Course Scheme for Undergraduate 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 Programme 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 teamwork 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 teamwork**: 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	**0**	**0**	**12**	**52**	**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 Conditioning	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	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	Sensors Technology	3	1	0	4	4
2	HDIE-612	Internet of Things	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	Industrial Automation	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

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

CO1: define the essential electric elements and components based on their electrical properties.

CO2: classify the various electrical engineering techniques used to analyze the behavior of electrical circuits.

CO3: list electrical engineering laws that implicate electrical elements and circuits.

CO4: develop a comprehensive understanding of the operating principles of electrical machines.

CO5: identify the various protection devices for electrical circuit troubleshooting.

Mapping Cos/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL2	BL1	BL6	BL1

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	2	2	1	3	1	2	-	3	3	-
CO2	3	2	2	-	1	2	1	3	1	2	-	1	3	-
CO3	3	-	2	3	1	1	1	1	2	2	2	3	3	-
CO4	2	1	2	1	2	-	2	1	2	2	2	3	2	1
CO5	2	2	2	1	1	1	1	1	2	3	3	2	3	2

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, Kirchhoff'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
	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

Unit-2	**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.	06

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
CO1: apply the knowledge of electrical engineering principles to solve dc and ac circuits.
CO2: formulate and analyze electrical circuits.
CO3: understand basic principles of electromagnetism to implement in electrical machines and transformers.
CO4: identify and select various electrical machines according to the applications.
CO5: apply the ethical principles for troubleshooting & installation of safety devices as per norms of engineering practice.

Mapping Cos/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL2	BL1	BL6	BL1

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	2	2	-	3	1	2	-	3	3	2
CO2	3	2	3	-	1	2	1	3	1	2	-	1	3	2
CO3	3	-	2	2	1	1	1	1	2	2	2	3	3	1
CO4	2	1	2	1	2	-	2	1	2	2	2	3	2	1
CO5	2	2	3	1	1	1	1	1	2	3	3	2	3	2

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 laws.
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
CO1: describe the use of various tools, components, and instruments.
CO2: develop work requiring individual and teamwork skill.
CO3: correlate the theoretical concepts with the practical outputs.
CO4: express their work effectively through verbal, written and gestural communication.

Mapping Cos/Bloom's Taxonomy Level (BLs)				
COs	CO1	CO2	CO3	CO4
BLs	BL1	BL3	BL4	BL6

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 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 (COs):

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

CO1: state various terms like: Node, Branch, Loop, Mesh, Open circuit, short circuit, Series and Parallel connections of Active and Passive elements.

CO2: convert a given circuit into an equivalent graph network of electrical circuits by employing the concepts of graph theory/ transfer functions.

CO3: employ network functions to obtain steady state response of an electrical circuit in the time domain.

CO4: transform given circuit components from time domain to frequency domain with the help of Laplace transform and **Report** stability with the help of Bode plots.

CO5: enumerate two-port networks in terms of generalized parameters and **reproduce** a network in frequency domain using foster and Cauer forms.

CO6: describe concept of filtering in both time and frequency domain.

Mapping COs/Bloom's Taxonomy Level (BLs)						
COs	CO1	CO2	CO3	CO4	CO5	CO6
BLs	BL1	BL2	BL3	BL2	BL1	BL1

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	1	1	2	2	1	-	3	3	1
CO2	3	3	1	1	2	1	1	2	2	1	-	3	3	1
CO3	3	3	1	1	2	1	1	2	2	1	-	3	3	1
CO4	3	2	1	1	2	1	-	2	2	2	-	3	3	1
CO5	3	3	1	1	2	1	1	2	2	1	-	3	3	1
CO6	3	2	-	1	1	2	1	3	1	2	-	3	3	-

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 (COs):

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

CO1: describe the structure and working principle of electronic components and devices.
CO2: analyze the BJT based amplifiers at low and high frequencies using hybrid model and Re- model.
CO3: apply the concept of feedback to design the various types of oscillators.
CO4: explain the characteristics of practical Operational amplifiers and discuss its applications in signal conditioning.
CO5: articulate the working of various waveform generators such as monostable multivibrator, a stable multivibrator, and PLL.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL4	BL3	BL2	BL3

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

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, a stable 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, C H 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

CO1: describe the operation of analog and digital instruments for the measurement of electrical quantities.

CO2: identify the appropriate bridge for the measurement of electrical circuit parameters.

CO3: apply the fundamentals of electronic devices such as BJT, FET and MOSFET in the operation of measuring instruments.

CO4: illustrate the operation of CRO, signal generator and analyzer for the measurement of various electrical parameters based on waveforms.

CO5: recall the fundamentals of electro-magnetism laws to understand the construction and working principles of various measuring instruments.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL2	BL3	BL3	BL1

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

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.	08
	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.	08
	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).	08
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.	08

	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.	05
	Instruments for generation and analysis of waveforms: Signal generators, function generator, wave analyzer, harmonic distortion analyzer, spectrum analyzer, spectrum analysis, Q-Meter.	05
	Frequency and time interval measurement: Frequency measurement, time period 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 (COs):
After successful completion of the course, the students should be able to
CO1: illustrate the forward bias and reverse bias characteristics of PN junction and Zener diode.
CO2: examine the various characteristics of full wave and half wave rectifiers, such as ripple factor, form factor, efficiency etc.
CO3: analyze the frequency response of a BJT when used in a CE configuration of amplifier circuit.
CO4: test the working of Operational amplifiers as an oscillator, wave generator, differentiator, and integrator.
CO5: articulate the role of 555 timers to design the circuits of monostable and a stable multivibrators.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL3	BL4	BL4	BL3

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

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 a stable 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

CO1: reproduce the knowledge of the characteristics, construction and working of measuring instruments.

CO2: choose the specific measuring instruments for the proficient measurement of various electrical and non-electrical parameters.

CO3: compare different transducers for the measurement of physical quantities like temperature, pressure, distance, and displacement.

CO4: experiment various instruments, DC bridges and AC bridges for the measurement of electrical and non-electrical parameters.

CO5: **analyze** the characteristics of a given signal from signal generator using Cathode Ray Oscilloscope (CRO).

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL3	BL4	BL4	BL4

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

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 (COs):

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

CO1: enumerate various number systems, their conversion, representation, and binary operations.

CO2: illustrate Boolean algebra and simplification techniques, encoders, decoders, and code conversion.

CO3: articulate working of latch, flip-flops, registers, counters, and their types.

CO4: **explain** basics of VHDL and design sequential circuit using VHDL.

CO5: **interpret** digital ICs, logic families, memories, and programmable logic arrays.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL2	BL3	BL3	BL2

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	2	2	2	-	2	1	3	3	-
CO2	3	-	1	-	1	2	2	2	-	2	1	3	3	-
CO3	3	2	2	1	-	2	2	1	1	1	2	2	2	-
CO4	3	1	2	-	1	2	2	2	2	1	2	3	2	-
CO5	2	-	2	-	2	2	1	2	1	-	1	3	3	2

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–Mc Cluskey algorithm, 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. DP 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

CO1: describe the concept of transducers and the related static and dynamic characteristics.
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.

Mapping Cos/ Blooms's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL2	BL3	BL3	BL4

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	2	1	3	1	-	3	3	3	-
CO2	3	-	-	1	-	1	-	-	1	-	1	1	2	1
CO3	3	2	2	1	2	3	1	2	2	2	3	3	1	3
CO4	3	2	2	1	-	2	-	2	1	1	2	2	2	2
CO5	3	3	3	2	1	2	1	2	1	1	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 & capacitive 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 (COs):
After successful completion of course, the students should be able to
CO1: define continuous and discrete time signals convolution and basic mathematical operations related to signals.
CO2: classify the given system in terms of stability, time variance, invertibility and causality under frequency domain and time domain.
CO3: calculate Fourier series coefficients and Fourier transform for classified signals.
CO4: describe the effects of sampling on a continuous time signal and digital signal processing.
CO5: analyze signal and system's stability and causality using Laplace and Z transforms.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL2	BL4	BL1	BL4

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	2	2	2	-	2	1	1	3	1
CO2	3	3	1	2	-	2	1	2	3	2	3	1	3	1
CO3	3	3	2	2	2	3	2	3	2	2	2	1	3	1
CO4	3	2	-	1	1	2	1	3	1	2	-	3	3	-
CO5	3	3	3	2	1	2	1	2	1	1	1	2	3	-

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
CO1: examine and verify the truth tables of TTL gates, universal gates.
CO2: develop and verify the truth tables of Half and Full adder, subtractor circuits.
CO3: test truth tables of Multiplexers 74150 and De multiplexer 74154.
CO4: develop and verify the truth tables of S-R (NOR/NAND gates based), J-K and D flip flops.
CO5: operate the counters, 4-bit shift register, modulo-4 counter using J K flip flops.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL3	BL3	BL4	BL3	BL3

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	2	2	2	2	2	1	1	2	1	3	1
CO2	3	1	-	1	1	1	-	2	1	1	2	1	3	1
CO3	2	1	-	-	-	-	-	2	2	1	3	2	3	1
CO4	2	1	3	3	3	3	3	3	2	2	3	2	3	1
CO5	3	1	2	2	2	2	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

CO1: **recall** the working principle of transducers for the measurement of parameters like displacement, temperature etc.

