupt service subroutine.	08
Unit-2	**Interfacing Memory with 8085**: Memory interfacing, I/O interfacing – memory mapped and peripheral mapped I/O, Data transfer schemes – Programmed, Interrupt driven and Direct Memory Access (DMA) data transfers, block diagram representation, control word formats, modes	12
	Peripheral devices: Interfacing of 8255A PPI, 8251 USART, 8254 programmable interval timer, 8259A programmable interrupt controller and 8279 with 8085, block diagram representation, control word formats, modes, simple programs. Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	12

Recommended Books

1. B Ram., "Fundamentals of Microprocessors and Microcontrollers", Dhanpat Rai Publications, 2012.
2. B B Bray, "The INTEL Microprocessors 8086/88, 80186, 286, 386, 486, Pentium Pro Processors, Architecture, Programming and Interfacing", 8th edition, Pearson education India,2008.
3. D V Hall, "Microprocessors and its Interfacing", 3rd edition, McGraw Hill Education, 2017.
4. R Gaonkar, "Microprocessor Architecture, Programming and Applications with the 8085",6th edition Penram International,2013.
5. A K Ray and K Bhurchandi, "Advanced Microprocessors and Peripherals",3rd edition, McGraw Hill Education,2017.

Subject Code : OEIE-621B
Title of the course : Elements of Power System

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:
After successful completion of course, the students should be able to
CO 1: acquire knowledge of basic transmission system.
CO 2: line parameter calculations.
CO 3: gain the knowledge of mechanical components of line.
CO 4: performance and losses awareness.
CO 5: acquire the knowledge of cable materials.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	3	2	1	2	2	1	3	1	1
CO2	3	2	2	1	1	3	3	1	3	3	3	2	2	2
CO3	3	2	2	1	2	2	3	1	3	3	3	2	3	2
CO4	3	2	2	1	2	3	3	1	3	3	2	1	3	1
CO5	3	3	3	1	2	2	3	1	3	3	3	2	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Supply system:** Introduction to transmission and distribution systems, comparison between DC and AC systems for transmission and distribution, comparison of cost of conductors, choice of working voltage for transmission & distribution, economic size of conductors, Kelvin's law, radial and mesh distribution networks, voltage regulation. Summarization of International and National standards related to this course .	08
	General: Conductor materials; solid, stranded, ACSR, hollow and bundle conductors., different types of supporting structures for overhead lines, elementary ideas about transmission line construction and erection, stringing of conductors, spacing, sag and clearance from ground, overhead line insulators, concept of string efficiency.	08
	Transmission line parameters : Introduction to line parameters, resistance, inductance, concept of G.M.D. ,inductance of three phase line, use of bundled conductor, transposition of power lines, capacitance of 1-Phase and 3-Phase lines, effect of earth on capacitance of conductors.	08
Unit-2	**Performance of transmission lines:** Representation of short transmission line, medium length line (nominal T and II circuits) long length line by hyperbolic equations and equivalent T & II circuits, power flow through transmission lines, ABCD constants, voltage regulation.	12
	Underground cables: Classification of cables based upon voltage and dielectric material, insulation resistance and capacitance of single core cable, dielectric stress, capacitance of 3 core cables, method of laying, heating effect, maximum current carrying capacity, cause of failure, comparison with overhead transmission lines. Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	12

Recommended Books-

1. C L Wadhwa, “Electrical Power Systems”, 6th edition, New Age International ,2010.
2. I J Nagrath and D P Kothari, “Power System Engineering”,3rd edition, McGraw Hill,2019.
3. D P Kothari and J S Dhillon, “Power System Optimization”,2nd edition, Prentice Hall India,2010.
4. O L Elgerd., “Electrical Energy Systems Theory”,2nd edition, McGraw Hill Education,2017.
5. J Grainger, Jr W Stevenson. and G W Chang, “Elements of Power System analysis” ,2nd edition, McGraw Hill Education ,2015.
6. J D Glover, T Overbye and M S Sarma, “Power System Analysis and Design”, 6th edition, Cengage Learning,2016.

Subject Code : OEIE-621C
Title of the course : Biomedical Instrumentation

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: know about basic nervous, circulatory and respiratory system and origin ofbio-potentials.

CO 2: utilize the concept of various bioelectric signals and electrodes for EEG, EMG and ECG.

CO 3: have competency to acquire the data of cardiovascular, electrical activity of brain and respiratory system.

CO 4: exercise knowledge of medical imaging, computerized ultrasonic diagnosis and types, X-Rays and computerized tomography and use them in diagnosis of disease.

CO 5: learn physiological parameters and components of biotelemetry system and their applications in medical field.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	3	2	2	1	2	2	3	3	1
CO2	3	2	2	2	2	2	3	2	2	1	2	2	3	1
CO3	3	2	2	2	2	2	1	1	2	2	1	1	3	1
CO4	2	3	2	2	3	2	2	2	1	1	2	3	3	1
CO5	3	2	1	2	3	2	1	1	2	2	2	3	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Physiological systems of body:** Brief description of nervous, circulatory and respiratory systems, the body as a control system, the nature of bioelectricity, the origin of bio-potentials.	06
	Bio electric signals and electrodes: Electro conduction system of the heart, the ECG Waveform, Neuron potential, muscle potential, electrodes for biophysical sensing, skin-contact-impedance, electrodes for EEG, EMG and ECG, electrical conductivity of electrode jellies and creams.	06
	Cardiovascular measurements: The standard lead system, the Electrocardiography(ECG) preamplifier; ECG machines, cardiac monitors, blood pressure measurements, direct and indirect, blood flow measurements, phonocardiography, defibrillators, pacemakers.	06
	Measurements of electrical activity in brain: Anatomy of human brain and nerve cell, Electroencephalography (EEG) electrodes and the 10-20 system, EEG amplitude and frequency bands, simplified block diagram, preamplifiers and EEG system specifications, EEG diagnostic uses and sleep patterns, visual and auditory evoked potential recordings, EEG system artefacts.	06
Unit-2	**Electromyography (EMG):** Muscular system, electrical signals of motor unit and gross muscle, human motor coordination system, electrodes, signal conditioning and processing, Block diagram & description of Electromyography (EMG).	04

	Respiratory System Measurements: Respiratory anatomy, parameters of respiration, regulation of respiration, respiratory system measurements, respiratory transducers and instruments, spirometry.	08
	Hospital Data Management: Hospital information system, functional capabilities of computerized hospital information system, efficiency, security and cost effectiveness of computer records, computerized patient data management.	08
	Biotelemetry: Physiological parameters adaptable to bio-telemetry, components of a biotelemetry system, implantable units, applications of telemetry system in patient care, introduction to telemedicine. Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	04

Recommended Books-

1. J G Webster, "Medical Instrumentation", 4th edition, Wiley, 2015.
2. J J Carr, J M Brown, "Introduction to Biomedical Equipment Technology", 4th edition, Pearson Education, 2000.
3. L Cromwell, F J Weibell, E A Pfeiffer "Biomedical Instrumentation and Measurement", 2nd edition, Pearson Education India, 2015.
4. R S Khandpur, "Handbook of Biomedical Instrumentation",3rd edition, McGraw Hill Education, 2014.
5. J L Semmlow and B Griffel, "Biosignal and Medical Image Processing",3rd edition, CRC Press,2014.

6.

Subject Code : OEIE-621D
Title of the course : Building Automation

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO1: acquire the knowledge of dynamic performance of building processes/systems, control fundamentals and building process control strategies for better energy efficiency and building environmental performance.
CO2: design and analyse. heating, ventilating and air conditioned (HVAC) system
CO3: implement control for building management.
CO4: design and analyse fire alarm system (FAS) and various Security systems
CO5: acquire the knowledge of energy management and calculate project life cycle.

CO/PO Mapping:(Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	2	1	2	1	1	3	1	2	3	1
CO2	3	2	3	3	3	3	3	2	3	2	3	3	3	3
CO3	3	2	1	2	2	1	2	1	2	3	1	2	3	2
CO4	3	3	3	3	3	3	3	3	3	2	3	3	3	3
CO5	3	2	3	3	3	3	3	2	3	2	3	3	3	3

Theory

Unit	Main Topics & Course Outline	Hour(s)
Unit 1	**Introduction to Heading, Ventilating and Air Conditioned (HVAC) System:** Fundamentals: Introduction to HVAC, HVAC fundamentals, basic processes (heating, cooling etc.) basic science: air properties, psychometric chart, heat transfer mechanisms, examples. human comfort: human comfort zones, effect of heat, humidity, heat loss processes: heating process & applications (i.e. boiler, heater), cooling process & applications (i.e. chiller), ventilation process & applications (i.e. central fan system, air handling unit (AHU), exhaust fans, unitary systems (variable air volume (VAV), fan coil unit (FCU)	08
	Control Theory: Control theory: instrumentation basics, field components & use, direct digital control (DDC) & applications Architecture: Honeywell Architecture, BMS components control panel: HVAC Control Panel, motor control centre (MCC) basics, panel components communication: communication basics, networks, building automation and control network (BAC net), Modbus, local operating network (LON).	**08**

Unit-2	**Fire Alarm System (FAS):** Fundamentals, fire modes, history, components, and principles of operation FAS components: field components, panel components, applications. FAS Architectures: types of architectures, examples FAS loops: classification of loops, examples. power supply design for FAS. cause & effect matrix: examples fire standards: FAS design procedure in brief, National Fire Protection Association (NFPA) 72A, BS 5839, IS.	08
	Energy Management: Energy management: advantages of building management (BMS), energy Savings concept & methods, lighting control, building efficiency improvement, green building concept & examples.	08
	Applications: Project life cycle: Integrated BMS (IBMS) (HVAC, Fire & Security) project cycle, project steps BMS verticals: applications of BMS, examples integration: IBMS architecture, normal & emergency operation.	08

Recommended Books-

1. Chartered Institution of Building Services Engineers, "Building Control Systems, Applications Guide", Butterworth-Heinemann Ltd, 2000.
2. In Partnership with NJATC, "Building Automation: Control Devices and Applications", Amer Technical Pub, 2008.
3. John E. Traister, "Security/Fire Alarm Systems: Design, Installation, and Maintenance", 2nd sub edition, McGgraw-Hil, 1995.
4. John I. Levenhagen, "HVAC Control System Design Diagrams", New edition, McGraw-Hill Professional, 1998.
5. John J. McGowan, "Building Automation Online", Fairmont Press, 2004.
6. Michael F. Hordeski, "HVAC Control in the New Millennium", Prentice Hall, 2001.
7. Robert M Gagnon, "Design of Special Hazards and Fire Alarm Systems", 2nd edition, Thomson Delmar Learning, 2007.
8. Reinhold A. Carlson, Robert A. Di Giandomenico, "Understanding Building Automation Systems (Direct Digital Control, Energy Management, Life Safety, Security, Access Control, Lighting, Building Management Programs)", R.S. Means Company, 1991.

Subject Code : OEIE-621E
Title of the course : Image and Video processing

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: exercise basics of digital image generation, processing, sampling and quantization.

CO 2: understand image transforms techniques and image enhancement techniques.

CO 3: become conversant in 2-D system, spectral density function, estimation and information theory.

CO 4: analyse image restoration including models, filters and digital processing.

CO 5: develop process of image segmentation, image data compression and associated techniques.

CO/PO Mapping:(Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	2	1	2	1	1	3	1	2	3	1
CO2	3	2	3	3	3	3	3	2	3	2	3	3	3	3
CO3	3	2	1	2	2	1	2	1	2	3	1	2	3	2
CO4	3	3	3	3	3	3	3	3	3	2	3	3	3	3
CO5	3	2	3	3	3	3	3	2	3	2	3	3	3	3

Theory:

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction:** Definition of image, generation of image, steps in image processing, elements of digital image processing systems, image enhancements, restoration and analysis.	06
	Digital image fundamentals: Elements of visible perception, image model, sampling and quantization, relationships between pixels, imaging geometry.	06
	Image transforms: Introduction to Discrete Fourier Transform (D.F.T.), 2-D.F.T., Fast Fourier Transform (F.F.T.), other separable image transforms (Walsh, Hadamard, discrete cosine, Haar, slant, KL).	06
	Image enhancements: Point operations, histogram modelling, spatial filtering-smoothing, sharpening, low pass, high pass, homomorphic filtering.	06
Unit -2	**2-D systems and mathematical preliminaries:** Introduction and definitions, matrix theory, random signals, spectral density function, results from estimation and information theory.	06
	Image restoration: Image observation models, inverse and wiener filtering, Finite Impulse Response (F.I.R.) wiener filters, filtering using image transforms, least squares filters, generalized inverse, Singular Value Decomposition (S.V.D.) and interactive methods, recursive filtering, causal models, digital processing of speckle images, maximum entropy restoration.	06
	Image segmentation: Detection of discontinuities, age linking and boundary detection, thresholding region oriented segmentation, use of motion in segmentation.	06
	Fundamentals of Video Coding: Inter-frame redundancy, motion estimation techniques, full search, fast search strategies, forward and backward motion prediction, frame classification, I, P and B; Video sequence hierarchy, Group of pictures, frames, slices, macro-blocks and blocks; Elements of a video encoder and decoder; Video coding standards: MPEG and H.26X. Video Segmentation: Temporal segmentation, shot boundary detection, hard-cuts and soft-cuts; spatial segmentation, motion-based; Video object detection and tracking.	06

Recommended Books-

1. A. K. Jain, "Fundamental of Digital Image Processing", PHI 2nd edition, 1995.
2. B. Chanda and D. Dutta Majumdar, "Digital Image processing", PHI, 2000.
3. C. Phillips, "Image Processing in C", BPB Publication, 1995.
4. Don Pearson, Image Processing (The ESSEX series in Telecommunication an information system, McGraw Hill International ELTL engg. series), 1991.
5. Emmauel C. Ifeachor and Barry W. Jervis, "Digital Signal Processing", Pearson Education, 2nd edition, 2000.
6. Johnny Johnson, "Introduction to DSP", PHI. 1996.
7. Proakis, "DSP", PHI 1997.
8. R. C. Gonzalez and R.E. Woods, "Digital Image Processing", Pearson Education, 3rd edition, 2008.
9. W. K. Pratt, "Digital Image Processing", John Wiley and Sons, 1994.
10. Rabnier Gold, "Theory and Application of DSP", PHI, 1996.
11. Milan Sonka, Vaclav Hlavac, "Image Processing analysis and machine vision", Thomson Learning, 2nd edition, 1999.
12. Murat Tekalp, "Digital Video Processing", Prentice Hall, 2nd edition 2015

Subject Code : OEIE-622A

Title of the course : Control System

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: acquire the basic knowledge of control engineering and its scope.

CO 2: analyze the mathematical model of a system and determine the response of different order systems for standard input inputs.

CO 3: solve the steady state and transient analysis of a system for standard input inputs.