CO2: **calculate** the static and dynamic characteristics for different sensors applications

CO3: measure the effects of loading on the transducers.

CO4: differentiate between ideal and real characteristics of transducers.

CO5: design of circuits for integrating transducers in different applications for measuring and conditioning signals.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL3	BL5	BL2	BL6

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

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

CO1: develop the project requiring individual and teamwork skills.

CO2: correlate the theoretical concepts with the real-life industrial environment.

CO3: explain the role of various tools and measuring instruments used in industries.

CO4: express their work effectively through verbal, written and gestural communication.

Mapping Cos/Bloom's Taxonomy Level (BLs)				
COs	CO1	CO2	CO3	CO4
BLs	BL3	BL4	BL2	BL6

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 (COs):

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

CO1: describe the working principle behind the analytical and optical instruments.

CO2: apply the fundamentals of spectrometry, electron microscopy, and chromatography to identify the constituents of complex mixture.

CO3: discuss the significance of potentiometry and gas analyzer for on-line and off-line processes.

CO4: assess and suggest a suitable analytical method for specific purpose.

CO5: illustrate the data presentation and statistical analysis techniques of analytical instruments.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL3	BL2	BL5	BL3

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

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, 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.

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

CO1: apply the basics of engineering fundamentals to form mathematical models and to obtain transfer function or state space representation of an LTI control system.

CO2: categorize different types of system and identify the set of algebraic equations to represent and model a complicated system into a simplified form.

CO3: evaluate the performance of LTI systems for standard inputs.

CO4: analyze the stability of a control system using Root Locus, Bode Plot, Nyquist, Routh Hurwitz.

CO5: design the compensators and controllers to meet the given time and frequency domain specifications.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL3	BL4	BL4	BL4	BL5

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

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
	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: 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

Unit -2	**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, eigen values and stability analysis, concept of controllability and observability.	06
Projects related to this course should be given to students (in groups) in order to promote teamwork and ethical values.		

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: **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

CO1: visualize the theoretical concepts of P, I, PI, PD and PID controller responses in the practical platform.

CO2: sketch different stability plots of a system using Root Locus, Bode Plot etc.

CO3: simulate different process components like motors and synchro transmitter and receiver to understand the open loop and closed loop characteristics.

CO4: analyze the performance of different controllers and servo at different load conditions.

CO5: design the compensators and controllers to meet the given time and frequency domain specifications.

Mapping Cos/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL3	BL3	BL4	BL6

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	-	1	-	1	2	2	2	-	2	1	3	3	-
CO2	3	2	-	1	1	2	1	3	1	2	-	3	3	-
CO3	3	2	2	1	2	3	1	2	2	-	2	3	1	3
CO4	3	3	3	2	1	2	1	2	1	1	1	2	3	1
CO5	3	2	2	1	2	3	1	2	2	-	2	3	1	3

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 (COs):

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

CO1: describe the evolution and operation of 8-bit, 16-bit, 32-bit and 64-bit microprocessors.

CO2: illustrate the architecture, hardware structure, and timing diagram of 8085 microprocessors.

CO3: write an assembly language program of 8085 to perform various tasks such as arithmetic operations, add delay, generate different waveforms etc.

CO4: apply the knowledge to interface the external memory and peripheral devices (8255, 8254, 8279 etc.) with microprocessor.

CO5: compare the microprocessors with microcontrollers based on their functioning, hardware, and software characteristics.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL4	BL6	BL3	BL5

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

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, overview 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.	08
Projects related to this course should be given to students (in groups) in order to promote teamwork and ethical values.		

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

CO1: recognize the instrumentation measurement process in the industry applications.

CO2: develop the skills necessary to operate particular measuring devices in industrial environments.

CO3: explain the construction and operation of measuring instruments.

CO4: establish the calibration of various industrial instruments as per international and national standards.

CO5: consider the transducers to obtain an electrical response from the measuring equipment.

Mapping Cos/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL6	BL2	BL4	BL5

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	2	2	-	3	1	2	-	3	3	-
CO2	3	2	3	-	3	2	1	2	1	2	-	1	3	-
CO3	3	2	2	2	2	1	1	1	2	2	2	3	3	1
CO4	2	1	2	-	2	2	2	1	2	2	2	3	2	2
CO5	2	2	3	1	3	1	1	1	2	3	3	2	3	2

Unit	Main Topics and Course Outline	Hour(s)
Unit-1	**Temperature measurement:** Temperature scale and conversion, principle of vapor, 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.	08
	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.	06
	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, venturi meter, 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.	10

	Ultrasonic Meter, thermal flow meter, positive displacement meters, calibration of flow meters.	
Unit-2	**Field Measurements:** Level Measurement: Float, Bubbler, DP cell, Ultrasonic, Capacitive, radioactive type, radar, solid level detectors. Viscosity: Saybolt, Searle's rotating cylinder, Cone and plate, Falling and rolling ball, Rotameter. Density: Chain-balanced float type, Hydrometer (Buoyancy type), U tube type, Hydrostatic Head (Air bubbler, DP Cell). Humidity: resistive and capacitive type sensors Miscellaneous Sensors: pH sensors, Conductivity sensors. Moisture: Different methods of moisture measurements – Thermal, Conductivity and Capacitive sensors, Microwave, IR and NMR sensors, Application of moisture measurement – Moisture measurement in solids.	12
	Force, speed, acceleration, torque and shaft power Measurement: Force Measurement: Different types of load cells: Hydraulic, Pneumatic, Strain gauge, Magneto-elastic and Piezoelectric load cells. Speed measurement: Capacitive tacho, Drag cup type tacho, D.C and A.C tacho generators: Stroboscope, photo electric pickup. Torque Measurement: strain gauges, Relative angular twist and magneto elastic principle Acceleration Measurement: LVDT, piezoelectric, strain gauge and variable reluctance type accelerometers: Mechanical type vibration instruments – Seismic instrument as an accelerometer and vibrometer: Calibration of vibration pick-ups. Shaft Power Measurement: Dynamometers.	12
Projects related to this course should be given to students (in groups) in order to promote teamwork 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 (COs):

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

CO1: develop a program for addition, subtraction of numbers in decimal, hexadecimal and BCD system.

CO2: write a program to perform multiplication, division of 8-bit numbers, obtain largest, smallest number from an array and arrange data in ascending, descending order.

CO3: write a program to convert hexadecimal number into ASCII number and vice versa.

CO4: connect 8251 with 8085 for serially communication and interfacing of 8253 timer to verify its operation in six different modes.

CO5: design a circuit to interface the DAC with 8085 for generation of square, saw tooth and triangular waves, and implement a serial communication through RS-232 C port.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL3	BL3	BL3	BL4	BL6

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

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 8085 instruction set.
7. Write a program to interface a stepper motor with 8085 and control its speed and direction of rotation.
8. Write a program to interface a 7-segment display with 8085 and show some message.
9. Write a program to interface Analog to digital converter with 8085.
10. Write a program to interface a DC motor with 8085 and change its speed.
11. Write a program for 8085 to generate a square wave of 25% duty cycle.
12. Write a program for 8085 to generate a triangular waveform.

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
CO1: implement the project requiring individual and teamwork skills.
CO2: correlate the theoretical concepts with the real-life industrial environment.
CO3: gather and analyze the scientific information.
CO4: communicate their work effectively through writing and presentation.

Mapping Cos/Bloom's Taxonomy Level (BLs)				
COs	CO1	CO2	CO3	CO4
BLs	BL1	BL6	BL2	BL4

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.