CO 4: analyze the stability analysis of a system.
CO 5: be competent to analyze closed loop control design problems and design compensating networks.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	2	3	1	3	2	2	2	3	1
CO2	3	3	2	3	3	3	2	1	2	1	3	1	3	1
CO3	3	2	3	2	2	2	3	2	3	3	2	2	3	1
CO4	2	2	2	2	3	3	2	3	2	3	3	1	3	1
CO5	3	3	3	2	2	2	2	2	3	3	1	2	3	1

Unit	Main Topics and Course Outline	Hour(s)
Unit-1	**Introductory concept:** Plant, systems, servomechanism, regulating systems, disturbances, open loop control system, closed loop control system, linear and non- linear systems, time variant and invariant, continuous and sampled-data control systems, concept of feedback, block diagrams.	08
	Modelling: Formulation of equation of linear electrical, mechanical, thermal, pneumatic and hydraulic system, electrical mechanical analogies, use of Laplace transforms, transfer function, concept of state variable modelling, block diagram representation, block diagram simplification for linear systems, signal flow graphs, Mason gain rules.	08
	Time domain analysis: Typical test-input signals, transient and steady state response of the first order systems, second order systems and higher order systems, transient response analysis with MATLAB, steady state error and coefficients, pole zero location and stability, Routh-Hurwitz criterion.	08
Unit 2	**Root locus analysis:** Introduction, root-locus plots, general rules for constructing root loci, root-locus plots with MATLAB, positive feedback systems, conditionally stable systems, root loci for systems with transport lag.	06
	Frequency domain analysis: Introduction, Bode diagrams, plotting Bode diagrams with MATLAB, polar plots, drawing Nyquist plots with MATLAB, log-magnitude versus phase plots, Nyquist stability criterion, stability analysis, relative stability, closed loop frequency response of unity feedback systems.	06
	Compensation: Necessity of compensation, series and parallel compensation, compensating networks, application of lag and lead compensation.	06
	Control components: Proportionate, derivative and integral control, feedback control, error detectors, potentiometers and synchro, AC &DC servomotors, tachogenerators. Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	06

Recommended Books-

1. B C Kuo, "Automatic Control System", 9th edition, Wiley, 2014.
2. J J Distefano, A R Stuberud and I J Williams, "Schaum's Outlines of Theory and Problems of Feedback and Control Systems", 2nd edition, Tata McGraw Hill, 2007.
3. I J Nagrath and M Gopal, "Control System Engineering", 6th edition, New Age International Publishers, 2017.
4. K Ogata, "Modern Control Engineering", 5th edition, Pearson Education India, 2015.
5. R C Dorf and RH Bishop, "Modern Control System", 12th edition, Pearson Education India, 2013.

Subject Code : OEIE-622B
Title of the course : Microcontrollers and Applications

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:
After successful completion of course, the students should be able to
CO 1: study 8051 microcontroller along with its the internal architecture.
CO 2: develop knowledge of programming of 8051 microcontroller using assembly language.
CO 3: analyze 8051 microcontroller design, memory mapping and serial data transmission.
CO 4: be conversant in applications of 8051 microcontroller.
CO 5: implement PLDs and FPGA with knowledge of their architecture and design.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	3	2	1	1	1	1	3	2	3	1
CO2	3	3	3	2	1	1	1	1	2	2	2	2	3	1
CO3	3	3	2	3	2	1	1	1	1	2	3	2	3	1
CO4	3	2	3	2	1	1	1	2	1	2	1	2	3	1
CO5	3	2	3	2	3	3	2	2	2	3	2	3	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction:** Microprocessor, Micro-controllers and their comparison. The 8051 Architecture: Introduction, 8051 micro-controller hardware, input/ output, pins, ports and circuits, external memory, counters and timers, serial data input/ output, interrupts. Summarization of International and National standards related to this course.	12
	8051 Assembly Language Programming: Instruction format and addressing techniques, instruction set (data moving, logical operations, arithmetic operations, jump and call instructions), The mechanics of programming, assembly language programming process, programming tools and techniques.	12
Unit-2	**8051 Microcontroller Design:** Micro-controller specification, external memory and memory space decoding, reset and clock circuits, expanding Input /Output (I/O), memory mapped I/O, memory address decoding, memory access times, testing the design, timing subroutines, lookup tables for the 8051, serial data transmission.	12
	Microcontroller Applications: Interfacing keyboards, displays, Digital to Analog (D/A) and Analog to Digital (A/D), multiple interrupts, serial data communications, introduction to the use of assemblers and simulators, Embedded systems: introduction to Programmable Logic Devices (PLDs) and Field Programmable Gate Array (FPGA) - architecture, technology and design issues, implementation of 8051 core. Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	12

Recommended Books-

1. K J Ayala, "The 8051 Micro Controller- Architecture, Programming and Application", 2nd edition, Penram International,2007.
2. M Mahalakshmi, "8051 Microcontroller Architecture, Programming and Application", Laxmi Publications ,2012.
3. B Ram, "Fundamentals of Microprocessors and Microcontrollers", Dhanpat Rai, Publications, 2012.
4. M A Mazidi and J G Mazidi, "The 8051 Micro-controller and Embedded System", 2nd edition, Pearson Education, 2013.
5. S Ghoshal, "The 8051 Microcontroller: Internals, Instructions, Programming and Interfacing", 2nd edition, Pearson Education India,2014.

Subject Code : OEIE-622C

Title of the course : Industrial Safety Engineering

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: know about the safety standards which must be maintained in compliance with regulatory requirements.
CO 2: demonstrate the knowledge of workplace injury prevention, risk management, and incident investigation.
CO 3: demonstrate knowledge of different types of exposure and biological effects.
CO 4: acquire knowledge of contemporary issues of pollution and its control methods.
CO 5: implement the concept of industrial hygiene.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	2	3	3	3	3	3	2	3	1	3	1
CO2	3	2	2	2	2	2	2	2	2	2	3	2	3	1
CO3	2	2	3	2	2	3	3	2	2	2	3	2	3	1
CO4	3	3	3	2	2	3	3	2	3	3	3	2	3	1
CO5	3	3	3	2	3	3	3	2	2	3	2	2	3	1

Unit	Main Topics & Course Outline	Hour(s)
Unit-1	**Introduction:** Introduction to the concept of safety, safety provisions in the factory act laws related to the industrial safety, measurement of safety performance, safety audit, work permit system, injury and accidents, definitions, unsafe act, unsafe condition, causes, investigations and prevention of accidents, hazards, type of industrial hazards, nature, causes and control measures, hazard identifications and control techniques, HAZOP, FMEA, FMECA etc. Summarization of International and National standards related to this course.	12
	Concept of Industrial hygiene, programmed: Recognition, Evaluation, Control, noise source, effects and noise control, exposure limits standards, hearing conservation programmed, Fire, fire load, control and industrial fire protection systems, fire hydrant and extinguishers, electrical hazards, protection and interlock, discharge rod and earthling device, safety in the use of portable tools.	12
Unit-2	**Logics of consequence analysis:** Estimation-Toxic release and toxic effects, threshold limit values, emergency planning and preparedness, air pollution classification, dispersion modelling, pollution source and effects, control method and equipment's gravitational settling chambers, cyclone separators, fabric filter systems, scrubbers.	12
	Concept of reliability: Definition-Failure rate and hazard function, system reliability models series, parallel systems, reliability hazard function for distribution functions, exponential normal, lognormal, Weibull and gamma distribution.	12

Recommended Books-

1. K S N Raju, “Chemical Process Industry safety”, Tata McGraw Hill Education,2014.
2. I T Cameron and R Raman, “Process Systems Risk Management” Volume 6, Elsevier Academic press,2005.
3. A K Gupta, “Industrial Safety and Environment”, Laxmi Publications,2006.
4. J E Daugherty, “Industrial Safety Management: A Practical Approach”, Government Institutes Inc. U.S., 1999.
5. L M Deshmukh, “Industrial Safety Management”, McGraw Hill Education, 2017.

Subject Code : OEIE-622D
Title of the course : Speech and Audio Processing

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:
After successful completion of course, the students should be able to
CO 1: mathematically model the speech signal.
CO 2: analyze the quality and properties of speech signal.
CO3: modify the speech and audio signals.
CO 4: become conversant with speech signal processing techniques.
CO 5: enhance the speech and audio signals.

CO/PO Mapping:(Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	2	1	2	1	1	3	1	2	3	1
CO2	3	2	3	3	3	3	3	2	3	2	3	3	3	3
CO3	3	2	1	2	2	1	2	1	2	3	1	2	3	2
CO4	3	3	3	3	3	3	3	3	3	2	3	3	3	3
CO5	3	2	3	3	3	3	3	2	3	2	3	3	3	3

Theory:

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction:** Speech production and modelling, Human Auditory System; General structure of speech coders; Classification of speech coding techniques, parametric, waveform and hybrid; Requirements of speech codecs, quality, coding delays, robustness.	08
	Speech Signal Processing: Pitch-period estimation, all-pole and all-zero filters, convolution; Power spectral density, periodogram, autoregressive model, autocorrelation estimation.	08
	Linear Prediction of Speech: Basic concepts of linear prediction; Linear Prediction Analysis of non-stationary signals, prediction gain, examples; Levinson-Durbin algorithm; Long term and short-term linear prediction models; Moving average prediction.	08
Unit-2	**Speech Quantization**: Scalar quantization, uniform quantizer, optimum quantizer, logarithmic quantizer, adaptive quantizer, differential quantizers; Vector quantization, distortion measures, codebook design, codebook types	08
	Scalar Quantization of LPC: Spectral distortion measures, Quantization based on reflection coefficient and log area ratio, bit allocation, Line spectral frequency, LPC to LSF conversions, quantization based on LSF.	08
	Linear Prediction Coding: LPC model of speech production, Structures of LPC encoders and decoders; Voicing detection; Limitations of the LPC model.	08

Recommended Books-

2. "Digital Speech" by A.M.Kondoz, Second Edition (Wiley Students Edition), 2004.
3. "Speech Coding Algorithms: Foundation and Evolution of Standardized Coders", W.C. Chu, WileyInter science, 2003.
4. Ian Vince McLoughlin, "Speech and audio processing: A Matlab based approach".
5. Dan Ellis, Nelson Morgan, Ben Gold, "Speech and Audio Processing and Perception of Speech and Music", 2nd edition.
6. Jayan A. R., "Speech And Audio Signal Processing".

Subject Code : OEIE-622 E
Title of the course : Artificial Intelligence

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: build intelligent agents for search and games.

CO 2: solve AI problems through programming

CO 3: design and develop programs for an agent to learn and act in a structured environment

CO 4: apply a soft computing methodology for a particular problem.

CO 5: develop expert system for a particular problem

CO/PO Mapping:(Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	2	1	2	1	1	3	1	2	3	1
CO2	3	2	3	3	3	3	3	2	3	2	3	3	3	3
CO3	3	2	1	2	2	1	2	1	2	3	1	2	3	2
CO4	3	3	3	3	3	3	3	3	3	2	3	3	3	3
CO5	3	2	3	3	3	3	3	2	3	2	3	3	3	3

Theory:

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Overview of Artificial Intelligence**: The concept and importance of AI, Human intelligence vs. machine intelligence, scope, agents, environments, Problem Formulations, Review of tree and graph structures, State space representation, Search graph and Search tree.	08
	Expert Systems: Expert system architecture, functions of various parts, mechanism and role of inference engine, types of expert system, tuning of expert systems, role of expert systems in instrumentation and process control.	08
	Search Algorithms: Random search, Search with closed and open list, Depth first and Breadth first search, Heuristic search, Best first search, algorithm, Game Search.	08
Unit-2	**Probabilistic Reasoning**: Probability, conditional probability, Bayes Rule, Bayesian Networks- representation, construction and inference, temporal model, hidden Markov model.	08
	Markov Decision process: MDP formulation, utility theory, utility functions, value iteration, policy iteration and partially observable MDPs.	08
	Reinforcement Learning: Passive reinforcement learning, direct utility estimation, adaptive dynamic programming, temporal difference learning, active reinforcement learning- Q learning. Introduction to unsupervised techniques	08

Recommended Books-

1. J.Ross Timothy, “Fuzzy Logic with Engineering Applications”, McGraw-Hill, International Editions, Electrical Engineering Series, Singapore, 1997.
2. J.S.R.Jang, C.T.Sun and E.Mizutani, “Neuro-Fuzzy and Soft Computing”, PHI, 2004, Pearson Education 2004.
3. R.Eberhart, P.Simpson and R.Dobbins, “Computational Intelligence - PC Tools”, AP Professional, Boston, 1996.
4. S. Rajasekaran and G.A.V.Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithms”, PHI, 2003.
5. E.Goldberg Davis, “Genetic Algorithms: Search, Optimization and Machine Learning”, Addison Wesley, N.Y., 1989.
6. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach”, 3rd Edition, Prentice Hall.
7. Elaine Rich and Kevin Knight, “Artificial Intelligence”, Tata McGraw Hill.
8. Trivedi, M.C., “A Classical Approach to Artifical Intelligence”, Khanna Publishing House, Delhi.
9. Saroj Kaushik, “Artificial Intelligence”, Cengage Learning India, 2011.

Subject Code : OEIE-711A

Title of the course : Signals and Systems

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: interpret signals, convolution and learn various properties.

CO 2: to gain knowledge to reduce noise, interference and their reduction methods.

CO 3: be conversant in Fourier series, Fourier transform along with their basic properties.

CO 4: analyze sampling, restructuring, sampling theorem, aliasing, digital signal processing.

CO 5: study Laplace and Z-transform, their basic properties, region of convergence, inverse Laplace and Z-transform, rational system functions.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	2	2	2	1	1	2	1	3	1
CO2	3	2	3	2	3	2	2	2	1	1	2	1	3	1
CO3	2	3	3	3	2	2	3	2	2	1	3	2	3	1
CO4	2	3	3	3	2	2	3	3	2	2	3	2	3	1
CO5	3	3	3	2	3	3	2	2	3	2	2	2	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction to Signals and Systems:** Signals and systems as seen in everyday life, and in various branches of engineering and science. Signal properties: periodicity, absolute integrability, determinism and stochastic character. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals; continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability.	06
	Behavior of continuous and discrete-time LTI systems: Impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs, cascade interconnections, characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. State-space representation of systems, state-space analysis, multi-input, multi-output representation. state transition matrix and its role, periodic inputs to an LTI system, the notion of a frequency response and its relation to the impulse response.	10
	Effect of noise: Convolution of Signals, correlation, effects of noise and interference on the measurement system, noise sources and coupling mechanism, method of reducing effects, reliability, choice and economics of the measurement system.	08
Unit-2	**Introduction to transforms:** Fourier series representation of periodic signals, waveform symmetries, calculation of Fourier coefficients. Fourier transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT).	08
	Sampling and reconstruction of the signal: The Sampling Theorem and its implications. Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold, aliasing and its effects, relation between continuous and discrete time systems, introduction to the applications of signal and system theory: modulation for communication, filtering, feedback control systems.	06
	Laplace and Z-transforms: Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals,	

	Laplace domain analysis, solution to differential equations and system behavior. The z-transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z-domain analysis. Projects related to this course should be given to students (in groups) in order to promote team work and ethical values.	10

Recommended Books:

1. AV Oppenheim, A S Willsky and S H Nawab, "Signals and Systems", Pearson,2nd edition, 2015.
2. J G Proakis and D G Manolakis, "Digital Signal Processing: Principles, Algorithms, and Applications", 4th edition, Pearson, 2007.
3. H P Hsu, "Signals and Systems", Schaum's series, 2nd edition, Tata McGraw Hill Education, 2017.
4. S Haykin and B V Veen, "Signals and Systems", 2nd edition, John Wiley and Sons, 2007.
5. E W Kamen and B Heck, "Fundamentals of Signals and Systems",3rd edition, Pearson Education, 2006.

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Subject Code : OEIE -711B

Title of the course : Sensors and Transducers

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

After successful completion of course, the students will be

CO 1: exposed to various sensors and transducers for measuring mechanical quantities.

CO 2: familiar with the specifications of sensors and transducers.

CO 3: able to design signal conditioning circuits for various sensors and transducers.

CO 4: exposed to advancements in sensor technology.

CO 5: able to identify or use a transducer for a specific measurement application.

CO/PO Mapping:(Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	2	2	2	1	1	2	1	3	1
CO2	3	2	3	2	3	2	2	2	1	1	2	1	3	1
CO3	2	3	3	3	2	2	3	2	2	1	3	2	3	1
CO4	2	3	3	3	2	2	3	3	2	2	3	2	3	1
CO5	3	3	3	2	3	3	2	2	3	2	2	2	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**General Concepts** – Basic block diagram of generalized instrumentation system, definition of transducer, classification of transducers, general input-output configuration, static and dynamic characteristics of a measurement system, statistical analysis of measurement data.	12
	Resistive transducers: Potentiometers, metal and semiconductor strain gauges, strain gauge applications: Load and torque measurement, Digital displacement sensors, RTDs, thermistors.	12
Unit-2	**Inductive and Capacitive Transducers**- Measurement of self and mutual inductance, capacitive transducers, eddy current transducers, proximity sensors, tacho-generators and stroboscope.	08
	Miscellaneous measurements: Seismic transducer and its dynamic response, photoelectric transducers, Hall effect sensors, magneto-strictive transducer, Smart sensors, Fiber optic sensors.	06
	Introduction to signal conditioning: Concept of signal conditioning, Op-amp circuits used in instrumentation, Instrumentation amplifiers, analogue-digital sampling, introduction to A/D and D/A conversion, signal filtering, averaging, grounding, and shielding. Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	10

Recommended Books-

1. D A Bell, "Electronic Instrumentation and measurement", 3rd edition, Oxford University Press, 2013.
2. J B Gupta, "A Course in Electronic and Electrical Measurements & Instrumentation", S K Kataria and Sons, 2014.
3. S M Sze, "Semiconductors sensors", John Wiley & Sons Inc.,2008.
4. D Patranabis, "Sensors and Transducers", Prentice Hall, 2nd edition, 2003.
5. D C Nakra and K K Chaudhary, "Instrumentation measurement and analysis",4th edition, Tata McGraw Hill, 2016.
6. A K Sawhney, "A course on electrical and electronic measurements and Instrumentation", Dhanpat Rai, 2016.

Subject Code : OEIE-711C
Title of the course : Introduction to Soft Computing

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: apply a soft computing methodology for a particular problem.

CO 2: exercise fuzzy logic and reasoning to handle uncertainty and solve engineering problems.

CO 3: implement genetic algorithms to combinational optimization problems.

CO 4: utilize neural networks to pattern classification and regression problems.

CO 5: implement various neuro fuzzy applications.

CO/PO Mapping:(Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	3	2	1	2	1	2	2	1	3	2
CO2	3	3	2	3	3	2	3	2	1	2	2	2	3	2
CO3	3	3	3	3	3	2	2	2	1	2	3	2	3	2
CO4	3	3	3	3	3	2	1	2	1	2	3	2	3	2
CO5	3	3	3	3	3	2	2	1	1	2	1	2	3	2

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction to fuzzy logic:** Basic concepts of fuzzy logic, fuzzy sets and crisp sets, fuzzy set theory and operations, properties of fuzzy sets, fuzzy and crisp relations relations, fuzzy to crisp conversion.	08
	Fuzzification and defuzzification: Fuzzy Membership functions, interference in fuzzy logic, fuzzy if-then rules, fuzzy implications and fuzzy algorithms, defuzzification, fuzzy controller, Industrial applications.	08
	Introduction to genetic algorithm(GA): Basic concepts, working principle, procedures of GA, flowchart of GA, genetic representations, (encoding) initialization, and selection , genetic operators, mutation, generational cycle, applications.	08
Unit-2	**Neural networks:** Neuron, nerve structure and synapse, artificial neuron and its model, activation functions, neural network architecture: single layer and multilayer feed forward networks, recurrent networks, various learning techniques; perception and convergence rule, auto-associative and hetro-associative memory.	08
	Neural network models: Architecture: perceptron model, solution, single layer artificial neural network, multilayer perception model; back propagation learning methods, effect of learning, effecting backpropagation training, introduction to CNN, architecture, various layers, activation function.	08
	Neuro fuzzy systems: Adaptive neuro-fuzzy inference systems, architecture, hybrid learning algorithm, learning methods that cross-fertilize ANFIS and RBFN, coactive neuro fuzzy modelling, framework neuron functions for adaptive networks, neuro networks, neuro fuzzy spectrum. Projects related to this course should be given to students (in groups) in order to promote team work and ethical values.	08

Recommended Books-

1. I Goodfellow, Y Bengio and A Courville "Adaptive Computation and machine Learning Series", MIT Press,2016.
2. T J Ross, "Fuzzy Logic with Engineering Applications", 3rd edition, Wiley, 2011.
3. S Haykin, "Neural Networks and learning Machines",3rd edition, Pearson Education,2016.
4. S N Sivanandam and S N Deepa, "Introduction to Genetic Algorithms", Springer, 2008.
5. S. Rajasekaran and G A V Pai, "Neural Networks, Fuzzy Logic and Evolutionary Algorithms: Synthesis and Applications",2nd edition, Prentice Hall India, 2017.
6. D K Pratihar, "Soft computing: Principles and Applications" Alpha Science International,2013.

Subject Code : Process control

Title of the course : OEIE -711D

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: do mathematical modelling of various processes, basic control actions.

CO 2: understand characteristics of different controllers.

CO 3: select, design and tune a controller to suit a particular process.

CO 4: design the characteristics of final control elements.

CO 5: understand the control schemes applied to various processes.

CO/PO Mapping:(Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	2	1	2	1	1	3	1	2	3	1
CO2	3	2	3	3	3	3	3	2	3	2	3	3	3	3
CO3	3	2	1	2	2	1	2	1	2	3	1	2	3	2
CO4	3	3	3	3	3	3	3	3	3	2	3	3	3	3
CO5	3	2	3	3	3	3	3	2	3	2	3	3	3	3

Theory:

Unit	Main Topics and Course Outline	Hour(s)
Unit-1	**Introduction to Process Control**: Need for process control, Hardware elements of a process control, Need for Mathematical modelling, Mathematical model of pressure ,level and thermal processes.	08
	Servo and regulator operation, Batch & Continuous process, Concept of self-regulation, Dead time, Degrees of freedom.	06
	Various Controllers and its Characteristics: Basic control actions, Characteristics of ON- OFF, Single speed **floating** controllers. Proportional, Integral and Derivative control modes, P+I, P+D a P+I+D control modes, pneumatic and electronic controllers to real various control actions. Response of P, PI and PID controller various type of error signals.	10
Unit-2	**Final Control Elements**: I/P, P/I converters, Pneumatic and electric actuators. Types of control valves , Valve positioner and its importance , Inherent and Installed characteristics of control valve.	09
	Advanced Control Methods : Feed forward control ,Ratio Control, Inferential control , Split range control, Cascade control.	08
	Design Considerations: Control valve sizing , selection criteria.	07

Reference Books:

1. G Stephanopoulos, "Chemical Process Control", Pearson Education, 2015.
2. S Bhanot, "Process Control: Principles and Applications", Oxford University Press, 2008.
3. K Kant, "Computer- Based Industrial Control", 2nd edition, Prentice Hall India, 2010.
4. C D Johnson, "Process Control Instrumentation Technology", 8th edition, Pearson Education, 2015.
5. B G Liptak, "Process Control: Instrument Engineer,' Handbook", 3rd edition, Butterworth Heinemann, 1995.
6. B W Bequette, "Process Control: Modeling, Design and Simulation", Prentice Hall, 2003.
7. D E Seaborg, D A Mellichamp and T F Edgar, "Process Dynamics and Control", 3rd edition, John Wiley & Sons, 2010.
8. F G Shinskey, "Process Control Systems: Application, Design and Tuning", 4th edition, McGraw Hill Higher Education, 1996.
9. G K Mcmillan and D M Considine, "Process/Industrial Instruments and Controls Handbook", 5th edition, McGraw Hill Professional, 1999.
10. P Harriott, "Process Control", McGraw Hill Education, 2001.

Subject Code : OEIE-711E

Title of the course : Environmental Instrumentation

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: understand instrumentation, control and various detectors used for environment.

CO 2: study water quality, its parameters, various analysers and their application. **CO 3:** become conversant in water treatment techniques and instrumentation used. **CO 4:** analyse waste water monitoring, treatment and latest treatment plants.

CO 5: study air pollution, its monitoring and rain water harvesting.

CO/PO Mapping:(Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	2	1	2	1	1	3	1	2	3	1
CO2	3	2	3	3	3	3	3	2	3	2	3	3	3	3
CO3	3	2	1	2	2	1	2	1	2	3	1	2	3	2
CO4	3	3	3	3	3	3	3	3	3	2	3	3	3	3
CO5	3	2	3	3	3	3	3	2	3	2	3	3	3	3

Theory

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction:** Necessity of instrumentation & control for environment, sensor requirement for environment. Instrumentation methodologies: ultraviolet analysers, total hydrocarbon analysers using flame ionization detector, gas chromatography in environmental analysis, photo ionization, portable & stationary analytical instruments.	06
	Water quality: Quality of water: Standards of raw & treated water, sources of water & their natural quality, effects of water quality. Water quality parameters: Thermal conductivity, detectors, opacity monitors, pH analysers& their application, conductivity analysers& their application. Water treatment: Requirement of water treatment facilities, process design.	08
	Water treatment techniques: Sedimentation & flotation: General equation for settling or rising of discrete particles, hindered settling, effect of temperature, viscosity, efficiency of an ideal settling basin, reduction in efficiency due to various causes, sludge, storage & removal, design criteria of settling tank, effect of temperature on coagulation. Ground water monitoring: Level measurement in ground water monitoring wells, laboratory analysis of ground water samples, instrumentation in ground water monitoring, instrumentation in assessment of soil & ground water pollution	10
Unit-2	**Waste water monitoring:** Waste water monitoring: Automatic waste water sampling, optimum waste water sampling locations, and waste water measurement techniques. Instrumentation set up for waste water treatment plant. Latest methods of waste water treatment plants. Air pollution: definitions, energy environment relationship, importance of air pollution, air pollution from thermal power plant, their characteristics & control. Air sampling methods &equipment's, analytical methods for air pollution studies. Control of air pollution.	12

	Air monitoring: Air monitoring: measurement of ambient air quality. Flow monitoring: Air flow measurement, gas flow, non-open channel flow measurement, open channel waste water flow measurement. Rain water harvesting: necessity, methods, rate of NGOs municipal corporation, Govt., limitations. Quality assurance of storage water.	12

Recommended Books-

1. M N Rao and H V N Rao, "Air pollution engineering", Tata Mcgraw Hill, 2000.
2. Wark and D Warner , "Air Pollution: Its Origin and Control", Pearson Education , 1997.
3. Weber and J Walter, "Physicochemical processes for water quality control", Wiley-Interscience, 1972.
4. L J Fritschen, Lloyd W. Gay, "Environmental Instrumentation", Springer ,2011

Subject Code : PEIE-611A

Title of the course : Biomedical Instrumentation

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: know about basic nervous, circulatory and respiratory system and origin of biopotentials.
CO 2: utilize the concept of various bioelectric signals and electrodes for EEG, EMG and ECG.
CO 3: have competency to acquire the data of cardiovascular, electrical activity of brain and respiratory system.
CO 4: exercise knowledge medical imaging, computerized ultrasonic diagnosis and types, X-Rays and computerized tomography and use them in diagnosis of disease.
CO 5: learn physiological parameters and components of biotelemetry system and their applications in medical field.

CO/PO Mapping:(Strong(S) / Medium(M) / Weak(W) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	3	2	2	1	2	2	3	3	1
CO2	3	2	2	2	2	2	3	2	2	1	2	2	3	1
CO3	3	2	2	2	2	2	1	1	2	2	1	1	3	1
CO4	2	3	2	2	3	2	2	2	1	1	2	3	3	1
CO5	3	2	1	2	3	2	1	1	2	2	2	3	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Physiological systems of body:** Brief description of nervous, circulatory and respiratory systems, the body as a control system, the nature of bioelectricity, the origin of bio potentials.	06
	Bio electric signals and electrodes: Electro conduction system of the heart, the ECG waveform, neuron potential, muscle potential, electrodes for biophysical sensing, skin-contact-impedance, electrodes for EEG, EMG and ECG, electrical conductivity of electrode jellies and creams.	06
	Cardiovascular measurements: The standard lead system, the Electrocardiography (ECG) preamplifier; ECG machines, cardiac monitors, blood pressure measurements, direct and indirect, blood flow measurements, phonocardiography, defibrillators, pacemakers.	06
	Measurements of electrical activity in brain: Anatomy of human brain and nerve cell, Electroencephalography (EEG) electrodes and the 10-20 system, EEG amplitude and frequency bands, simplified block diagram, preamplifiers and EEG system specifications, EEG diagnostic uses and sleep patterns, visual and auditory evoked potential recordings, EEG system artefacts.	06
Unit-2	**Electromyography (EMG):** Muscular system, electrical signals of motor unit and gross muscle, human motor coordination system, electrodes, signal conditioning and processing, block diagram & description of Electromyography (EMG).	06
	Respiratory system measurements: Respiratory anatomy, parameters of respiration, regulation of respiration, respiratory system measurements, respiratory transducers and instruments, spirometry.	08
	Medical imaging: Introduction to medical imaging, computers in medical imaging, Computerized ultrasonic diagnosis and types, X-Rays, Computerized Tomography(CT), Computerized Emission Tomography(CET). Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	10

Recommended Books:

1. J G Webster, “Medical Instrumentation”, 4th edition, Wiley, 2015.
2. J J Carr, J M Brown, “Introduction to Biomedical Equipment Technology”, 4th edition, Pearson Education, 2000.
3. L Cromwell, F J Weibell, E A Pfeiffer “Biomedical Instrumentation and Measurement”, 2nd edition, Pearson Education India, 2015.
4. R S Khandpur, “Handbook of Biomedical Instrumentation”,3rd edition, McGraw Hill Education, 2014.
5. J L Semmlow and B Griffel, “Biosignal and Medical Image Processing”,3rd edition, CRC Press,2014.

Subject Code : PEIE-611B
Title of the course : Electrical Machines

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: understand construction and working principle of single phase and auto transformers.

CO 2: acquire the knowledge of three phase transformers, different type of winding connection, parallel operation and testing of transformers.

CO 3: explain construction and working principle of DC generator and various method of improving commutation.

CO 4: describe the construction, working principle and characteristics of DC motor.

CO 5: learn various method of starting and braking of DC motor.