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 (COs):
After successful completion of the course, the students should be able to

CO1: discuss the working and modeling of various processes, like heat exchanger, distillation column etc.
CO2: design the closed loop systems for different applications with appropriate selection of controllers.
CO3: articulate the working of various final control elements, like control valves.
CO4: explain the concept of multiple loop control, like cascade controller, feed forward controller, split range controller, ratio controller, and direct digital controller.
CO5: select and **recommend** the appropriate equipment and method to ensure industrial safety.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL6	BL3	BL3	BL5

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

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 processes, like 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 (ON-OFF), 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:** 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 teamwork 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,
8. John Wiley Sons, 2010.
9. F G Shinskey, "Process Control Systems: Application, Design and Tuning", 4th edition, McGraw Hill, 1996.
10. G K Mcmillan and D M Considine, "Process/Industrial Instruments and Controls Handbook", 5th eds., 1999.
11. 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 (COs):
After successful completion of course, the students should be able to
CO1: describe data communication networks, internet protocols, standards, layered tasks & addressing.
CO2: explain the features and operations of various application layer protocols such as HTTP, DNS and SMTP.
CO3: interpret technologies, issues, and challenges in wireless communication networks.
CO4: discover various Routing and dissemination protocols.
CO5: design industrial internet of things (IoT - Industry 4.0).

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL2	BL3	BL2	BL6

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	1	3	1	2	-	3	3	-
CO2	3	1	2	-	1	2	2	2	2	1	2	3	2	-
CO3	3	-	-	-	-	1	-	2	-	3	2	1	2	2
CO4	2	-	-	2	1	-	-	2	-	2	1	1	2	-
CO5	2	2	3	-	-	3	2	2	1	2	3	2	2	2

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.	12
Projects related to this course should be given to students (in groups) to promote teamwork and ethical values.		

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 (COs):

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

CO1: illustrate the design and tuning methods of P, PI, PD, and PID controllers.

CO2: explain the working and construction of a pressure transmitter.

CO3: apply the fundamentals of instrumentation engineering to demonstrate the working of feedback control system and I/P converter.

CO4: analyze the operation of feedback-based temperature and pressure control systems.

CO5: compare the design, working principle, and characteristics of ratio, cascade, and feed forward control.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL2	BL3	BL4	BL5

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	**Program Outcomes (POs)/Program Specific Outcome (PSO's)**													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1	1	2	2	2	1	2	1	3	3	-
CO2	3	1	2	-	1	2	2	2	2	1	2	3	2	-
CO3	3	2	2	1	2	3	1	2	2	-	2	3	1	3
CO4	3	3	3	2	1	2	1	2	1	1	1	2	3	1
CO5	3	1	3	1	1	2	2	1	1	1	1	2	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. Study of the design and tuning methods of proportional (P) controller.
2. Study of the design and tuning methods of proportional plus integral (PI) controller.
3. Study of the design and tuning methods of proportional plus derivative (PD) controller.
4. Study of the design and tuning methods of proportional plus integral plus derivative (PID) controller.
5. Study the characteristics of feed-back control system.
6. Study and experimental evaluation of I/P Converter output to control the valve displacement.
7. Study of feedback pressure control plant with DCS panel.
8. Study and experimental evaluation of feedback temperature control system.
9. Study the working principle and construction of pressure transmitter.
10. Study the design, working principle, and characteristics of ratio control.
11. Study the design, working principle, and characteristics of cascade control.
12. Study the design, working principle and 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

CO1: express their work effectively through writing and presentation.

CO2: apply the research-based knowledge in the latest area of technology.

CO3: develop the project requiring individual and teamwork skills.

CO4: compile design calculations and implementations in the area of the project development.

Mapping Cos/Bloom's Taxonomy Level (BLs)				
COs	CO1	CO2	CO3	CO4
BLs	BL2	BL3	BL3	BL6

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
CO1: correlate the theoretical concepts with the real-life industrial environment.
CO2: develop strategies like time management, multi-tasking in an industrial setup.
CO3: summarize various technologies and instruments used in industrial applications.
CO4: express their work effectively through writing and presentation.

Mapping Cos/Blooms's Taxonomy Level (BLs)				
COs	CO1	CO2	CO3	CO4
BLs	BL4	BL3	BL2	BL6

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

CO1: develop the project requiring individual and teamwork skills.

CO2: explain the recent advancements in industrial instrumentation.

CO3: compile the design calculations and implementations in the area of the project.

CO4: express their work effectively through writing and presentation.

CO5: show professional responsibilities and respect for ethics.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL3	BL2	BL6	BL2	BL2

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: demonstrate the transient and steady-state response of electrical circuits.
CO3: examine circuits in the sinusoidal steady-state (single-phase and three-phase).
CO4: analyze two port circuit's behavior.
CO5: determine the power factor of a given electrical circuit.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL3	BL2	BL4	BL4	BL5

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	1	2	3	3	1	3	-
CO2	3	3	3	2	2	1	-	2	1	2	2	1	3	-
CO3	3	2	2	2	2	1	1	2	2	2	-	-	3	1
CO4	2	2	2	2	1	-	-	1	-	2	1	1	2	2
CO5	2	2	3	2	1	-	1	-	-	2	3	2	3	2

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.	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. 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.

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
CO1: illustrate an in depth knowledge about the conducting materials.
CO2: distinguish properties of dielectric and insulator materials.
CO3: understand the selection of magnetic materials for electrical devices.
CO4: recognize the material for economically and eco-friendly fabrication of electrical equipment.
CO5: select the materials for special applications in electrical equipment.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL4	BL4	BL5	BL3

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	1	2	3	3	1	3	-
CO2	3	3	3	2	2	1	-	2	1	2	2	1	3	-
CO3	3	2	2	2	2	1	1	2	2	2	-	-	3	1
CO4	2	2	2	2	1	-	-	1	-	2	1	1	2	2
CO5	2	2	3	2	1	-	1	-	-	2	3	2	3	2

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: **describe** fundamentals of solar energy and its storage methods.

CO2: **discuss** methods of collection of solar energy.

CO3: a**nalyze** the performance characteristics of wind energy.

CO4: **explain** the principles of various renewable energy resources.

CO5: **apply** various energy harvesting techniques.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL2	BL4	BL3	BL3

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	1	3	1	2	-	3	3	-
CO2	3	2	-	2	1	2	1	3	1	2	1	3	3	-
CO3	3	2	2	2	2	1	3	-	2	2	-	1	3	1
CO4	3	3	3	2	1	2	1	2	1	1	1	2	3	1
CO5	3	2	2	1	2	3	1	2	-	-	2	3	1	3

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

CO1: explain the construction and working of various optical sources and detectors.

CO2: apply the knowledge of engineering to understand the generation of light from LASER.

CO3: describe the role of fiber-optic sensors for various industrial applications, such as measurement of flow, pressure, level etc.

CO4: analyze the transmission characteristics of optical fiber channels by applying the fundamentals of instrumentation.

CO5: summarize some industrial applications of LASERS, like measurement, trimming, welding, and vaporization.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL3	BL1	BL4	BL2

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	2	2	2	2	1	2	3	2	-
CO2	3	2	2	1	2	3	1	2	2	-	2	3	1	3
CO3	3	2	-	1	1	2	1	3	1	2	-	3	3	-
CO4	3	3	3	2	1	2	1	2	1	1	1	2	3	2
CO5	3	1	2	-	1	2	2	2	2	1	2	3	2	-

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 – hetero junction 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

CO1: explain the laws, operating principles and constructional features of hydraulic and pneumatic systems.

CO2: identify the components such as valves, actuators etc. for hydraulic and pneumatic applications.

CO3: list the advantages of hydraulic and pneumatic systems to understand the practical application of hydraulic and pneumatic systems.

CO4: sketch the symbols of the basic elements in hydraulic and pneumatic systems for designing practical hydraulic and pneumatic systems.

CO5: analyze the need of pressure and time dependent controls in hydraulic and pneumatic systems.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL1	BL1	BL3	BL4

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	2	2	2	2	1	2	3	2	-
CO2	3	-	-	1	-	1	-	-	1	1	-	1	2	1
CO3	3	2	2	1	2	3	1	2	2	-	2	3	1	3
CO4	3	-	1	-	1	2	2	2	-	2	1	3	3	-
CO5	3	3	3	2	1	2	1	2	1	1	1	2	3	1

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: explain the basic energy conversion principles and concepts
CO2: illustrate how electrical energy can be utilized efficiently.
CO3: articulate comprehensive idea on `energy efficiency of thermal units
CO4: explain utilization and effects of energy on environment.
CO5: analyze the effective energy conversion procedures for sustainable development

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL2	BL3	BL2	BL4

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	1	3	1	2	-	3	3	-
CO2	3	-	1	-	1	2	2	2	-	2	1	3	3	-
CO3	3	2	2	1	-	2	2	1	1	1	2	2	2	-
CO4	3	1	2	-	1	2	2	2	2	1	2	3	2	-
CO5	3	3	3	2	1	2	1	2	1	1	1	2	3	1

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: explain the energy management and auditing.
CO2: illustrate how energy can be conserved and managed in industries.
CO3: articulate comprehensive idea on tariffs in transmission & distribution systems.
CO4: explain utilization and effects of energy on environment.
CO5: analyze the energy auditing procedure.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL2	BL3	BL2	BL4

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	1	3	1	2	-	3	3	-
CO2	3	-	1	-	1	2	2	2	-	2	1	3	3	-
CO3	3	2	2	1	-	2	2	1	1	1	2	2	2	-
CO4	3	1	2	-	1	2	2	2	2	1	2	3	2	-
CO5	3	3	3	2	2	2	1	2	1	1	1	2	3	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.	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. 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

CO1: discuss different elements and their functions involved in hydro, thermal, nuclear, solar and wind power generation.