CO/PO Mapping:(Strong(S) / Medium(M) / Weak(W) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2	2	1	1	1	2	1	2	2	3	3	1
CO2	3	2	2	2	1	2	2	2	2	2	2	3	3	2
CO3	3	2	2	2	2	2	2	3	2	2	2	3	2	2
CO4	3	3	3	3	2	2	3	3	3	2	2	3	3	2
CO5	3	2	3	3	2	2	3	3	3	2	3	3	3	2

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**D.C. machines:** Working principle, construction of DC machines, armature windings, single and double layer winding diagrams, Electro Motive Force (E.M.F.) and torque equations, armature reaction, compensating winding, methods of excitation of DC. generators and their characteristics, working principle characteristics, starting of shunt and series motor, starters, speed control methods: field and armature control, testing: Swin burn's test, Hopkinson test, field test, estimation of losses and efficiency.	12
	Transformers: Working principle, construction of single phase transformer, EMF equation, phasor diagrams on no-load and on loaded conditions, open circuit and short circuit tests, equivalent circuit parameters estimation, voltage regulation and efficiency, parallel operation of single phase transformers, principle of operation, equivalent circuit and phasor diagrams, comparison with two winding transformer, different types of winding connections, voltage and current ratios, parallel operation of three phase transformers.	12
Unit-2	**Fundamentals of AC machine windings:** Physical arrangement of windings in stator and cylindrical rotor; slots for windings; single turn coil , active portion and overhang, full-pitch coils, concentrated winding, distributed winding, winding axis, air-gap, MMF distribution with fixed current through winding, concentrated and distributed, sinusoidally distributed winding, winding distribution factor, constant magnetic field, pulsating magnetic field , alternating current in windings with spatial displacement, magnetic field produced by a single winding, fixed current and alternating current pulsating fields produced by spatially displaced windings, revolving magnetic field.	08

	Induction machines: Construction, Types (squirrel cage and slip-ring), torque and slip, torque slip characteristics, equivalent circuit, phasor diagram, losses and efficiency, parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency), methods of starting, starting torque, full load torque and maximum torque, current speed characteristics, torque speed curves and operating region, power loss and efficiency, rotor output, synchronous watt, max power output, constructional features, double revolving field theory, equivalent circuit, determination of parameters. split-phase starting methods and applications.	08
	Synchronous machines: Constructional features, cylindrical rotor synchronous machine generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation, operating characteristics of synchronous machines, V-curves, salient pole machine, two reaction theory, analysis of phasor diagram, power angle characteristics. Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	08

Recommended Books-

1. A E Fitzgerald, C Kingsley and S D Umans, "Electric Machinery", 6th edition, McGraw Hill, 2005.
2. E H Langsdorff, "Principles of D.C. machines", McGraw Hill, 2013.
3. I J Nagrath and D P Kothari, "Electrical Machines", 5th edition, McGraw Hill Education, 2018.
4. M G Say, Alternating Current Machines, 3rd edition, CBS, 2002.
5. P S Bimbhra, "Electric Machines", 2nd edition, Khanna Publishers, 2017.

Subject Code : PEIE-611C
Title of the course : Industrial Safety

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO1: know about the safety standards which must be maintained in compliance with regulatory requirements.

CO2: demonstrate the knowledge of workplace injury prevention, risk management, and incident investigation.

CO 3: demonstrate knowledge of different types of exposure and biological effects.

CO 4: acquire knowledge of contemporary issues of pollution and its control methods.

CO 5: implement the concept of industrial hygiene.

CO/PO Mapping:(Strong(S) / Medium(M) / Weak(W) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	2	3	3	3	3	3	2	3	1	3	1
CO2	3	2	2	2	2	2	2	2	2	2	3	2	3	1
CO3	2	2	3	2	2	3	3	2	2	2	3	2	3	1
CO4	3	3	3	2	2	3	3	2	3	3	3	2	3	1
CO5	3	3	3	2	3	3	3	2	2	3	2	2	3	1

Unit	Main Topics & Course Outline	Hour(s)
Unit-1	**Introduction:** Introduction to the concept of safety, safety provisions in the factory act laws related to the industrial safety, measurement of safety performance, safety audit, work permit system, injury and accidents, definitions, unsafe act, unsafe condition, causes, investigations and prevention of accidents, hazards, type of industrial hazards, nature, causes and control measures, hazard identifications and control techniques, HAZOP, FMEA, FMECA. Summarization of International and National standards related to this course.	12
	Concept of Industrial hygiene, programmed: Recognition ,evaluation, control, noise source ,effects and noise control, exposure limits standards, hearing conservation programmed, fire :fire load, control and industrial fire protection systems, fire hydrant and extinguishers, electrical hazards, protection and interlock, discharge rod and earthling device, safety in the use of portable tools.	12
Unit-2	**Logics of consequence analysis:** Estimation, toxic release and toxic effects, threshold limit values, emergency planning and preparedness, air pollution classification, dispersion modelling, pollution source and effects, control method and equipment's gravitational settling chambers, cyclone separators, fabric filter systems, scrubbers.	12
	Concept of reliability: Definition-Failure rate and Hazard function, system reliability models series, parallel systems, reliability hazard function for distribution functions, exponential normal, lognormal, Weibull and gamma distribution.	12

Recommended Books-

1. K S N Raju, “Chemical Process Industry safety”, Tata McGraw Hill Education,2014.
2. I T Cameron and R Raman, “Process Systems Risk Management” Volume 6, Elsevier Academic press,2005.
3. A K Gupta, “Industrial Safety and Environment”, Laxmi Publications,2006.
4. J E Daugherty, “Industrial Safety Management: A Practical Approach”, Government Institutes Inc. U.S., 1999.
5. L M Deshmukh, “Industrial Safety Management”, McGraw Hill Education, 2017.

1.

Subject Code : PEIE-621A
Title of the course : Biomedical Signal and Image Processing

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:
After successful completion of course, the students should be able to
CO 1: describe, analyze, characterize and design bio-amplifiers.
CO 2: identification of problems of physical challenged persons and solutions for the improvement of social life.
CO 3: acquire the fundamental concepts of a digital image processing system such as image acquisition, enhancement, segmentation, transforms.
CO 4: implement new algorithms for processing the images for better results.
CO 5: design and implement algorithms on MATLAB platform for digital image processing operations.

CO/PO Mapping:(Strong(S) / Medium(M) / Weak(W) indicates strength of correlation)													
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	2	1	1	2	1	3	2	3	1
CO2	3	3	3	3	2	2	3	2	1	3	1	2	3	1
CO3	3	2	3	2	3	2	2	2	2	1	2	2	3	1
CO4	3	2	3	1	3	2	2	3	2	2	3	2	3	1
CO5	3	2	3	3	2	3	2	1	2	1	3	1	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Bio electric amplifiers:** Bioelectric amplifiers, operational amplifiers, basic amplifier configurations, multiple-input circuits, differential amplifiers, signal processing circuits, isolation amplifiers, chopper stabilized amplifiers, input grounding.	08
	Signal processing and recording circuits: Processing and recording of ECG, EEG, EMG, visual and auditory evoked potentials, electrostatic and electromagnetic coupling to AC. signals, input guarding, grounding, optical isolation, patient isolation and accident prevention, computer aids for blind and visually handicapped and deaf.	08
	Fundamentals of digital image and transforms: Elements of visual perception, image sampling and quantization, neighborhood pixel relationships, basic image operations: arithmetic, geometric and morphological, image transform: 2D DFT, discrete cosine, sine, Haar, and Hadamard transform.	08
Unit-2	**Image enhancement**: Basic gray level transformation, histogram processing, smoothening by spatial filters, smoothening, frequency domain filters, color image processing, color image transformation.	08
	Image segmentation: Basic gray level transformation, histogram processing, smoothening by spatial filters, smoothening, frequency domain filters, color image processing, edge detection, basic global thresholding, region based segmentation, watershed segmentation algorithm.	08
	Image restoration and reconstruction of images: Image degradation models, algebraic approach to restoration, inverse filtering, least mean square filter, image reconstruction from projections. Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	08

Recommended Books:

1. W K Pratt, “Introduction to Digital Image Processing”, CRC Press, 2013.
2. G R Sinha and B C Patel, “Medical Image Processing: Concepts and Applications”, Prentice Hall India, New ,2014.
3. R C Gonzalez, R E Woods and S E Eddins, “Digital Image Processing using Matlab”, McGraw Hill Education, 2nd edition, 2017.
4. J G Webster, “Medical Instrumentation”, 4th edition, Wiley, 2015.
5. J J Carr, J M Brown, “Introduction to Biomedical Equipment Technology”, 4th edition, Pearson Education, 2000.
6. L Cromwell, F J Weibell, E A Pfeiffer “Biomedical Instrumentation and Measurement”, 2nd edition, Pearson Education India, 2015.
7. R S Khandpur, “Handbook of Biomedical Instrumentation”,3rd edition, McGraw Hill Education, 2014.
8. J L Semmlow and B Griffel, “Biosignal and Medical Image Processing”,3rd edition, CRC Press,2014.

Subject Code : PEIE-621B
Title of the course : Power Electronics and Drives

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:
After successful completion of course, the students should be able to
CO 1: explain the need and role of power electronic switches, their properties and characteristics.
CO 2: analysis and design of AC-DC converters, AC-AC converters and DC-DC converters.
CO 3: analysis and design of inverters which consist of half and full bridge, single and three phase etc.
CO 4: know topologies of voltage source inverters.
CO 5: study of power electronics with drives.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):														
COs	Programme Outcomes (POs)/Program Special Outcome (PSOs)													
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2	1	2	2	2	1	2	1	1	3	1	2
CO2	3	2	3	2	3	3	3	1	2	1	3	2	1	2
CO3	3	2	3	2	3	2	2	1	2	1	3	2	2	1
CO4	3	3	3	3	3	1	3	1	2	1	3	2	2	1
CO5	3	2	3	3	2	2	1	1	3	1	3	2	2	1

Unit	Main Topics and Course outlines	Hour(s)
Unit-1	**Introduction:** Need of switching and role of power electronic switches, properties and characteristics of various power electronic switches : power Diode, Thyristor, Gate Turn Off (GTO), power transistor, Power Metal Oxide Semiconductor Field Effect Transistor (MOSFET), Insulated Gate Bipolar Transistor (IGBT), Metal Oxide Semiconductor (MOS) controlled Thyristor, static induction devices, gate triggering circuit and protection circuits, selection criteria of these switches for various applications, basic concept of phase control.	09
	Phase controlled converters: Single Phase half wave and full wave controlled rectifiers with R, RL, RLC and RLE load, with and without freewheeling diode, three phase half controlled and full controlled converter, different loads, with and without freewheeling diode, effect of source impedance, principle of dual converters.	09
	Chopper: Chopper classification, operation, control strategies, chopper configurations, thyristor chopper circuit, Jone's chopper, Morgan chopper, AC chopper, source filter, multiphase chopper, fly back converters.	06
Unit-2	**Cycloconverter:** Basic principle, single phase to single phase cycloconverter, three phase half wave cycloconverter, control circuits, comparison between cycloconverter and DC link converter.	09
	DC-AC converters (inverters): Classification, single phase half bridge voltage source inverter, single phase full bridge inverter voltage control of single phase inverter PWM inverter.	06
	Drives: Control of DC, drives, scheme for DC motor speed control, single phase separately excited drive, single phase series DC motor drives, DC chopper drives, PLL control of DC. drives principle of operation, speed control of induction motor, stator voltage control, variable frequency control, rotor resistance control, drive selection. Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	09

Recommended Books:

1. B K Bose, “Modern Power Electronics and AC drives”, Prentice Hall India, 2005.
2. M H Rashid, “Power Electronics: Devices, Circuits and Applications” ,4th edition, Pearson Education,2017.
3. N Mohan, T M Undeland and W B Robbins, Power Electronics: Converters, Applications and Design, 3rd edition, Wiley, 2007.
4. N Kularatna, “DC Power Supplies: For Power Management and Surge Protection for Power Electronic System”, CRC Press, 2012.
5. D W Hart, “Power Electronics”, McGraw Hill Education, 2010**.**
6. M Singh and K Khanchandani, “Power Electronics”, 2nd edition, McGraw Hill Education,2017.

Subject Code : PEIE-621C
Title of the course : Telemetry and Data Acquisition

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: analyze various data acquisition systems, their components and applications.

CO 2: learn methods of data transmission, transmission channels and different type of modulation.

CO 3: describe construction and working principle of digital to analog and analog to digital converters.

CO 4: acquire knowledge of block diagram, classification, working principle of different telemetry system.

CO 5: know about the construction and working principle of display system and recorders.

CO/PO Mapping:(Strong(S) / Medium(M) / Weak(W) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	3	2	2	3	3	3	3	3	1
CO2	3	2	2	2	2	3	2	2	3	3	2	2	3	1
CO3	3	2	2	3	3	3	2	1	2	2	2	2	3	2
CO4	3	1	2	2	3	2	2	2	1	3	2	1	3	2
CO5	3	2	2	2	2	2	3	2	2	3	2	1	3	2

Unit	Main Topics and Course Outline	Hour(s)
Unit-1	**Data acquisition systems (DAS):** Block diagram of data acquisition system, analog and digital acquisition systems, review of signal conditioning circuits using op amp, single channel data acquisition, multi-channel DAS, computer based DAS, data logger, applications of DAS.	08
	Data transmission system: Methods of data transmission, transmission channels and media, analog modulation and demodulation, amplitude, frequency and phase modulation and their circuits, comparison between frequency & amplitude, introduction to ASK, FSK,PSK, pulse modulation (PAM, PDM, PPM, PCM), delta modulation, adaptive data modulation, digital data codes, error correcting and error detecting codes, pulse code formats used in data transmission, radio link, frequency division and time division multiplexing, time division multiplexing using mechanical commutator and electronic time division multiplexing system.	08
	Signal converters: Digital to Analog(D/A) converters, R-2R and binary weighted type D/A and Analog to Digital (A/D) converters, flash type, successive approximation type, dual slope type and counting converter type A/D.	08
Unit-2	**Introduction to telemetry principles:** Definition, generalized block diagram of telemetry System, classification of telemetry system, working principle, salient features and applications of the following telemetry systems: dc voltage, current and position telemetry system, pulse telemetry system, force balance telemetry system Introduction to satellite telemetry and fiber optic telemetry system, introduction to WDM (wavelength division multiplexing).	12
	Display systems: Construction, principle of operation and salient features of various kinds of display devices.	06
	Recorders: Working principle, Construction, operation and salient features of strip chart recorder, X-Y recorder and magnetic recorders.	06

	Projects related to this course should be given to students (in groups) in order to promote team work and ethical values.	

Recommended Books-

1. A K Sawhney, "Electrical and Electronic Measurement and Instrumentation", Dhanpat Rai, 2016.
2. D Patranabis, "Telemetry Principles", Tata McGraw Hill., 1999.
3. E L Gruenberg, "Handbook of Telemetry & Remote Control", Tata McGraw Hill, digitized 2007.
4. H S Kalsi, "Electronic Instrumentation and Measurement",4th edition, Tata McGraw Hill, 2019.
5. F Carden, R Henry and R Jedlica, "Telemetry system Engineering",2nd edition, Artech House, 2002.
6. R N Baral, "Telemetry and Data Transmission", S K Kataria and Sons, 2012.

Subject Code : PEIE 711A

Title of the course : Wind and Solar Energy Systems

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: understand the energy scenario and the consequent growth of the power generation from renewable energy sources.

CO 2: understand the basic physics of wind and solar power generation.

CO 3: understand the power electronic interfaces for wind and solar generation.