CO2: identify the important power plant measurements and instruments used in different power plants.

CO3: sketch the layout of hydro, thermal, nuclear, solar and wind power plants.

CO4: apply the control concepts and control techniques to handle boiler and turbine used in different power plants.

CO5: describe the economic and safety principles involved with different power plants.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL1	BL3	BL3	BL1

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	2	1	3	1	2	-	3	3	-
CO2	3	-	1	1	-	1	-	-	1	1	-	1	2	1
CO3	3	-	1	-	1	2	2	2	-	2	1	3	3	-
CO4	3	2	2	1	2	3	1	2	2	-	2	3	1	3
CO5	3	2	-	1	1	2	1	3	1	2	-	3	3	-

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction:** Energy sources, their availability, worldwide energy production, energy scenario of India. Introduction to Power generation, load curve, load factor. Classification of energy generation resources.	08
	Thermal Power Plant- Method of power generation, layout and energy conversion process. Types of Turbines & their control. Types of Boilers and their control. Types of Generators and their control, Condensers. Types of Pumps and Fans, variable speed pumps and Fans, Material handling system, study of all loops-water, steam, fuel etc. Schematics of Gas turbine and Diesel power plant. Application of DCS in power plants.	08
	Hydroelectric Power Plant- Site selection, Hydrology, Estimation electric power to be developed, classification of Hydropower plants. Types of Turbines for hydroelectric power plant, pumped storage plants, storage reservoir plants.	08
Unit-2	**Nuclear Power Plant –** Concept of energy generation from nuclear fission, control of chain reaction. Schematics of Nuclear power plant, types of reactors, reactor control, safety measures.	06
	Non-conventional Energy Resources Wind Energy: Power in wind, Conversion of wind power, Aerodynamics of wind turbine, types of wind turbine and their modes of operation, power control of wind turbines, Betz limit, Pitch & Yaw control, wind mill, wind pumps, wind farms, different generator protections, safety. Solar Energy: Solar resource, solar energy conversion systems. Solar PV technology: Block diagram of PV system, advantages and limitations. Solar thermal energy system: Principle, solar collector and its types, solar concentrator and its types, safety.	12

	Introduction to Modern Biomass, Bio-fuels, Geothermal energy, Tidal energy and Ocean thermal energy	
	Comparison of different types of power plant: thermal power plant, hydro electric power plant, wind, solar, nuclear power plant on the basis of: Performance, efficiency, site selection, Economics-capital and running, safety. Introduction to Hybrid Power Generation concept.	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

CO1: explain the architecture, salient features, and applications of virtual instrumentation.

CO2: compare the conventional programming with graphical programming based on their functioning, capabilities, hardware requirements etc.

CO3: develop virtual instruments to process data and display on charts and graphs in LabVIEW.

CO4: discuss the interfacing, software and hardware installation of essential equipment with LabVIEW for real-time data acquisition.

CO5: apply the knowledge of networking to use LabVIEW as a network client server.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL4	BL6	BL2	BL3

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	2	2	2	2	1	2	3	2	-
CO2	3	3	3	2	1	2	1	2	1	1	1	2	3	1
CO3	3	2	2	1	2	3	1	2	2	-	2	3	1	3
CO4	3	2	-	2	1	2	1	3	1	2	-	3	3	-
CO5	3	2	2	1	2	3	1	2	2	-	2	3	2	3

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.	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. Sanjay Gupta, "Virtual Instrumentation Using Labview", 2nd edition, McGraw Hill 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 Techniques, 2nd 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
CO1: explain the working of nuclear system, its basics and radiation detection techniques.
CO2: compare electronic and counting system, various analyzers and Energy Resolution.
CO3: describe nuclear instrumentation system in industries.
CO4: discuss application of nuclear instruments in medicine and health care.
CO5: apply various safety aspect, shielding and emergency schemes.

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Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL4	BL6	BL2	BL3

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	2	2	2	2	1	2	3	2	-
CO2	3	3	3	2	1	2	1	2	1	1	1	2	3	1
CO3	3	2	2	1	2	3	1	2	2	-	2	3	1	3
CO4	3	2	-	2	1	2	1	3	1	2	-	3	3	-
CO5	3	2	2	1	2	3	1	2	2	-	2	3	2	3

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 Electronic*s"*, 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
CO1: describe the evolution and operation of 8-bit, 16-bit, 32-bit and 64-bit microprocessors.
CO2: illustrate the architecture, hardware structure, and timing diagram of 8085 microprocessors.
CO3: write an assembly language program of 8085 to perform various tasks such as arithmetic operations, add delay, generate different waveforms etc.
CO4: apply the knowledge to interface the external memory with a microprocessor.
CO5: summarize the characteristics of various peripheral devices, such as 8255, 8254, 8279 etc.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL4	BL6	BL3	BL2

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	1	3	1	2	-	3	3	-
CO2	3	-	1	-	1	2	2	2	-	2	1	3	3	-
CO3	3	2	2	1	2	3	1	2	2	-	2	3	1	3
CO4	3	2	2	1	2	3	2	2	2	-	2	3	2	3
CO5	3	2	-	2	1	2	2	3	1	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.	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 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
CO1: classify the basic transmission system of power delivery..
CO2: find the line parameter of short, medium and long transmission line.
CO3: summarize the knowledge of mechanical components of line.
CO4: distinguish between the different equivalent representations of line.
CO5: analyze the working of underground cable.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL1	BL2	BL4	BL4

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	1	1	2	3	3	1	3	-
CO2	3	3	3	2	3	3	-	2	1	2	2	1	3	-
CO3	3	2	2	2	2	1	1	2	2	2	-	-	3	1
CO4	2	2	2	2	2	-	-	1	-	2	1	1	2	2
CO5	2	2	3	2	3	-	1	1	2	2	3	2	3	2

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,	12

	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.		

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

CO1: describe the physiological systems of the human body, such as respiratory, nervous, and circulatory systems.

CO2: explain the working principle, electrical and mechanical characteristics of biopotential electrodes.

CO3: analyze the ECG, EEG, and EMG signals to determine the various abnormal conditions.

CO4: apply the principles of Gas laws to measure the respiratory parameters.

CO5: illustrate the functionality of biotelemetry and hospital information systems using the fundamentals of multimedia technology.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL2	BL4	BL3	BL3

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	1	3	1	2	-	3	3	-
CO2	3	1	2	-	1	2	2	2	2	1	2	3	2	-
CO3	3	3	3	2	1	2	1	2	1	1	1	2	3	1
CO4	3	2	2	1	2	3	1	2	2	-	2	3	1	3
CO5	3	-	1	-	1	2	2	2	-	2	1	3	3	-

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
	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

Unit-2	**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.	04
Projects related to this course should be given to students (in groups) in order to promote team work and ethical values.		

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: **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 the 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.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL4	BL2	BL4	BL2

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	1	2	3	1	1	2	3	3	1	3	-
CO2	2	3	3	2	3	3	-	2	1	2	2	1	3	-
CO3	3	2	2	2	2	1	1	2	2	2	2	-	3	1
CO4	2	1	2	-	2	2	2	1	2	2	2	1	2	2
CO5	2	2	3	-	3	1	-	1	2	2	3	2	3	2

Unit	Main Topics & Course Outline	Hour(s)
Unit-1	**Introduction to Heating, 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, McGraw-Hill, 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

CO1: explain the basics of digital image generation, processing, sampling and quantization.

CO2: illustrate image transforms techniques and image enhancement techniques.

CO3: reproduce 2-D system, spectral density function, estimation and information theory for application in image and video processing..