CO 4: understand the issues related to the grid-integration of solar and wind energy systems.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	1	2	1	3	2	3	2	2	3	1
CO2	2	1	1	1	1	3	3	3	2	3	3	2	3	2
CO3	3	2	3	1	1	3	2	3	2	3	3	2	2	2
CO4	3	2	3	1	1	3	2	3	2	3	3	2	2	1

Unit	Main Topics and Course Outline	Hour(s)
Unit 1	**Physics of wind power:** History of wind power, Indian and Global statistics, wind physics, Betz limit, tip speed ratio, stall and pitch control, wind speed statistics-probability distributions, wind speed and power, cumulative distribution functions.	06
	Wind generator topologies: Review of modern wind turbine technologies, fixed and variable speed wind turbines, induction generators, doubly ,fed induction generators and their characteristics, permanent magnet synchronous generators, power electronics converters, generator-converter configurations, converter control.	10
	The Solar resource: Introduction, solar radiation spectra, solar geometry, earth -sun angles, observer sun angles, solar day length, estimation of solar energy availability.	08
Unit-2	**Solar photovoltaic:** Technologies-Amorphous, monocrystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, power electronic converters for solar systems, maximum power point tracking (MPPT) algorithms, converter control**.**	08
	Network integration issues: Overview of grid code technical requirements, fault ride-through for wind farms, real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances, power quality issues, power system interconnection experiences in the world, hybrid and isolated operations of solar PV and wind systems.	08
	Solar thermal power generation: Technologies, parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis.	08

Recommended Books-

1. T Ackermann, “Wind Power in Power Systems”, Wiley-Blackwell, 2005.
2. G M Masters, “Renewable and Efficient Electric Power Systems”, 2nd edition, Wiley-Blackwell, 2013.
3. S P Sukhatme and J K Nayak, “Solar Energy”,4th edition, McGraw Hill Education,2017.
4. S Heier and R J Waddington, “Grid integration of wind energy conversion systems” 2nd edition, Wiley,2006.
5. G N Tiwari, “Solar Energy: Fundamental, Design, Modelling and Applications”, Narosa Publications, 2012.
6. D P Kothari, K C Singal and R Rajan, “Renewable Energy Sources and Emerging Technologies”, 2nd edition, Prentice Hall India,2011.

Subject Code : PEIE-711 B
Title of the course : Telemedicine and Robotic- Surgery

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:
After successful completion of course, the students should be able to
CO 1: apply multimedia technologies in telemedicine.
CO 2: use protocols for secure transmission of data.
CO 3: apply telehealth in healthcare.
CO 4: use the principle behind robotic drive system and end effectors.
CO 5: us**e** machine vision robot kinematics.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	1	3	2	3	1	2	1	1	2	3	2
CO2	3	3	3	3	2	2	3	2	3	3	1	2	3	2
CO3	3	3	3	2	3	2	2	2	2	2	2	2	3	2
CO4	2	2	2	1	3	2	2	3	2	2	2	1	3	2
CO5	2	2	2	2	2	3	3	2	2	3	3	1	3	2

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Telemedicine and Health**: History and evolution of telemedicine, functional diagram of telemedicine system, telemedicine, telehealth, tele care, organs of telemedicine, global and Indian scenario, ethical and legal aspects of telemedicine, confidentiality, social and legal issues, safety and regulatory issues, advances in telemedicine.	08
	Telemedicine technology: Principles of multimedia - text, audio, video, data, data communications and networks, PSTN, POTS, ANT, ISDN, internet, air/ wireless communications: GSM satellite, and microwave, modulation techniques, types of antenna, integration and operational issues, communication infrastructure for telemedicine – LAN and WAN technology, telemedicine using world wide web (www). video and audio conferencing. clinical data, local and centralized.	08
	Telemedicine standards: Data security and standards: encryption, cryptography. protocols: TCP/IP, ISO-OSI, standards to followed DICOM, HL7, H. 320 series (video phone based ISBN) T. 120, H.324 (video phone based PSTN), video conferencing, real-time telemedicine integrating doctors / hospitals, cyber laws related to telemedicine.	08
Unit-2	**Introduction to Medical Robotics** : Introduction to medical robotics (applications and paradigms), Basic kinematics concepts (forward, inverse, remote center of motion), basic control concepts (impedance, admittance), surgery for engineers, interventional radiology for engineers.	08
	Minimally Invasive Surgery (MIS): Human-machine interfaces, teleoperation, cooperative manipulation, port placement for MIS, robot design concepts, video images in MIS, augmented reality, minimally invasive surgery training.	08
	Image-Guided Interventions: Medical imaging modalities (e.g., MRI, US, X-ray, CT), robot compatibility with medical imagers, image segmentation and modeling, tracking devices, frames and transformations, surgical navigation, calibration, rigid and non-rigid registration. Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	08

Recommended Books:

1. J J Carr, J M Brown, “Introduction to Biomedical Equipment Technology”, 4th edition, Pearson Education, 2000.
2. J J Craig, “Introduction to Robotics Mechanics and Control”,3rd edition, Pearson, 2009.
3. M P Groover, "Industrial Robots - Technology, Programming and Applications", McGraw Hill, New York, 2008
4. A C Norris, “Essentials of Telemedicine and Telecare”, Wiley-Blackwell, 2001.
5. R Wootton, J Craig and V Patterson, “Introduction to Telemedicine”,2nd edition, Royal Society of Medicine Press, 2006.
6. O Ferrer-Roca and M Sosa– Iudicissa, “Handbook of Telemedicine”, Volume 54, IOS Press, 2002.

Subject Code : PEIE-711C

Title of the course : Non-Linear and Optimal Control

L	T	P	Credits	Weekly Load

3	**0**	**0**	**3**	**3**

Course Outcomes:

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

CO 1: recognize features of nonlinear system.

CO 2: analyze of non-linear systems using describing function and phase plane method.

CO 3: construct phase plane plots**.**

CO 4: analyze the Lyapunov stability properties for nonlinear systems.

CO 5: analyze optimal control problems, their classification along with performance indices and selection of dynamic optimization.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	2	3	1	3	2	2	2	3	2
CO2	3	3	2	3	3	3	2	1	2	1	3	1	3	2
CO3	3	2	3	2	2	2	3	2	3	3	2	2	3	2
CO4	2	2	2	2	3	3	2	3	2	3	3	1	3	2
CO5	3	3	3	2	2	2	2	2	3	3	1	2	3	2

Unit	Main Topics and Course Outline	Hour(s)
Unit-1	**Non-linear control systems:** Introduction to non-linear feedback control system, different types of non-linearities, special features of non-linear systems: limit cycles, jump resonance and sub harmonics resonance etc., definition of describing function. (D.F.), D.F.'s for various non-linearities, D.F. analysis of non-linear control systems, stability analysis using Limit cycles, and jump resonance.	08
	Phase plane analysis: Phase-plane analysis for nonlinear systems, singular points, construction of phase-plane plots for non -linear systems.	08
	Lyapunov's stability analysis: Introduction, concept of local, global and asymptotic stability, Lyapunov's Stability criterion, the direct method of Lyapunov and the linear systems, methods of constructing Lyapunov function for non-linear system.	08
Unit-2	**Introduction to optimal control:** Introduction to optimal control problems, classification of optimal control problems, performance indices for optimal control and their selection, problem formulation using calculus of variation.	12
	Parametric Optimization: Regulator problem, tracking problem, convex set and convex function, convex optimization problem, quadratic optimization problem. Projects related to this course should be given to students (in groups) in order to promote team work and ethical values.	12

Recommended Books-

1. B C Kuo, “Automatic Control System”, 9th edition, Wiley, 2014.
2. I J Nagrath and M Gopal, “Control System Engineering”, 6th edition, New Age International Publishers, 2017.
3. K Ogata, “Modern Control Engineering”, 5th edition, Pearson Education India, 2015.
4. R C Dorf and R H Bishop, “Modern Control System”, 12th edition, Pearson Education India, 2013.
5. J J Distefano, A R Stuberud and I J Williams, “Schaum’s Outlines of Theory and Problems of Feedback and Control Systems”, 2nd edition, Tata McGraw Hill,2007.
6. L Grune and J Pannek “Nonlinear Model Predictive Control: Theory and Algorithms”,2nd edition, Springer,2017.

Subject Code : PEIE-712A
Title of the course : Digital Signal Processing

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:
After successful completion of course, the students should be able to
CO 1: exercise discrete Fourier transform (DFT), its properties, convolution and associated methods.
CO 2: know about Fast Fourier transform (FFT), decimation in time and frequency.
CO 3: develop Finite Impulse Response (FIR), Infinite Impulse Response (IIR) filter and analyze their design techniques.
CO 4: analyze structure of FIR and IIR filters for direct, cascade and parallel arrangement.
CO 5: apply digital signal processing for the analysis of real-life signals.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	1	1	1	2	1	1	2	3	1
CO2	3	2	2	2	1	1	1	1	2	1	1	2	3	1
CO3	3	2	2	2	1	1	1	1	2	2	1	2	3	1
CO4	3	2	2	2	1	1	1	1	2	2	1	2	3	1
CO5	3	2	2	2	1	1	1	1	2	2	1	2	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**The discrete Fourier Transform:** Definition of DFT and relation to Z-transform, properties of the Discrete Fourier Transform (DFT), Linear and periodic convolution using the DFT, zero padding, spectral leakage, resolution and windowing in the DFT.	08
	The Fast Fourier transform: Decimation in time Fast Fourier Transform (FFT), decimation in frequency FFT. positive displacement, frequency domain analysis, Parseval's Identity, implementation of discrete time systems.	08
	FIR and IIR filters: Window design techniques, Kaiser window design technique, equiripple approximations, Bilinear transform method, examples of bilinear transform method.	08
Unit-2	**Structures and Properties of FIR and IIR filters and review:** IIR - direct, parallel and cascaded realizations., FIR – direct and cascaded realizations, coefficient quantization effects in digital filters, parametric and non-parametric spectral estimation, introduction to multi-rate signal processing.	08
	Applications of digital signal processing : Correlation functions and power spectra, stationary processes, optimal filtering using ARMA Model, linear mean-square estimation, Wiener filter.	08
	Introduction to DSP Processor Architecture: Basic architectural features, DSP processor computational building blocks, bus architecture and memory, data addressing capabilities, address generation unit. Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	08

Recommended Books:

1. J G Proakis and D G Manolakis, "Digital Signal Processing: Principles, Algorithms, and Applications", 4th edition, Pearson, 2007.
2. J McClellan, R Schafer and M A Yoder "DSP First",2nd edition, Pearson Education India, 2016.
3. E W Kamen and B Heck, "Fundamentals of Signals and Systems",3rd edition, Pearson Education, 2006.
4. AV Oppenheim, A S Willsky and S H Nawab, "Signals and Systems", 2nd edition, Pearson, 2015.
5. H P Hsu, "Signals and Systems", Schaum's series, 2nd edition, Tata McGraw Hill Education, 2017.
6. S Haykin and B V Veen, "Signals and Systems", 2nd edition, John Wiley and Sons, 2007.

Subject Code : PEIE-712B

Title of the course : Optimization Techniques

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: develop the concept of optimization problems.

CO 2: analyze unconstrained optimization problem using various gradient, direct search techniques.

CO 3: solve constrained optimization problems.

CO 4: solve multi-objective optimization problems.

CO 5: solve the optimization problem using random search methods.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	1	2	1	1	1	1	2	3	1
CO2	3	3	3	2	2	1	1	2	1	1	2	2	3	1
CO3	3	3	3	2	2	1	2	2	1	2	2	3	3	1
CO4	2	3	3	2	2	3	1	2	1	2	2	3	3	1
CO5	3	3	3	2	2	3	2	1	1	2	2	3	3	1

Unit	Main Topics and Course Outline	Hour(s)
Unit-1	**Optimization Problem:** Definition, types, optimality criteria, single-variable optimization, exhaustive search, region elimination, Fibonacci search and golden section search, cubic interpolation method, Newton-Raphson bisector and secant method.	12
	Multivariable Optimization Algorithms: Direct search methods-evolutionary simplex, Hooke-Jeeves pattern search, gradient based method, steepest method, Newton conjugate gradient method.	12
Unit-2	**Constrained Optimization:** Kuhn Tucker condition, transformation methods, penalty function, method of multipliers, sensitivity analysis, interior point optimization.	08
	Non-Traditional Optimization: Genetic algorithms, Particle Swarm Optimization(PSO) for constrained optimization, simulated annealing, multi objectives optimization problems, weighting method, $\in$- constrained method, decision-making, min-max problem.	08
	Metaheuristic: Classes of difficult problems and corresponding search spaces, classes of metaheuristics, overall structure of a metaheuristic algorithm, efficiency of metaheuristics, comparison of metaheuristics, multi objective optimization problem, multi-modal optimization, applications of metaheuristic algorithms for networks design, data mining, scheduling etc. Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	08

Recommended Books:

1. J Branke, K Deb, K Miettinen and R Slowinski, "Multiobjective Optimization: Interactive and Evolutionary Approaches", Springer, 2008.
2. S S Rao, "Engineering Optimization: Theory and Practice", 4th Edition, Wiley Publication, 2009.
3. G C Onwubolu, "Emerging Optimization Techniques in Production Planning & Control", Imperial College Press, 2002.
4. X Yang, "Optimization Techniques and Applications with Examples", Wiley,2018.
5. H.A Taha., "Operations Research: An Introduction",10th edition, Pearson, 2017.
6. A Ravindran , K M Ragsdell. and G V Reklaitis., "Engineering Optimization Methods and applications", 2nd edition, Wiley,2006.

Subject Code : PEIE-712C
Title of the course : Virtual Instrumentation

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: exercise basics of digital image generation, processing, sampling and quantization.

CO 2: know about image transforms techniques and image enhancement techniques.

CO 3: become conversant in 2-D system, spectral density function, estimation and information theory.

CO 4: analyze image restoration including models, filters and digital processing.

CO 5: develop process of image segmentation, image data compression and associated techniques.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1	2	1	2	2	1	2	1	2	3	1
CO2	3	3	2	2	3	1	1	2	2	3	2	2	3	1
CO3	2	2	2	3	2	1	2	2	2	3	2	2	3	1
CO4	2	2	2	2	3	2	2	2	2	2	3	3	3	1
CO5	2	2	3	3	3	1	3	2	2	3	3	3	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction to Virtual Instrumentation:** Historical perspective, classification of different instruments / instrumentation system, definition and architecture of virtual instrumentation system, salient features and application area of virtual instrumentation.	06
	Data flow and programming techniques: Graphical programming in data flow, comparison with conventional programming, popular data flow and VI software packages, building a VI front panel and block diagram, sub VI.	08
	Programming techniques: For and while loops, case and sequence structure, formula nodes, local and global variables, array and clusters, charts and graphs, string and file I/O, event driven programming.	10
Unit-2	**Data acquisition basics:** ADC, DAC, I/O, counters and timer, PC hardware structure, timing, interrupts, DMA, software and hardware installation, configuring data acquisition hardware using the drives in application software, use of DAQ library functions for different analog and digital input/output operations.	06
	Common instrument interfaces: RS 232, RS485, GBIP, use of library functions to communicate with different instruments, introduction to VISA.	06
	Applications of VI: Measurement of max, min, peak-peak voltage, time period of a signal, power spectrum and logging Fourier transform, correlation methods, windowing and filtering.	06
	Networking in Labview: Labview as a network client server, publishing vis on web, projects related to this course should be given to students (in groups) in order to promote team work and ethical values.	06

Recommended Books:

7. Sanjay Gupta, "Virtual Instrumentation Using Labview", 2nd edition, McGraw Hioll Education,2017.
8. J Travis and J Kring, "LabVIEW for Everyone", 3rd edition, Prentice Hall India,2006.
9. R Jennings and F D A Queva, "Lab view Graphical Programming", 5th edition, McGraw-Hill Education, 2019.
10. P A Blume, **"**LabVIEW Style Book", Prentice Hall India,2017.
11. J Jarome, "Virtual Instrumentation using Labview, Prentice Hall India,2010.
12. R Bitter, T Mohiuddin and M Nawrocki, Labview Advanced Programming Techniques2nd edition,CRC Press,2017.