CO4: analyze image restoration models, filters and digital processing used in image and video processing.

CO5: apply image segmentation, image data compression and associated techniques to various images.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL2	BL1	BL4	BL3

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	2	2	2	2	1	2	3	2	-
CO2	3	-	1	-	1	2	2	2	-	2	1	3	3	-
CO3	3	-	-	1	-	1	-	1	1	1	-	2	2	1
CO4	3	3	3	2	1	2	1	2	1	1	1	2	3	1
CO5	3	2	2	1	2	3	1	2	2	-	2	3	1	3

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 (DFT.), 2-DFT, Fast Fourier Transform (FFT), 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
	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

Unit -2	**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

CO1: apply the knowledge of engineering fundamentals to form mathematical model and obtain transfer function or state space representation of a system.

CO2: categorize different types of system and identify the set of algebraic equations to represent and model a complicated system into a simplified form.

CO3: evaluate the performance of LTI systems for standard inputs by applying steady state and transient analysis.

CO4: analyze the stability of a system using Root Locus, Bode Plot, Nyquist, Routh Hurwitz.

CO5: design the compensators and controllers to meet the given time and frequency domain specifications.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL3	BL4	BL4	BL4	BL5

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

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
	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, tacho-generators.	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 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

CO1: compare the microprocessors with microcontrollers based on their functioning, hardware, and software characteristics.

CO2: illustrate the architecture, hardware structure, and timing diagram of 8051 microcontroller.

CO3: write an assembly language program of 8051 to perform various tasks such as arithmetic operations, add delay, generate different waveforms etc.

CO4: apply the knowledge to interface the keyboard, display, A/D converter and D/A converter with 8051.

CO5: explain the role of assemblers and simulators in the programming of 8051 microcontrollers.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL4	BL2	BL6	BL3	BL2

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	1	2	1	2	1	1	1	2	3	1
CO2	3	-	1	-	1	2	2	2	-	2	1	3	3	-
CO3	3	2	2	1	2	3	1	2	2	-	2	3	1	3
CO4	3	2	2	2	2	3	1	2	2	-	2	3	2	3
CO5	3	1	2	-	1	2	2	2	-	2	2	2	3	-

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.	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. 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

CO1: **enumerate** safety standards which must be maintained in compliance with regulatory requirements.

CO2: **estimate** frameworks for workplace injury prevention, risk management, and incident investigation.

CO3: **identify** different types of exposure and biological effects.

CO4: **explain** contemporary issues of pollution and its control methods.

CO5: **describe** the concept of industrial hygiene.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL4	BL2	BL3	BL1

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

CO1: describe the production of speech relative to human anatomy.

CO2: analyze the time domain and frequency domain models for speech signals to understand their quality and properties.

CO3: explain the role of Linear Prediction Coding (LPC) in speech production and detection.

CO4: modify the speech and audio signals using quantization and LPC to LSF conversions.

CO5: compare the various speech and audio signals enhancement techniques.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL4	BL2	BL3	BL4

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	1	3	1	2	-	3	3	-
CO2	3	3	3	1	1	2	1	2	1	-	2	2	3	1
CO3	3	1	2	-	1	2	2	2	2	1	2	3	2	-
CO4	3	2	2	1	-	2	2	1	1	1	1	2	2	2
CO5	3	3	3	2	1	2	1	2	1	-	-	2	3	1

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-

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

CO1: build intelligent agents for search and games.

CO2: solve AI problems through programming

CO3: design and develop programs for an agent to learn and act in a structured environment

CO4: apply a soft computing methodology for a particular problem.

CO5: **develop** expert system for a particular problem

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL3	BL6	BL6	BL3	BL3

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	1	2	3	-	1	2	3	-	1	3	-
CO2	2	3	3	2	3	3	-	2	1	2	-	1	3	-
CO3	3	2	2	2	2	1	1	2	2	2	2	-	3	1
CO4	2	1	2	-	2	2	2	1	2	2	2	1	2	2
CO5	2	2	3	1	3	1	-	1	2	2	3	2	3	2

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

CO1: apply the knowledge of linear algebra topics like vector space, orthogonal basis etc. to signals.

CO2: classify systems based on their properties and determine the response of LSI systems using convolution.

CO3: discuss the concept of Fourier series, Fourier transform, Laplace and Z-transform along with their basic properties for application in signal analysis.

CO4: summarize sampling and the related sampling theorem, restructuring, aliasing etc. for reconstruction of signals.

CO5: simulate problems related to signals and systems using modern simulation tools.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL3	BL2	BL2	BL5	BL3

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	2	3	1	2	2	-	2	3	1	3
CO2	3	2	2	1	-	2	-	2	1	1	2	2	2	2
CO3	3	2	-	2	1	2	1	3	1	2	-	3	3	-
CO4	3	-	1	-	1	2	2	2	-	2	1	3	3	-
CO5	3	2	2	1	2	3	1	2	2	-	2	3	1	3

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.	10
Projects related to this course should be given to students (in groups) in order to promote team work and ethical values.		

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: **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

CO1: elaborate various sensors and transducers for measuring mechanical quantities.

CO2: classify the specifications of sensors and transducers.

CO3: formulate 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.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL6	BL2	BL6	BL3	BL2

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	1	2	3	1	1	2	3	3	1	3	-
CO2	3	3	3	2	3	3	-	2	1	2	2	1	3	-
CO3	3	2	2	2	2	1	1	2	2	2	-	-	3	1
CO4	2	2	2	1	2	1	-	1	-	2	1	1	2	2
CO5	2	2	3	1	-	-	1	1	2	2	3	2	3	2

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, Tachogenerator 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.	10
Projects related to this course should be given to students (in groups) to promote team work and ethical values.		

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

CO1: explain the concept of fuzzy system and difference between binary and fuzzy system.

CO2: apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems.

CO3: simulate genetic algorithms to combinatorial optimization problems.

CO4: apply neural networks to pattern classification and regression problems.

CO5: describe various neuro fuzzy systems and their applications.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL3	BL3	BL3	BL1

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	2	2	2	2	1	2	3	2	-
CO2	3	2	2	1	2	3	1	2	2	-	2	3	1	3
CO3	3	2	2	2	2	1	1	2	2	2	-	-	3	1
CO4	3	2	2	1	2	3	1	2	2	-	2	3	1	3
CO5	3	2	-	1	1	2	1	3	1	2	-	3	3	-

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, 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.	08
Projects related to this course should be given to students (in groups) in order to promote teamwork and ethical values.		

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

CO1: associate basic principles and importance of process control in industrial process plants.

CO2: describe the use of block diagrams & the mathematical basis for the design of control systems.

CO3: indicate the required instrumentation and final elements to ensure that well-tuned control is achieved.

CO4: analyze process controller response of a particular process.

CO5: compare the traditional and advanced control schemes applied to various processes.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL1	BL2	BL4	BL2

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	2	3	1	2	2	-	2	3	1	3
CO2	3	2	-	1	1	2	1	3	1	2	-	3	3	-
CO3	3	-	-	1	-	1	-	-	1	1	-	1	2	1
CO4	3	3	3	2	1	2	1	2	1	1	1	2	3	1
CO5	3	2	2	1	2	3	1	2	2	-	2	3	1	3

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

CO1: understand instrumentation, control and various detectors used for environment.

CO2: study water quality, its parameters, various analyzers, and their application.

CO3: become conversant in water treatment techniques and instrumentation used.

CO4: analyze wastewater monitoring, treatment, and latest treatment plants.

CO5: study air pollution, its monitoring and rainwater harvesting.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL6	BL2	BL6	BL4	BL2

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	1	2	3	1	1	2	3	3	1	3	-
CO2	3	3	3	2	3	3	-	2	1	2	2	1	3	-
CO3	3	2	2	2	2	1	1	2	2	2	-	-	3	1
CO4	2	2	2	1	2	1	-	1	-	2	1	1	2	2
CO5	2	2	3	1	3	1	1	1	2	2	3	2	3	2

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction:** Necessity of instrumentation & control for environment, sensor requirement for environment. Instrumentation methodologies: ultraviolet analyzers, total hydrocarbon analyzers using flame ionization detector, gas chromatography in environmental analysis, photo ionization, portable & stationary analytical instruments.	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 analyzers& their application, conductivity analyzers& 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	**Wastewater monitoring:** Wastewater monitoring: Automatic wastewater sampling, optimum wastewater sampling locations, and wastewater measurement techniques. Instrumentation set up for wastewater treatment plant. Latest methods of wastewater 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 wastewater flow measurement. Rainwater 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-Inter science, 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 (COs):

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

CO1: describe the physiological systems of human body, such as respiratory, nervous, and circulatory system.