Subject Code : PEIE-721A
Title of the course : Robotics

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: learn the fundamentals of robotics, various actuators and transmission systems.

CO 2: study various sensors for motion, detection and machine visiontechniques.

CO 3: become conversant in various end effectors, gripping mechanism and arm kinematics in robots.

CO 4: manipulate robot arm dynamics & trajectory using Lagranges Euler, Newton Euler formulations.

CO 5: analyze case studies.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	1	2	1	3	2	2	1	3	2
CO2	3	3	2	2	3	2	2	2	3	2	2	2	3	2
CO3	3	3	3	2	2	2	2	1	3	1	1	1	3	2
CO4	2	2	3	2	2	2	2	1	3	2	2	2	3	2
CO5	3	3	3	3	3	3	1	2	3	2	2	1	3	2

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Fundamentals of robot technology:** Robots in science fiction, automation and robotics, Asimov's laws of Robotics, definition of robot, anatomy of a robot, classification (type of control, capability, configuration and mobility), use of robots, robot motions and degrees of freedom, joint notation scheme, work volume, speed of motion, load carrying capacity, speed of response and stability, precision of movement. Summarization of International and National standards related to this course.	06
	Actuators and power transmission system: Pneumatic, hydraulic, electric, DC servomotor, stepper motor, AC servomotors ,gears, power screws, pulleys, chains and harmonic drives, horse power, electric motor efficiency.	06
	Transducer and sensors: Position sensors, potentiometers, resolvers, encoders, velocity sensors, tactile sensors, touch sensors (capacitance, resistance, resistive material, etc.), force sensors (force sensing resistor, capacitance, force sensing wrist, joint sensing, and tactile array sensors), proximity sensors, optical proximity sensors/range sensors (two emitter proximity sensor, ranging light based sensor, LIDAR, etc.) , acoustic sensors, magnetic sensors.	06
	Machine vision: Introduction, the sensing and digitalizing function in machine vision, imaging devices, lighting techniques, ADC, image processing and analysis, image data reduction, segmentation feature extraction, object recognition, training the vision system, robotic applications.	06
Unit -2	**Robot end effectors:** Type of end effectors, mechanical grippers, basic definitions and operations, type of gripper mechanism, other types of grippers (vacuum cups, magnetic grippers, adhesive grippers, and hooks and scoops), tools, the robot to end effector interface ,checklist of factors in the selection and design of grippers.	06

	Robot arm kinematics: Construction of manipulator, the direct kinematics problem, the inverse kinematics problem, inverse transform techniques for Euler Angles solution, geometrical approach.	06
	Robot arm dynamics & planning of manipulator trajectories: Lagrange Euler formulation, kinetic energy of a robot manipulator, potential energy of robot manipulator, motion equations of a manipulator, Newton Euler formulation, rotating coordinate system, moving coordinate system. Joint interpolated trajectory, planning of Cartesian path trajectories, four types of robot controls.	06
	Case studies: Hill climbing techniques, multiple robots, machine interface, robot cell design, selection of robot. Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	06

Recommended Books-

1. H H Poole, "Fundamental of Robotics engineering", Springer, 2012.
2. P Corke, "Robotics Vision and Control: Fundamental Algorithms in MATLAB", 2nd edition, Springer, 2017.
3. K M Lynch, and F C Park, "Modern Robotics Mechanics, Planning and Control", Cambridge University Press,, 2017.
4. B Siciliano, L Sciavicco, L Villani and G Oriolo, "Robotics Modelling, Planning and Control", Springer, 2010.
5. I J Nagrath and R K Mittal, "Robotics and Control", McGraw Hill,2008.

Subject Code : PEIE-721B

Title of the course : Computer Control of Processes

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: acquire knowledge of computer control system.

CO 2: know about Programmable Logic Controller(PLC) including its characteristic and classification.

CO 3: know about distributed control system and its configuration.

CO 4: analyze SCADA system, its hardware and software interfacing and applications.

CO 5: design cloud based process applications.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2	3	2	3	2	3	2	3	3	1
CO2	3	2	2	2	2	1	2	1	2	3	2	2	3	1
CO3	3	2	2	2	2	1	1	2	2	2	2	3	3	1
CO4	3	3	3	3	3	2	1	2	2	2	2	2	3	1
CO5	3	2	3	2	3	3	2	3	3	3	3	2	3	1

Unit	Main Topics and Course Outline	Hour(s)
Unit-1	**Introduction:** Hierarchical computer control system, data acquisition system, stand-alone data acquisition, PC based data acquisition, analog signal conditioning, analog isolation, surge protection, digital signal conditioning, digital isolation, analog multiplexer, data loggers, supervisory control computer based controllers, direct digital control (DDC), smart transducers and transmitters, smart pressure transmitter, smart temperature transmitter, smart control valve, capabilities of smart transducer. Summarization of International and National standards related to this course.	12
	Programmable Logic Controller (PLC): PLC versus relay, characteristic functions of a PLC ,PLC versus PC,PLC block diagram, input (I)/ output (O) configuration, direct I/O , Parallel I/O, Serial I/O, slice I/O, input and output module (discrete and analog), input and output devices – RS 232, 488 and 485, CPU, memory unit, input image file, output image file, power supply ,program loaders, hand held and computer based loaders, types of PLC software , programming languages – ladder programming, file organizing and addressing, instruction set , timers and counters instructions, communication instructions, I/O and Interrupt instructions , math instruction, logical instruction, complete scan cycle ,program execution, different types of PLC, system installation recommendations.	12
Unit-2	**Distributed control systems (DCS):** PLC versus DCS, DCS configuration, control room for DCS, the control console equipment, displays, software configurations, relay rack mounted equipment, local control units, communication between components, data highway design, highway compatibility, data highway communications, network access methods.	10
	Introduction to Supervisory Control and Data Acquisition (SCADA) system: Definition of SCADA, elements of SCADA system block diagram, communication in SCADA,SCADA hardware and Software, applications ,IoT based SCADA systems.	08
	Communication systems: MAP/TOP protocol, types of bus: Field Bus, Rack Bus, PROFIBUS, FIPBUS, Comparison of buses, HART protocol.	06

	Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	

Recommended Books:

1. B G Liptak, "Process Control: Instrument Engineers' Handbook", 3rd edition, Butterworth Heinemann, 1995.
2. D E Seaborg, D A Mellichamp and T F Edgar, "Process Dynamics and Control", 3rd edition, John Wiley & Sons, 2010.
3. G K Mcmillan and D M Considine, "Process/Industrial Instruments and Controls Handbook", 5th edition, McGraw Hill Professional, 1999.
4. K Kant, "Computer- Based Industrial Control", 2nd edition, Prentice Hall India, 2010.
5. P Harriott, "Process Control", McGraw Hill Education, 2001.
6. S Bhanot, "Process Control: Principles and Applications", Oxford University Press, 2008.
7. S K Singh, "Industrial Instrumentation and Control", McGraw Hill Education, 3rd edition, 2017.
8. C D Johnson, "Process Control Instrumentation Technology", 8th edition, Pearson Education,2015.
9. M. Chidambaram, "Computer Control of Processes", Narosa Publication, 2006.

Subject Code : PEIE-721C
Title of the course : Introduction to MEMS

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: acquire the knowledge of Micro-Electro-Mechanical Systems (MEMs) and its scope.

CO 2: learn the bulk micromachining process.

CO 3: become conversant in classification and working of physical micro sensors.

CO 4: learn the various fabrication techniques.

CO 5: acquire the knowledge of surface micromachining.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
Cos	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2	1	1	1	2	2	1	2	1	3	3	1
CO2	3	2	2	1	2	2	2	2	1	2	1	2	3	1
CO3	3	2	2	2	2	2	3	2	1	2	1	3	3	1
CO4	3	2	2	1	2	2	2	1	1	2	1	2	3	1
CO5	3	1	2	2	2	2	2	3	1	2	1	2	3	1

Unit	Main Topics & Course Outline	Hour(s)
Unit-1	**Introduction:** Historical background: silicon pressure sensors, micromachining, micro electro mechanical systems. microfabrication and micromachining: integrated circuit processes, potential of MEMS in industry.	06
	Bulk micromachining: Bulk micromachining: isotropic etching and anisotropic etching, wafer bonding, high aspect-ratio processes (LIGA).	06
	Physical micro sensors: Physical micro sensors: classification of physical sensors, integrated, intelligent, or smart sensors, sensor principles and examples: thermal sensors, electrical sensors, mechanical sensors, chemical and biosensors. micro actuators: electromagnetic and thermal micro actuation, mechanical design of micro actuators, micro actuator examples, micro valves, micro pumps, micro motors, Micro actuator systems, Ink-Jet printer heads, Micro-mirror TV Projector.	12
Unit-2	**Fabrication techniques-I:** Microstereolithography (MSL) for 3D fabrication, two photon MSL, dynamic mask MSL, scanning systems, Opto mechatronics system for MSL, ceramic and metal Microstereolithography.	08
	Fabrication techniques-II: Ceramic and metal Microstereolithography. scattering of light by small particles. effect of particle properties on accuracy and resolution of component in ceramic and metal MSL. Monte Carlo ray tracing method. Nanolithography.	08
	Surface micromachining: Surface Micromachining: One or two sacrificial layer processes, surface micromachining requirements, polysilicon surface micromachining, other compatible materials, silicon dioxide, silicon, micro motors, gear trains, mechanisms. characterization of MEMS devices. Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	08

Recommended Books-

1. V K Jain, "Introduction to Micromachining", Narosa, 2010.
2. M J Madou, "Fundamentals of Microfabrication and nanotechnology", 3rd edition, CRC Press, 2011.
3. N P Mahalik, "MEMS", McGraw Hill Education, 2009.
4. G Kibria, B Bhattacharyya and J P Davim, "Non-traditional Micromachining Processes", Springer, 2017.
5. S D Senturia, "Microsystem Design", Springer, 2005.
6. T R Hsu, "MEMS and Microsytems: Design, Manufacture, and Nanoscale Engineering", 2nd edition, Wiley, 2008.
7. V Vardan K J Vinoy and K A Jose, "RF MEMS and Their Applications", Wiley, 2011.

Subject Code : PEIE-722A
Title of the course : Advanced Microprocessors and Microcontrollers

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:
After successful completion of course, the students should be able to
CO 1: study 8086 microprocessor along with its the internal architecture.
CO 2: develop knowledge of programming of 8086 microprocessor using assembly language.
CO 3: analyze 8051 microcontroller design, memory mapping and serial data transmission.
CO 4: be conversant in application of 8051 microcontroller and its architecture and design.
CO 5: interfacing of 8086 with peripheral devices.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	3	2	1	1	1	1	3	2	3	1
CO2	3	3	3	2	1	1	1	1	2	2	2	2	3	1
CO3	3	3	2	3	2	1	1	1	1	2	3	2	3	1
CO4	3	2	3	2	1	1	1	2	1	2	1	2	3	1
CO5	3	2	3	2	3	3	2	2	2	3	2	3	3	1

Unit	Main Topics and Course Outline	Hours(s)
Unit-1	**Introduction to 16-bit microprocessor:** 8086 internal architecture, instruction format, addressing modes, program development steps, and 8086 instruction set, assembler directives, assembly language, program development tools,8086 system connections, timing, troubleshooting: pin-diagram, max/min. modes, timing diagrams.	08
	Programming of 8086: Simple sequence programs, jumps, flags, conditional jumps and sub- programs.	08
	Interfacing of 8086: Memory interfacing, programmable parallel ports & handshake, 8254 software- programmable timer/counter, 8259 A priorities interrupt controller, interfacing to peripheral devices, 8279 D/A and A/D converters.	08
Unit -2	**Introduction:** Microprocessor, micro-controllers and their comparison. The 8051 Architecture: Introduction, 8051 micro-controller hardware, input/ output, pins, ports and circuits, external memory, counters and timers, serial data input/ output, interrupts.	08
	8051 Assembly Language Programming: Instruction format and addressing techniques, instruction set and Programming.	08
	8051 Microcontroller Design: Micro-controller specification, external memory and memory space decoding, reset and clock circuits, expanding input/output (I/O), memory mapped I/O, memory address decoding, memory access times, testing the design, timing subroutines, lookup tables for the 8051, serial data transmission. Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	08

Recommended Books-

1. B Ram., "Fundamentals of Microprocessors and Microcontrollers", Dhanpat Rai Publications, 2012.
2. B B Bray, "The INTEL Microprocessors 8086/88, 80186, 286, 386, 486, Pentium Pro Processors, Architecture, Programming and Interfacing", 8th edition, Pearson education India,2008.
3. D V Hall, "Microprocessors and its Interfacing", 3rd edition, McGraw Hill Education, 2017.
4. R Gaonkar, "Microprocessor Architecture, Programming and Applications with the 8085",6th edition Penram International,2013.
5. A K Ray and K Bhurchandi, "Advanced Microprocessors and Peripherals",3rd edition, McGraw Hill Education,2017.
6. K J Ayala, "The 8051 Microcontroller-Architecture, Programming and Application",2nd edition, Penram International,2007.
7. M Mahalakshmi, "8051 Microcontroller Architecture, Programming and Application", Laxmi Publications, 2012.
8. M A Mazidi and J G Mazidi, "The 8051 Micro-controller & Embedded System", 2nd edition, Pearson Education, 2008.

Subject Code : PEIE-722B
Title of the course : Power Plant Instrumentation

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: get an overview on power generation through various methods.
CO 2: understand the important power plant measurements and devices.
CO 3: understand basic boiler control techniques.
CO 4: understand the turbine control techniques.
CO 5: important parameters to be monitored and controlled in a thermal power plant.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	2	2	1	2	1	2	2	3	1
CO2	3	3	2	2	1	1	2	1	1	2	1	1	3	1
CO3	3	2	1	3	3	3	3	2	2	3	3	2	3	1
CO4	3	2	2	2	2	2	1	2	2	2	2	2	3	1
CO5	3	3	2	2	1	2	2	2	1	2	1	1	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Overview of Power Generation:** Survey of methods of power generation: hydro, thermal, nuclear, solar and wind power, importance of instrumentation in power generation, thermal power plant, building blocks, combined cycle system, combined heat and power system, sub critical and supercritical boilers.	12
	Measurements in Power Plants: 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.	12
Unit-2	**Boiler Control I:** Combustion of fuel and excess air, firing rate demand, steam temperature control, control of deaerator, drum level control, single, two and three element control, furnace draft control, implosion, flue gas dew point control, trimming of combustion air, soot blowing.	09
	Boiler Control II: Burners for liquid and solid fuels, burner management, furnace safety interlocks, coal pulverizer control, combustion control for liquid and solid fuel fired boilers, air/fuel ratio control, fluidized bed boiler, cyclone furnace.	09
	Control of Turbine: types of steam turbines, impulse and reaction turbines, compounding, turbine governing system, speed and load control, transient speed rise, free governor mode operation, automatic load frequency control, turbine oil system, oil pressure drop relay, oil cooling system, turbine run up system. Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	06

Recommended Books:

1. D Lindsely, J Grist and D Parker, "Thermal Power Plant Control and Instrumentation: The control of boilers and HRSGs (Energy Engineering)",2nd edition, Institution of Engineering and Technology, 2018.
2. E B Woodruff, H B Lammers and T F Lammers, "Steam Plant Operation",9th edition, McGraw Hill Education, 2011.
3. R K Rajput., "A Text Book of Power Plant Engineering." 5thedition, Lakshmi Publications, 2013.
4. B G Liptak, "Instrumentation in Process Industries", Chilton Book Company, 2005.
5. P K Nag, "Power Plant Engineering", McGraw-Hill Education, 4th edition, 2014.
6. P Tamilmani," Power Plant Instrumentation", Sams Publishers, 2018.
7. K Krishnaswamy and M P Bala., "Power Plant Instrumentation", 2nd edition, Prentice Hall India, 2013.