CO2: explain the working principle, electrical and mechanical characteristics of bio-potential electrodes.

CO3: analyze the ECG, EEG, and EMG signals to determine the various abnormal conditions.

CO4: apply the principles of Gas laws to measure the respiratory parameters.

CO5: compare the different medical imaging techniques (X-ray, ultrasound, CT scan) based on their radiation intensities, penetration depths etc.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL2	BL4	BL3	BL5

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Program Outcomes (POs)/Program Specific Outcome (PSO's)													
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO 1	2	2	-	1	1	2	1	3	1	2	-	3	3	-
CO 2	2	1	2	-	1	2	2	2	2	1	2	3	2	-
CO 3	3	3	3	2	1	2	1	2	1	1	1	2	3	1
CO 4	3	2	2	1	2	3	1	2	2	-	2	3	1	3
CO 5	3	3	3	2	1	2	1	2	1	1	1	2	3	2

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	06

	specifications, EEG diagnostic uses and sleep patterns, visual and auditory evoked potential recordings, EEG system artefacts.	
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).	10
Projects related to this course should be given to students (in groups) to promote teamwork and ethical values.		

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

CO1: generalized the working principle and of direct current machines.

CO2: illustrate the operation of single-phase and three-phase transformers.

CO3: describe the fundamental hypothesis and design of various alternating current machines.

CO4: analyze the performance parameters obtained from testing of electrical machines in numerous condition.

CO5: assemble the electrical components for starting and controlling the speed of rotating electrical machines.

Mapping Cos/Blooms' Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL2	BL1	BL4	BL6

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	2	3	1	2	3	2	1	1	-	-	3	3	-
CO2	2	2	3	-	3	3	2	2	1	1	-	1	3	-
CO3	3	2	2	2	2	1	1	-	2	-	2	3	3	1
CO4	2	1	2	-	2	2	2	1	2	2	2	3	2	2
CO5	2	2	3	1	3	1	1	1	2	-	3	2	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 principal characteristics, starting of shunt and series motor, starters, speed control methods: field and armature control, testing: Swim 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.	08
Projects related to this course should be given to students (in groups) in order to promote teamwork and ethical values.		

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 (COs):

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

CO1: categorize various safety and hazard issues and related standards which must be maintained in compliance with regulatory requirements.

CO2: identify various industrial hygiene issues like; noise, fire, hearing, and tools to address these issues.

CO3: illustrate various sources of toxic release and their proper estimate and modelling.

CO4: classify contemporary issues of pollution and its control methods.

CO5: assess the concept of reliability and various statistical tools to improve the reliability of the plant

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL4	BL2	BL2	BL4	BL5

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	1	-	2	2	1	1	1	2	2	2	-
CO2	3	3	3	2	1	2	1	2	1	1	1	2	3	1
CO3	3	-	1	-	1	2	2	2	-	2	1	3	3	-
CO4	3	2	2	1	-	2	2	1	1	1	2	2	2	-
CO5	3	3	3	2	1	2	1	2	1	1	1	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 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: **PEIE-621A**
Title of the course: **Biomedical Signal and Image Processing**

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes (COs):

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

CO1: discuss the design characteristics and working of bio-electric amplifiers.

CO2: explain the processing and recording methodologies for EEG, EMG, ECG, and EOG signals with circuit design.

CO3: analyze the one-dimensional and two-dimensional biomedical signals with the application of signal transformation techniques.

CO4: apply the fundamentals of digital signal and image processing for the enhancement and segmentation of medical images.

CO5: illustrate the various methods for image restoration and reconstruction.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL3	BL4	BL3	BL2

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

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,	08

	watershed segmentation algorithm.	
	Image restoration and reconstruction of images: Image degradation models, algebraic approach to restoration, inverse filtering, least mean square filter, image reconstruction from projections.	08
Projects related to this course should be given to students (in groups) to promote teamwork and ethical values.		

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 JCarr, 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

CO1: describe the need and role of various power electronic components like switches, thyristors, converters etc. and interpret their properties and characteristics.

CO2: compare the standard topologies of various converters, voltage source inverters and drives.

CO3: analyze the design of various AC-DC converters, AC-AC converters, and DC-DC converters in different operating conditions.

CO4: analyze the design of inverters consisting of half and full bridge, single and three phase etc.

CO5: develop the various drive control circuits used in power electronics.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL2	BL4	BL4	BL5

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	**Program Outcomes (POs)/Program Specific Outcome (PSO's)**													
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO 1	3	2	-	1	1	2	-	3	1	2	-	3	3	-
CO 2	3	2	2	1	-	2	-	2	-	1	1	2	1	2
CO 3	3	3	3	2	1	2	1	2	1	1	1	2	1	3
CO 4	3	3	3	2	1	2	1	2	1	1	1	2	1	3
CO 5	3	2	2	1	2	3	1	1	2	2	2	3	1	3

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.	09
Projects related to this course should be given to students (in groups) to promote teamwork and ethical values.		

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 (COs):

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

CO1: state various data acquisition systems, their components, and applications.

CO2: describe methods of data transmission, transmission channels and different type of modulation.

CO3: determine construction and working principle of digital to analog and analog to digital converters.

CO4: illustrate block diagram, classification, working principle of different telemetry system.

CO5: explain the construction and working principle of display system and recorders.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL2	BL3	BL1	BL4

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	1	-	1	1	2	1	1	1	2	-	2	3	-
CO2	3	2	-	1	1	2	1	1	1	2	-	2	3	-
CO3	3	3	3	2	2	2	1	2	2	1	1	2	3	1
CO4	2	2	1	1	1	2	1	2	1	2	-	2	3	1
CO5	3	1	2	1	2	2	2	2	2	2	2	2	2	1

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 modulation, introduction to ASK, FSK,PSK, pulse modulation (PAM, PDM, PPM, PCM), delta modulation, adaptive delta 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; Analog to Digital (A/D) converters: flash type, successive approximation type, dual slope type and counting converter type A/D.	08
Unit-2	**Telemetry Systems:** 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, viz. cathode ray tube (CRT), LCD, LED, and Plasma display.	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) to promote teamwork 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

CO1: examine the existing energy situation and the subsequent accumulation in renewable energy's share of the power generation sector.

CO2: describe the fundamental physics of solar and wind energy generation.

CO3: create power electronic interfaces for wind turbines and solar photovoltaic.

CO4: list the challenges related to integrating renewable energy resources into the grid.

Mapping Cos/Blooms's Taxonomy Level (BLs)				
COs	CO1	CO2	CO3	CO4
BLs	BL1	BL2	BL6	BL1

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	1	2	3	1	1	1	2	-	3	3	-
CO2	2	3	3	2	3	3	-	2	1	1	-	1	3	-
CO3	3	2	2	2	2	1	1	-	2	-	2	3	3	1
CO4	2	1	2	-	2	2	2	1	2	2	2	3	2	2

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-711B**
Title of the course: **Telemedicine and Robotic- Surgery**

L	T	P	Credits	Weekly Load
3	0	0	3	3

Course Outcomes (COs):

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

CO1: describe the functioning, current scenario, legal and ethical aspects of telemedicine.

CO2: apply the fundamentals of multimedia technology, like security, modulation, and networking techniques in telemedicine.

CO3: explain the control and kinematic concepts behind the functioning of medical robotics.

CO4: discuss the essential components of minimally invasive surgery, including human-machine interface, tele-operation, and augmented reality.

CO5: connect the medical imaging modalities with robotics for better surgical navigation.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL3	BL3	BL2	BL4

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Program Outcomes (POs)/Program Specific Outcome (PSO's)													
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO 1	3	2	-	1	1	2	1	3	1	2	1	3	3	-
CO 2	3	2	2	1	2	3	1	2	2	-	2	3	1	3
CO 3	3	1	2	-	1	2	2	2	2	1	2	3	2	1
CO 4	3	2	-	1	1	2	1	3	1	2	-	3	3	-
CO 5	3	2	1	2	1	2	1	3	1	2	1	3	3	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Telemedicine and Health**: History and evolution of telemedicine, functional diagram of telemedicine system, telemedicine, tele-health, 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, tele-operation, 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.	08
Projects related to this course should be given to students (in groups) in order to promote teamwork and ethical values.		

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. 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 (COs):

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

CO1: describe features of a nonlinear system.

CO2: interpret non-linear systems using describing function and phase plane method.

CO3: predict stability of a nonlinear control system.

CO4: analyze the Lyapunov stability properties for nonlinear systems.

CO5: formulate optimal control problems, their classification along with performance indices and selection of dynamic optimization.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL3	BL2	BL4	BL6

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	1	3	1	2	-	3	3	-
CO2	3	2	2	1	-	2	2	1	1	1	2	2	2	-
CO3	3	3	3	2	1	2	1	2	1	1	1	2	3	1
CO4	3	3	3	2	1	2	1	2	1	1	1	2	3	1
CO5	3	1	2	-	1	2	2	2	2	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.	12
Projects related to this course should be given to students (in groups) in order to promote teamwork and ethical values.		

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

CO1: recall concepts of trigonometry, complex algebra, Fourier transform, z-transform to analyze the operations on signals and acquire knowledge about systems

CO2: enumerate the properties, convolution, and associated methods of discrete Fourier transform (DFT) and Fast Fourier transform (FFT).

CO3: simulate the Finite Impulse Response (FIR), Infinite Impulse Response (IIR) filters for realizing and analyzing their design techniques.

CO4: review the structure of FIR and IIR filters for direct, cascade and parallel arrangement.

CO5: employ signal processing strategies for engineering applications as teamwork.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL1	BL3	BL2	BL3

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Program Outcomes (POs)/Program Specific Outcome (PSO's)													
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO 1	3	-	-	-	1	2	1	1	1	2	-	3	3	-
CO 2	3	2	-	2	1	2	1	3	1	2	-	3	3	-
CO 3	3	2	2	1	2	3	1	2	2	-	2	3	1	3
CO 4	3	2	-	2	1	2	1	3	1	2	-	3	3	-
CO 5	3	2	2	1	2	3	1	2	2	-	2	3	1	3

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.	08
Projects related to this course should be given to students (in groups) in order to promote teamwork and ethical values.		

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 (COs):

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

CO1: convert statement .of the given optimization problem into a mathematical model.

CO2: interpret the nature of optimization problem in terms of single variable, multivariable, constrained, unconstrained, unimodal, multimodal, single, and multi-objective problem.

CO3: enumerate and **compare** classical and metaheuristic algorithms for solving optimization problems

CO4: solve and **design** real-world optimization problems with the help of studied algorithms

Mapping COs/Bloom's Taxonomy Level (BLs)				
COs	CO1	CO2	CO3	CO4
BLs	BL2	BL3	BL1	BL6

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	2	2	2	2	1	2	3	3	1
CO2	3	3	3	2	1	2	2	2	1	1	1	2	3	1
CO3	3	3	3	1	1	2	2	2	2	-	2	1	3	1
CO4	2	3	3	1	1	2	2	2	2	1	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, and scheduling.	08
Projects related to this course should be given to students (in groups) to promote teamwork and ethical values.		

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 (COs):

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

CO1: explain the architecture, salient features, and applications of virtual instrumentation.

CO2: compare the conventional programming with graphical programming based on their functioning, capabilities, hardware requirement etc.

CO3: develop virtual instruments to process data and display on charts and graphs in LabVIEW.

CO4: discuss the interfacing, software and hardware installation of essential equipment's with LabVIEW for real-time data acquisition.

CO5: apply the knowledge of networking to use LabVIEW as a network client server.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL4	BL6	BL2	BL3

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

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.	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. Sanjay Gupta, "Virtual Instrumentation Using Labview", 2nd edition, McGraw-Hill 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 Techniques 2nd 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 (COs):

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

CO1: describe the fundamentals of robotics, various actuators, and transmission systems.
CO2: illustrate various sensors for motion, detection, and machine vision techniques.
CO3: determine gripping mechanism and arm kinematics in robots.
CO4: calculate robot arm dynamics & trajectory using Lagrange's Euler, Newton Euler formulations.
CO5: editorialize case studies for proper selection of robot for particular problem.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL2	BL3	BL3	BL5

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	1	3	1	2	-	3	3	-
CO2	3	-	1	-	1	2	2	2	-	2	1	3	3	-
CO3	3	3	3	2	1	2	1	2	1	1	1	2	3	1
CO4	3	2	1	-	2	2	1	1	1	2	2	2	2	-
CO5	1	2	2	-	3	3	1	3	3	2	1	2	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, horsepower, 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
	Robot arm kinematics: Construction of manipulator, the direct kinematics problem, the inverse kinematics problem, inverse transform techniques for Euler Angles solution, geometrical approach.	08

Unit-2	**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.	08
	Case studies: Hill climbing techniques, multiple robots, machine interface, robot cell design, selection of robot.	08
Projects related to this course should be given to students (in groups) to promote teamwork and ethical values.		

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 (COs):

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

CO1: explain the functioning, essential components, and characteristics of computer control systems.

CO2: discuss the operation, interfacing, programming language, hardware and software requirement of PLCs.

CO3: compare the Distributed Control Systems with PLCs based on the control strategies, hardware etc.

CO4: select the hardware and software components for a SCADA system.

CO5: discuss the various protocols (MAPS, HART) and types of bus (Fieldbus, Rackbus, Profibus, Fipbus) used in automation technology.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL3	BL2	BL4	BL5	BL2

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

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, handheld and computer based loaders, types of PLC software, programming languages – ladder programming, file organizing and addressing, instruction set, timer and counter instructions, communication instructions, I/O and Interrupt instructions, math instructions, 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
	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: MAPS protocol, types of bus: Fieldbus, Rackbus, Profibus, Fipbus, Comparison of buses, HART protocol.	06
Projects related to this course should be given to students (in groups) in order to promote teamwork 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

CO1: visualize the history, past and present status of Micro-Electro-Mechanical Systems (MEMs).

CO2: summarize the bulk micromachining process for MEMS industry.

CO3: select physical micro sensors for different applications based on the category and working of the sensors.

CO4: illustrate the various fabrication techniques for MEMS devices.

CO5: **connect** the knowledge of surface micromachining to the fabrication techniques of MEMS devices.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL2	BL1	BL2	BL4

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

Unit	Main Topics & Course Outline	Hour(s)
Unit-1	**Introduction:** Historical background: silicon pressure sensors, micromachining, micro electromechanical 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:** Micro stereo lithography (MSL) for 3D fabrication, two photon MSL, dynamic mask MSL, scanning systems, Opto mechatronics system for MSL, ceramic and metal Micro-stereolithography.	08
	Fabrication techniques-II: Ceramic and metal Micro-stereolithography. 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.	08
Projects related to this course should be given to students (in groups) in order to promote teamwork and ethical values.		

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 (COs):

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

CO1: **describe** 8086 microprocessor along with its the internal architecture.
CO2: **articulate** knowledge of programming of 8086 microprocessor using assembly language.
CO3: **explain** 8051 microcontroller design, memory mapping and serial data transmission.
CO4: **illustrate** application of 8051 microcontroller and its architecture and design.
CO5: **relate** interfacing of 8086 with peripheral devices.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL3	BL2	BL3	BL3

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	1	3	1	2	-	3	3	-
CO2	3	2	2	1	-	2	2	1	1	1	2	2	2	-
CO3	3	1	2	-	1	2	2	2	2	1	2	3	2	-
CO4	3	-	1	-	1	2	2	2	-	2	1	3	3	-
CO5	3	2	-	1	1	2	1	3	1	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, 8259A 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.	08
Projects related to this course should be given to students (in groups) in order to promote teamwork and ethical values.		

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 (COs):

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

CO1: describe the operation, infrastructure, and instrumentation of various types of power plants (hydro, nuclear, thermal).

CO2: apply the fundamentals of instrumentation to measure the various parameters of power plants.

CO3: discuss the various techniques for boiler control of Level-I, such as control of steam temperature, deaerator, drum level, and furnace draft.

CO4: explain the boiler control of Level-II, like furnace safety interlocks, coal pulverizer control, combustion control, etc.

CO5: compare the different types of steam turbines based on their operation, exhaust condition, stage design and shaft design.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1, BL2	BL3	BL2	BL3	BL4

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	1	3	1	2	-	3	3	-
CO2	3	2	2	1	2	3	1	2	2	-	2	3	1	3
CO3	3	2	-	2	1	2	1	3	1	2	-	3	3	-
CO4	3	1	2	-	1	2	2	2	2	1	2	3	2	-
CO5	3	2	3	2	1	2	1	2	1	1	1	2	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.	06
Projects related to this course should be given to students (in groups) in order to promote teamwork and ethical values.		

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." 5th edition, 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

CO1: develop the modeling of various testing systems.

CO2: explain the simulation of continuous and discrete systems by applying distinctive distribution methods.