Subject Code : PEIE-722C
Title of the course : Modelling and Simulation

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes:

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

CO 1: become conversant in systems modelling and their computer simulation.

CO 2: know about simulation of continuous and discrete system with various distribution methods.

CO 3: analyze simulation experiments, learn to verify results and terminate running simulation.

CO 4: develop knowledge of simulation languages, their features and various operations.

CO 5: model stochastic network using simulation and its merits.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)													
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	2	2	1	1	1	2	2	3	2
CO2	3	2	2	2	2	2	1	2	1	2	2	1	3	2
CO3	3	3	2	2	1	2	2	2	2	1	1	2	3	2
CO4	2	2	1	1	3	2	2	1	1	1	2	2	3	3
CO5	3	3	2	3	2	1	1	2	1	1	1	1	3	3

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction:** Introduction to systems and models, computer simulation and applications.	04
	System simulation: Continuous system simulation, modelling continuous systems, simulation of continuous systems, discrete system simulation, methodology ,event scheduling and process interaction approaches, random number generation, testing of randomness, generation of stochastic variates ,random samples from continuous distributions, uniform distribution, exponential distribution, Erlang distribution, gamma distribution, normal distribution ,beta distribution, random samples from discrete distributions: Bernoulli, discrete uniform, binomial, geometric and Poisson.	10
	Evaluation and validation: Evaluation of simulation experiments, verification and validation of simulation experiments , statistical reliability in evaluating simulation experiments, confidence intervals for terminating simulation runs.	10
Unit-2	**Simulation languages:** Simulation languages, programming considerations, general features of GPSS, SIM SCRIPT and SIMULA. Simulation of queueing systems, parameters of queue, formulation of queueing problems, generation of arrival pattern, generation of service patterns, Simulation of single server queues, simulation of multi-server queues, simulation of random queues.	12
	Simulation of various networks: Simulation of stochastic network, simulation of PERT network, definition of network diagrams, forward pass computation, simulation of forward pass, backward pass computations, simulation of backward pass, determination of float and slack times determination of critical path, simulation of complete network, merits of simulation of stochastic networks. Projects related to this course should be given to students(in groups) in order to promote team work and ethical values.	12

Recommended Books:

1. V Mityushev, W Nawalaniec and N Rylko , "Introduction to Mathematical Modelling and Computer Simulation", CRC Press,2018.
2. A Puliafito and K S Trivedi, "System Modelling: Methodologies and Tools", Springer, 2019.
3. A M Law, "Simulation Modelling and Analysis", 4th edition, McGraw Hill Education, 2017.
4. J N Kapur, "Mathematical Modelling", 2nd edition, New Age International,2015.
5. K Velten., "Mathematical Modelling and Simulation**:** Introduction for Scientist and Engineers", Wiley, 2009.

Subject Code	**:**	**MDIE-511**
Title of the course	**:**	**Transducers and Signal Processing**

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

After successful completion of course, the students will be

CO1: exposed to various sensors and transducers for measuring mechanical quantities.
CO2: familiar with the specifications of sensors and transducers.
CO3: able to design signal conditioning circuits for various sensors and transducers.
CO4: exposed to advancements in sensor technology.
CO5: able to identify or use a transducer for a specific measurement application.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSO)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	3	1	3	1	2	2	2	2	3	2
CO2	3	2	1	1	3	1	3	1	2	2	2	2	3	2
CO3	2	2	3	3	3	3	3	3	3	3	3	3	3	3
CO4	2	3	1	1	3	1	3	1	3	2	2	2	3	2
CO5	3	3	2	3	3	3	3	3	2	3	3	3	3	3

Theory

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction**: Basic block diagram of generalized instrumentation system, general input-output configuration, definition of transducer, classification of transducers.	04
	Resistive transducers: Potentiometers, metal and semiconductor strain gauges, strain gauge applications, load and torque measurement, digital displacement sensors, RTDs, thermistors, Thermocouples	12
	Inductive and Capacitive Transducers: Measurement of self and mutual inductance, LVDT, Variable reluctance transducers, capacitive transducers: frequency response, advantaged disadvantages and uses of capacitive transducers Capacitance pick up, Condenser microphones, Differential capacitor pick up.	08
Unit-2	**Miscellaneous measurements**: Seismic transducer and its dynamic response, photoelectric transducers, Hall effect sensors, magnetostrictive transducer, optic sensors, eddy current transducers, proximity sensors, tacho-generators and stroboscope..	08
	Introduction to signal conditioning: Concept of signal conditioning, Op-amp circuits used in instrumentation, summer, buffer, integrator, differentiator, instrumentation amplifiers, analogue-digital sampling, signal filtering, averaging	08
	Signal Converters : Ratiometric converters, logarithmic converters, VCO , PLL , voltage to frequency converter, frequency to voltage converter , voltage to current converter, current to voltage converter.	08

Recommended Books-

1. A.K. Sawhney and Puneet Sawhney, "A course on electrical and electronic measurements and Instrumentation", Dhanpat Rai, 2012.
2. David A Bell, "Electronic Instrumentation and measurement", 3rd edition, Oxford University Press.
3. J.B Gupta, "A Course in Electronic and Electrical Measurements & Instrumentation", S K Kataria and Sons.
4. S.M Sze, "Semiconductors sensors", John Wiley & Sons Inc., 3rd Edition,2006.
5. Patranabis, "Sensors and Transducers", Prentice Hall, 2nd Edition, 2003.
6. H. S. Kalsi, "Electronic Instrumentation", Tata McGraw Hill (2006).
7. Joseph J Carr, "Elements of electronic instrumentation and measurement", Pearson Education (2005)
8. C. S. Rangan, G. R. Sharma and V. S. Mani, "Instrumentation Devices and Systems", Tata McGraw Hill (1998).

Subject Code : MDIE-521

Title of the course : Data Acquisition System

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

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

CO 1: analyze various data acquisition systems, their components and applications.

CO 2: learn methods of data transmission, transmission channels and different type of modulation.

CO 3: describe construction and working principle of digital to analog and analog to digital converters.

CO 4: acquire knowledge of block diagram, classification, working principle of different telemetry system.

CO 5: know about the satellite and fiber optic telemetry system.

CO/PO Mapping:(Strong(S) / Medium(M) / Weak(W) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	3	2	2	3	3	3	3	3	1
CO2	3	2	2	2	2	3	2	2	3	3	2	2	3	1
CO3	3	2	2	3	3	3	2	1	2	2	2	2	3	2
CO4	3	1	2	2	3	2	2	2	1	3	2	1	3	2
CO5	3	2	2	2	2	2	3	2	2	3	2	1	3	2

Unit	Main Topics and Course Outline	Hour(s)
Unit-1	**Data acquisition systems (DAS):** Block diagram of data acquisition system, analog and digital acquisition systems, single channel data acquisition, multi-channel DAS, computer based DAS, data logger, applications of DAS.	04
	Data transmission system : : Methods of data transmission, transmission channels and media, analog modulation and demodulation, amplitude, frequency and phase modulation and their circuits, comparison between frequency & amplitude, introduction to ASK, FSK,PSK, pulse modulation (PAM, PDM, PPM, PCM), delta modulation, adaptive data modulation, frequency division and time division multiplexing, time division multiplexing using mechanical commutator and electronic , time division multiplexing system.	12
	Error Detection and Correction: digital data codes: half binary and full binary transmission, return to zero and non-return type, unipolar and bipolar type, error detecting codes and error correction codes, pulse code formats used in data transmission	08
Unit-2	**A/D and D/A converters:** Digital to Analog(D/A) converters, R-2R and binary weighted type D/A and Analog to Digital (A/D) converters, flash type, successive approximation type, dual slope type and counting converter type A/D.	06
	Transmitters and Receivers:AM Transmitters-Low level and High level transmitters, AM Receivers, TRF receiver and super-hetrodyne receiver, FM Transmitters, FM Receivers, PCM transmitters and receiver	04
	Introduction to telemetry principles: Definition, generalized block diagram of telemetry System, classification of telemetry system, working principle, salient features and applications of the following telemetry systems: dc voltage, current and position telemetry system, pulse telemetry system, force balance telemetry system	08

	Satellite telemetry system : Introduction**, t**ypes of transmission**,** FDMA,CDMA,TDMA	03
	Fiber optic telemetry system: Introduction to fiber optics and signal transmission through optical fiber, WDM (wavelength division multiplexing),Coarse and dense WDM	03

Recommended Books-

1. A K Sawhney, "Electrical and Electronic Measurement and Instrumentation", Dhanpat Rai, 2016.
2. D Patranabis, "Telemetry Principles", Tata McGraw Hill., 1999.
3. E L Gruenberg, "Handbook of Telemetry & Remote Control", Tata McGraw Hill, digitized 2007.
4. H S Kalsi, "Electronic Instrumentation and Measurement",4th edition, Tata McGraw Hill, 2019.
5. F Carden, R Henry and R Jedlica, "Telemetry system Engineering",2nd edition, Artech House, 2002.
6. R N Baral, "Telemetry and Data Transmission", S K Kataria and Sons, 2012.

Subject Code : MDIE-611
Title of the course : Automatic Control System

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

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

CO 1: obtain the working mathematical model of a system.
CO 2: do the time-domain and frequency-domain analyses of the system.
CO 3: design the specifications of the control systems.
CO 4: obtain the state space analysis of the system.
CO 5: do the stability analysis of non-linear systems.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSO)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	2	3	1	3	2	2	2	3	1
CO2	3	3	2	3	3	3	2	1	2	1	3	1	3	1
CO3	3	2	3	2	2	2	3	2	3	3	2	2	3	1
CO4	2	2	2	2	3	3	2	3	2	3	3	1	3	1
CO5	3	3	3	2	2	2	2	2	3	3	1	2	3	1

Unit	Main Topics and Course Outline	Hour(s)
Unit-1	**Mathematical Modelling:** Mathematical modelling of electrical systems, mechanical systems, electro-mechanical systems. Laplace transforms, transfer functions, electrical analogues of other dynamical systems. Block diagrams, block diagram reductions. Signal flow graph, Mason's gain formula, linearity, time-invariance versus nonlinearity and time-variance.	08
	Time Response of dynamical systems Obtaining solutions from mathematical models. Poles and zeros and their effects on solutions, test-input signals, Step response of first and second order systems, time-domain specifications and their formulae.	08
	Stability Analysis: Definition of stability. Routh-Hurwitz test, general rules for constructing Root Loci, root-locus plots, positive feedback systems, conditionally stable systems, root loci for systems with transport lag.	08
Unit -2	**Frequency domain Analysis** Bode plot, Nyquist plot, Nyquist stability criterion, gain and phase margins, introduction to compensator design.	08
	State variable Analysis: Concepts of state variables, state space model, diagonalization of state matrix, solution of state equations, eigenvalues and stability analysis, concept of controllability and observability. .	06

	Non-linear systems Analysis Introduction, common nonlinear system behaviours, common nonlinearities in control systems, fundamentals, describing functions of common nonlinearities, stability analysis by describing function method, concept of phase plane analysis, construction of phase portraits, Lyapunov stability definitions	10

Recommended Books –

1. B C Kuo, "Automatic Control System", 9th edition, Wiley, 2014.
2. J J Distefano, A R Stuberud and I J Williams, "Schaum's Outlines of Theory and Problems of Feedback and Control Systems", 2nd edition, Tata McGraw Hill,2007.
3. I J Nagrath and M Gopal, "Control System Engineering", 6th edition, New Age International Publishers, 2017.
4. K Ogata, "Modern Control Engineering", 5th edition, Pearson Education India, 2015.
5. R C Dorf and RH Bishop, "Modern Control System", 12th edition, Pearson Education India, 2013.

6.

Subject Code : MDIE-621
Title of the course : Industrial Measurements

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

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

CO1: acquire the knowledge of purpose and scope of instrumentation in Industries.

CO2: become competent to handle of different types of temperature measuring instruments and their application in various Industrial processes.

CO3: become conversant in construction and working various pressure measuring instruments.

CO4: become conversant in construction and working various flow and level measurement devices used for industrial purposes.

CO5: understand the calibration of various industrial instruments and use of instruments for other parameter measurements like force, torque, viscosity ,humidity etc.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSO)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	1	3	1	3	1	2	3	3	1
CO2	3	3	3	3	3	3	3	3	3	3	2	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	2	2	1	3	3	3	1	3	1	2	3	3	1

Theory:

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Temperature measurement:** Introduction to temperature measurements, principle of vapour, gas, liquid filled thermometers, bimetallic thermometer, pressure spring thermometer , Thermocouple, Resistance Temperature Detector, Thermistor and its measuring circuits, Radiation pyrometers and digital thermometry.	08
	Level measurement: Introduction, Differential pressure level detectors, Capacitance level sensor, Ultrasonic level detectors , Gamma rays level measurement, level limit switches, level measurement of closed vessel.	08
	Force, torque, and shaft power: Basic methods of force measurement; characteristics of elastic force transducer-Bonded strain gauge, differential transformer, Piezo electric transducer, variable reluctance/FM-oscillator, digital systems. Loading effects; Torque measurement on rotating shafts, shaft power measurement, (dynamometers).	08
Unit- 2	**Pressure measurement:** Introduction, definition and units, Mechanical, Electro-mechanical pressure measuring instruments. Low pressure measurement, Transmitter definition and types, I/P and P/I Converters.	10
	Flow measurement: Introduction, definition and units, classification of flow meters, differential pressure and variable area flow meters, Differential pressure meter(primary elements)- theory, construction and applications of orifice plate, venturimeter, flow nozzle, pitot tube Positive displacement flow meters, Electro Magnetic flow meters.	10
	Miscellaneous measurement: Measurement of Viscosity ,pH ,Density Humidity ,Moisture , Specific gravity and Conductivity .	04

Recommended Books-

1. Ernest. O. Doebelin and Dhanesh. N. Manik, Doebelin's Measurement Systems, McGraw Hill Education, 6th Edition, 2011.
2. B. G. Liptak, "Process Measurement and Analysis", CRC Press, 4th Edition, 2003.
3. Patranabis D, "Principles of Industrial Instrumentation", Tata McGraw Hill, 3rd Edition, 2010.
4. B. E. Noltingk, "Instrumentation Reference Book", Butterworth Heinemann, 2nd Edition, 1995.
5. Douglas M. Considine, "Process / Industrial Instruments & Controls Handbook", McGraw Hill, Singapore, 5th Edition, 1999.
6. Andrew W.G, "Applied Instrumentation in Process Industries – A survey", Vol I &Vol II, Gulf Publishing Company, Houston, 2001
7. Spitzer D. W., "Industrial Flow measurement", ISA press, 3rd Edition, 2005.
8. Tony R. Kuphaldt, "Lessons in Industrial Instrumentation", Version 2.02, April 2014.

Subject Code : MDIE-711
Title of the course : Industrial Automation

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:
After successful completion of course, the students should be able to
CO 1: acquire knowledge of process automation techniques.
CO 2: design and development of PLC ladder programming for simple process applications.
CO 3: know about distributed control system and different communication protocols. **CO 4:** analyze SCADA system, its hardware and software interfacing and applications. **CO 5:** design cloud based process applications.

CO/PO Mapping:(Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	2	1	2	1	1	3	1	2	3	1
CO2	3	2	3	3	3	3	3	2	3	2	3	3	3	3
CO3	3	2	1	2	2	1	2	1	2	3	1	2	3	2
CO4	3	3	3	3	3	3	3	2	3	2	3	3	3	3
CO5	3	2	3	3	3	3	3	2	3	2	3	3	3	3

Theory:

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction:** Introduction and overview of Industrial automation ,automation strategy ,role of automation in industries, introduction to descriptive automation tools PLC, DCS, SCADA, Hybrid DCS/PLC, automation strategy evolution, control system audit, and performance criteria	06
	Hierarchical computer control system stand- alone and PC based data acquisition, analog and digital signal conditioning, data loggers, supervisory control, computer based ,controllers, direct digital control (DDC) .	05
	Programmable Logic Controller (PLC): Block diagram of PLC, different types of PLC, Type of input and output, Introduction to relay logic, Application of PLC.	08
	Introduction to Ladder logic programming: Basic instructions, Timer and Counter instruction- Arithmetic and logical instruction, communication instruction, I/O and Interrupt instructions - Case studies and examples for each instruction set.	05
Unit- 2	**Distributed control systems (DCS):** Introduction to DCS, PLC versus DCS, Block diagram and function of each component, control room for DCS, the control console equipment, engineering station interface, communication requirements, programming, functions including database management, reporting, alarm management, communication, third party interface, control, display, enhanced functions viz. advance process control, batch application, historical data management, OPC supports, security and access control.	08

	DCS Applications : Applications of DCS in Power plant, Iron plant, Steel plant, Cement plant.	04
	Introduction to Supervisory Control and Data Acquisition (SCADA) system: Definition of SCADA, elements of SCADA , communication in SCADA ,hardware and Software, applications of IoT based SCADA systems.	06
	Communication systems: MAP/TOP protocol, types of bus: Field Bus, Rack Bus, PROFIBUS, FIPBUS, Comparison of buses, HART protocol its frame structure, programming, implementation examples, benefits, advantages and limitation..	06

Recommended Books-

1. John W. Webb and Ronald A Reis, "Programmable Logic Controllers - Principles and Applications", Prentice Hall Inc., New Jersey, 5th Edition, 2002.
2. Lukcas M.P, "Distributed Control Systems", Van Nostrand Reinhold Co., New York, 1986.
3. Frank D. Petruzella, "Programmable Logic Controllers", McGraw Hill, New York, 4th Edition, 2010.
4. Deshpande P.B and Ash R.H, "Elements of Process Control Applications", ISA Press, New York, 1995.
5. Curtis D. Johnson, "Process Control Instrumentation Technology", Prentice Hall, New Delhi, 8th Edition, 2005.
6. Krishna Kant, "Computer-based Industrial Control", Prentice Hall, New Delhi, 2nd Edition, 2011.
7. Gary, Dunning, " Introduction to PLCs", Tata McGraw Hill, 2005

Subject Code : HDIE-611
Title of the course : Advanced Sensors

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

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

CO 1: understand recent trends in sensor technology and its engineering applications.
CO 2: gain knowledge on smart-sensor..
CO 3: gain knowledge on different concepts of smart sensors and systems, and their design methods.
CO 4: use smart chemical, robotics, fiber optics sensors, bio sensors in different application areas.
CO 5: understand the fabrication techniques (IC, MEMS/NEMS), data processing and coding methods & functions.

CO/PO Mapping:(Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	2	1	2	1	1	3	1	2	3	1
CO2	3	2	3	3	3	3	3	2	3	2	3	3	3	3
CO3	3	2	1	2	2	1	2	1	2	3	1	2	3	2
CO4	3	3	3	3	3	3	3	3	3	2	3	3	3	3
CO5	3	2	3	3	3	3	3	2	3	2	3	3	3	3

Theory:

Unit	Main Topics and Course Outline	Hour(s)
Unit-1	**Smart Sensors:** Introduction, Importance of sensor/smart sensor in automation. Features of Advanced sensing techniques. Introduction of advanced sensing materials. Properties (physical, electrical, chemical, biological) of materials which makes it suitable for sensing in different domain standards for smart sensor interface, Design and modelling issue in advanced sensing technique.	08
	Recent trends in sensor technology: Introduction, film sensors, thick film sensors, Thin film sensors, semiconductor IC technology-standard methods, thick film processes, thin film processes, thin film deposition methods, thin film characterization methods, thin film delineation technique, compatibility issues, Longmuir-Blodgett films for sensor materials, film forming apparatus, dipping-ion sensors-gas sensors. Applications of thin and thick film sensors.	08
	MEMS/NANO: Micro electromechanical systems (MEMS), Micromachining, Biomedical Applications, Nano-sensors, Carbon Nanotubes.	08
Unit-2	**Fibre optic sensors:** Fibre optic sensors for the measurement of temperature, pressure, displacement, turbidity, pollution.	06
	Chemical Sensors: Introduction, semiconductor gas detectors, Ion selective electrodes, conductometric sensors,mMass sensors, electro chemical sensors, potentiometric sensors, amperometric sensors, enhanced catalytic gas sensors	06
	Robotics sensors: Introduction, characteristics, types of sensors, touch or tactile sensors, binary and analog sensors, proximity sensors, types of proximity sensors, contact and non-contact proximity sensors, robotic vision.	06
	Biosensors: Enzyme sensors, Cell based biosensors using Microelectrodes, Biosensors in Food Analysis.	06

Reference Books:

1. Khazan AD, “Transducers and their Elements – Design and Applications,” Prentice Hall.
2. Patranabis D, “Sensors and Transducers,” Prentice Hall.
3. Middlehook S and Audet SA, “Silicon Sensors,” Academic Press.
4. Dorf RC, “Sensors, Nanoscience, Biomedical engineering and instruments,” CRC Press.
5. Zanger H and Zanger C, “Fiber optics Communication and other applications,” Macmillan publishing.
6. Joshi RM, “Biosensors,” ISHA Books.
7. Webster JG, “Medical Instrumentation, Application and Design,” Wiley India.

Subject Code : HDIE-612
Title of the course : Random and Stochastic Process

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

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

CO 1: understand the basic aspects of statistics, probability and random processes.

CO 2: understand the basic concepts of one and two random variables and their properties

CO 3: comprehend the knowledge of stochastic processes and its application

CO 4: apply the concept of mean square estimation

CO 5: identify the stationary process and types.

CO/PO Mapping:(Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	2	1	2	1	1	3	1	2	3	1
CO2	3	2	3	3	3	3	3	2	3	2	3	3	3	3
CO3	3	2	1	2	2	1	2	1	2	3	1	2	3	2
CO4	3	3	3	3	3	3	3	3	3	2	3	3	3	3
CO5	3	2	3	3	3	3	3	2	3	2	3	3	3	3

Theory:

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction:** Probability and induction, causality vs. randomness, set theory, probability space, conditional probability, combined experiments ,probability distribution function of discrete random variable, Distribution and density functions, specific random variables ,conditional distributions, various probability density functions.	08
	One Random variables: Expected value**,** function of random variable g(x), distribution of g(x), mean and variance, moments, characteristics functions, transformations of density and distribution functions ,convolution ,convolution theorem	08
	Two random variables: Bivariate distributions, one function of two random variables, two functions of two random variables, joint moments, joint characteristics functions, conditional distributions, conditional expected values, moments ,characteristics function ,joint characteristic function, marginal characteristic function, mean square estimation by a constant, mean square estimation by another random variable and a random variable by a constant, nonlinear mean square estimation of Y in terms of X ,linear mean square estimation, orthogonality principle.	08
Unit-2	**Stochastic processes:** Definitions, systems with stochastic inputs, power spectrum, discrete time processes, First and second order statistics and complex process, n-dimensional and complex process: mean, auto correlation, auto covariance, cross correlation, cross covariance, moment, Poission processes, Telegraphic signals: semi random and random.	08
	Stationary process: strict sense and wide sense stationary: other form of stationarity Transformation of stochastic process time invariant system without memory, stochastic	08

	continuity, stationary processes, time averages ergodicity, correlations, power spectrum, linear system, existence theorem, shot noise, thermal noise, Nyquist theorem, autocorrelation of thermal noise, average noise power, mean square periodicity and Fourier series, band limited processes. .	
	Mean square estimation: Introduction to linear mean square estimation ,orthogonality in LSME, prediction, filtering and prediction, Wiener Kolmogroff theory, solution of WienerHoff equation, Wide sense Markoff sequences, recursive filtering and Kalman filters	08

RECOMMENDED BOOKS:

1. A Papoulis and S ialliP U, "Probability, random variables and stochastic processes", Tata-McGraw Hill.
2. M.H Hayes, "Probability, random variables and stochastic processes", John Wiley & Sons.
3. H Stark and W J sdooW, "Probability and Random Processes with applications to signal processing", 3rd edition, Pearson Education, 2002.
4. K S Shanmugan, "Random Signal: Detection, Estimation and Data Analysis ", John Wiley & Sons, 1988.

Subject Code : HDIE-621
Title of the course : Wireless Sensor Networks

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

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

CO 1: design wireless sensor networks for a given application.

CO 2: understand emerging research areas in the field of sensor networks.

CO3: understand MAC protocols used for different communication standards used in WSN

CO 4: explore new protocols for WSN .

CO 5: gain knowledge of the operating system in this field.

CO/PO Mapping:(Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	2	1	2	1	1	3	1	2	3	1
CO2	3	2	3	3	3	3	3	2	3	2	3	3	3	3
CO3	3	2	1	2	2	1	2	1	2	3	1	2	3	2
CO4	3	3	3	3	3	3	3	3	3	2	3	3	3	3
CO5	3	2	3	3	3	3	3	2	3	2	3	3	3	3

Theory:

Unit	Main Topics & Course Outline	Hour(s)
Unit-1	Introduction to Sensor Networks, unique constraints and challenges, Advantage of Sensor Networks, Applications of Sensor Networks, Types of wireless sensor networks.	08
	Mobile Ad-hocNetworks (MANETs) and Wireless Sensor Networks, Enabling technologies for Wireless Sensor Networks. Issues and challenges in wireless sensor networks.	08
	Routing protocols, MAC protocols: Classification of MAC Protocols, S-MAC Protocol, B-MAC protocol, IEEE 802.15.4 standard and ZigBee	08
Unit-2	Dissemination protocol for large sensor network. Data dissemination, data gathering, and data fusion; Quality of a sensor network; Real-time traffic support and security protocols.	08
	Design Principles for WSNs, Gateway Concepts Need for gateway, WSN to Internet Communication, and Internet to WSN Communication	06

	Single-node architecture, Hardware components & design constraints.	06
	Operating systems and execution environments, introduction to Tiny OS and nesC	04

Recommended Books-

1. W Dargie and C Poellabauer, “Fundamentals Of Wireless Sensor Networks Theory And Practice”, John Wiley & Sons Publications, 2011.
2. S Soloman, “Sensors Handbook" by McGraw Hill publication 2009.
3. F Zhao and L Guibas, “Wireless Sensor Networks”, Elsevier Publications, 2004.
4. K Sohrby and D Minoli, “Wireless Sensor Networks”: Technology, Protocols and Applications, Wiley-Inter science.
5. P Levis and D Gay "Tiny OS Programming” by Cambridge University Press 2009.

Subject Code ` : HDIE-711
Title of the course : Internet of Things and Its Applications

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:
After successful completion of course, the students should be able to:
CO 1: understand internet of Things and its hardware and software components
CO 2: interface I/O devices, sensors & communication modules
CO 3: remotely monitor data and control devices
CO 4: develop real life IoT based projects
CO 5: understand security aspects of IoT

CO/PO Mapping:(Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	2	1	2	1	1	3	1	2	3	1
CO2	3	2	3	3	3	3	3	2	3	2	3	3	3	3
CO3	3	2	1	2	2	1	2	1	2	3	1	2	3	2
CO4	3	3	3	3	3	3	3	3	3	2	3	3	3	3
CO5	3	2	3	3	3	3	3	2	3	2	3	3	3	3

Theory:

Unit	Main Topics & Course Outline	Hour(s)
Unit-1	**Introduction to Internet of Things**: Overview of internet of things- the edge, cloud and the application development, anatomy of the thing, industrial internet of things (IoT - Industry 4.0), real time diagnostics, design and development for IoT, understanding system design for IoT, design model for IoT.	08
	Elements of IoT ;hardware component : Hardware components, communication, sensing, actuation, I/O interfaces,CC3200 Launchpad for Rapid Internet Connectivity with Cloud Service Providers	10
	Understanding Internet Protocols: Simplified OSI model, network topologies, standards, types of internet networking – ethernet, WiFi, local networking, bluetooth, Bluetooth Low Energy (BLE), Zigbee. Programming API's for communication Protocols-MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP.	06
Unit-2	**Securing the Internet of Things (IoT):** Security requirements in IoT architecture - security in enabling technologies, security concerns in IoT applications. security architecture in the internet of things, security requirements in IoT - insufficient authentication/authorization - insecure access control - threats to access control.	12
	IoT applications: IoT applications for smart homes, smart cities, smart parking, agricultural and healthcare.	12

Recommended Books-

1. Lucas Darnell,"The Internet of Things (A Look at Real World Use Cases and Concerns)", Kindle Edition, 2016.
2. Joe Biron & Jonathan Follett, "Foundational Elements of an IoT Solution – The Edge, The Cloud and Application Development", Oreilly,1st Edition, 2016.
3. Vijay Madisetti, Arshdeep Bahga, "Internet of Things, A Hands on Approach", University Press
4. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
5. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press
6. Jeeva Jose, "Internet of Things", Khanna Publishing House, Delhi
7. Adrian McEwen, "Designing the Internet of Things", Wiley
8. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill
9. Cuno Pfister, "Getting Started with the Internet of Things", O Reilly Media.

Subject Code : PHIE-721
Title of the course : Project Honors

L	T	P	Credits	Weekly Load
0	0	8	4	8

Course Outcomes:

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

CO 1: implement the project requiring individual and teamwork skills.

CO 2: update recent knowledge in the area of project.

CO 3: carry out design calculations and implementations in the area of project.

CO 4: communicate their work effectively through writing and presentation.

CO 5: handle professional responsibilities and respect for ethics.

CO/PO Mapping:(Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Programme Outcomes (POs)/ Program Specific Outcomes (PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	2	1	2	1	1	3	1	2	3	1
CO2	3	2	3	3	3	3	3	2	3	2	3	3	3	3
CO3	3	2	1	2	2	1	2	1	2	3	1	2	3	2
CO4	3	3	3	3	3	3	3	3	3	2	3	3	3	3
CO5	3	2	3	3	3	3	3	2	3	2	3	3	3	3

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

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