CO3: compute simulation experiments, become proficient at verifying findings, and end the simulation.

CO4: compare and contrast the operations and features of the simulation languages.

CO5: validate the simulation outcomes before it estimates the stochastic network.

Mapping Cos/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL3	BL2	BL3	BL5	BL6

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation)														
COs	Program Outcomes (POs)/Program Specific Outcome (PSO's)													
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO 1	3	2	-	1	1	2	1	3	1	2	-	3	3	-
CO 2	3	2	2	1	2	3	1	2	2	-	2	3	1	3
CO 3	3	2	-	2	1	2	1	3	1	2	-	3	3	-
CO 4	3	1	2	-	1	2	2	2	2	1	2	3	2	-
CO 5	3	2	3	2	1	2	1	2	1	1	1	2	3	1

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.	12
Projects related to this course should be given to students (in groups) in order to promote teamwork and ethical values.		

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 Conditioning**

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:

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

CO1: illustrate the working of measurement systems using the model of input-output configuration.

CO2: summarize the various sensors and transducers by understanding their principle, construction, and accuracy.

CO3: compare resistive, capacitive, and inductive type transducers based on the various parameters, such as construction, power requirement, accuracy etc.

CO4: apply the knowledge of operational amplifiers to design the signal conditioning circuits for sensors.

CO5: explain the role of signal converters, like radiometric, logarithmic, voltage to current and frequency to voltage with sensors and transducers.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL2	BL4	BL3	BL2

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	-	1	-	1	2	2	2	-	2	1	3	3	-
CO2	3	2	2	1	-	2	2	1	1	1	2	2	2	1
CO3	3	3	3	2	1	2	1	2	1	1	1	2	3	1
CO4	3	2	2	1	2	3	1	2	2	-	2	3	1	3
CO5	3	1	2	-	1	2	2	2	2	1	2	3	2	-

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, Resistance Temperature Detectors (RTDs), Thermistors, Thermocouples	12
	Inductive and Capacitive Transducers: Measurement of self and mutual inductance, Linear Variable Differential Transformer (LVDT), Variable reluctance transducers, capacitive transducers: frequency response, advantages and 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: Radiometric converters, logarithmic converters, Voltage Controlled Oscilloscope (VCO), Phase Locked Loops (PLL), voltage to frequency	08

	converter, frequency to voltage converter, voltage to current converter, and current to voltage converter.	

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.

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

CO1: analyze various data acquisition systems, their components, and applications.

CO2: learn methods of data transmission, transmission channels and different type of modulation.

CO3: describe construction and working principle of digital to analog and analog to digital converters.

CO4: acquire knowledge of block diagram, classification, working principle of different telemetry system.

CO5: know about the satellite and fiber optic telemetry system.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL2	BL4	BL3	BL2

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
	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

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	08
	Satellite telemetry system : Introduction**, t**ypes of transmission**,** DMA, 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: **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
CO1: explain the working mathematical model of a system.
CO2: distinguish the time-domain and frequency-domain analyses of the system.
CO3: design the specifications of the control systems.
CO4: obtain the state space analysis of the system.
CO5: analyze the stability analysis of non-linear systems.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL4	BL6	BL3	BL2

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	1	2	3	1	1	2	3	3	1	3	-
CO2	3	3	3	2	3	3	-	2	1	2	2	1	3	-
CO3	3	2	2	2	2	1	1	2	2	2	-	-	3	1
CO4	2	2	2	1	2	-	-	1	-	2	1	1	2	2
CO5	2	2	3	1	3	-	1	1	2	2	3	2	3	2

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
	Control Actions: Study of process characteristics; controller operating models, on-off, proportional, integral, derivative, proportional-integral, proportional-derivative, proportional integral-derivative, relative merits of the above control modes, suitability of various control actions for different application, controller tunning, performance criterion.	08
Unit -2	**Stability Analysis:** Definition of stability, Routh-Hurwitz test, construction of Root Loci, root-locus plots, positive feedback systems, conditionally stable systems, root loci for systems with transport lag.	10
	Frequency domain Analysis: Bode plot, gain and phase margins, introduction to compensator design.	06
	State variable Analysis: Concepts of state variables, state space model, diagonalization of state matrix, solution of state equations, eigen values and stability analysis, concept of controllability and observability.	08

Recommended Books –

1. N.S. Nise, "Nise's Control System Engineering", Wiley India Ed, 2018.
2. B C Kuo, “Automatic Control System”, 9th edition, Wiley, 2014.
3. 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.
4. I J Nagrath and M Gopal, “Control System Engineering”, 6th edition, New Age International Publishers, 2017.
5. K Ogata, “Modern Control Engineering”, 5th edition, Pearson Education India, 2015.
6. R C Dorf and RH Bishop, “Modern Control System”, 12th edition, Pearson Education India, 2013.

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: describe the method of measurement of various parameters like temperature, level etc. that has scope in industries.

CO2: identify the different instruments for measurement of temperature, level, pressure etc. and their application in industries.

CO3: illustrate the construction and working of various measuring instruments used in industries.

CO4: summarize the calibration of various industrial instruments and use of instruments for other parameter measurements like force, torque, viscosity, humidity etc.

CO5: conclude the importance of measuring instruments and their calibration in industries.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL2	BL3	BL2	BL5

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	1	3	1	2	-	3	3	-
CO2	3	2	2	1	2	3	1	2	2	-	2	3	1	1
CO3	3	-	1	-	1	2	2	2	-	2	1	3	3	-
CO4	3	2	-	2	1	2	1	3	1	2	-	3	3	-
CO5	3	2	2	1	-	2	-	2	1	1	1	2	2	2

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Temperature measurement:** Introduction to temperature measurements, principle of vapor, 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, venturi meter, 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

CO1**: omit** the knowledge of process automation techniques.
CO2: develop PLC ladder programming for simple process applications.
CO3: **compare** distributed control system and different communication protocols.
CO4: analyze SCADA system, its hardware and software interfacing and applications.
CO5: **design** cloud-based process applications.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL6	BL2	BL4	BL6

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	1	2	3	1	1	2	3	3	1	3	-
CO2	3	3	3	2	3	3	-	2	1	2	2	1	3	-
CO3	3	2	2	2	2	1	1	2	2	2	-	-	3	1
CO4	2	2	2	1	2	1	-	1	-	2	1	1	2	2
CO5	2	2	3	1	3	1	1	1	2	2	3	2	3	2

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.	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: Power plant, Iron plant, Steel plant, Cement plant, Fertilizer plant and Food industries.	04

	Introduction to Supervisory Control and Data Acquisition (SCADA) system: Definition, elements: hardware and software, communication, 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, real-time implementation, advantages and limitation.	06

Recommended Books-

1. Curtis D. Johnson, "Process Control Instrumentation Technology", Prentice Hall, New Delhi, 8th Edition, 2005.
2. John W. Webb and Ronald A Reis, "Programmable Logic Controllers - Principles and Applications", Prentice Hall Inc., New Jersey, 5th Edition, 2002.
3. Lukcas M.P, "Distributed Control Systems", Van Nostrand Reinhold Co., New York, 1986.
4. Frank D. Petruzella, "Programmable Logic Controllers", McGraw Hill, New York, 4th Edition, 2010.
5. Deshpande P.B and Ash R.H, "Elements of Process Control Applications", ISA Press, New York, 1995.
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: **Sensors Technology**

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: explain the recent trends in sensor technology and its engineering applications.

CO2: compare various advanced sensing materials based on physical, electrical, chemical, and biological properties.

CO3: express knowledge on different concepts of smart sensors and systems, and their design methods.

CO4: choose the appropriate sensor, such as chemical, robotics, fiber optics sensors, and biosensors in different application areas.

CO5: classify the fabrication techniques (IC, MEMS/NEMS), data processing and coding methods.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1	BL4	BL2	BL3	BL4

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	2	2	2	2	1	2	3	2	-
CO2	3	3	3	2	1	2	1	2	1	1	1	2	3	1
CO3	3	2	-	1	1	2	1	3	1	2	-	3	3	-
CO4	3	3	3	2	1	2	1	2	1	2	1	2	3	1
CO5	3	2	-	1	1	2	1	3	1	2	-	3	3	1

Unit	Main Topics and Course Outline	Hour(s)
Unit-1	**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 modeling issue in advanced sensing technique.	08
	Latest 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	**Fiber optic sensors:** Fiber optic sensors for the measurement of temperature, pressure, displacement, turbidity, pollution.	06
	Chemical Sensors: Introduction, semiconductor gas detectors, Ion selective electrodes, conductometric sensors, Mass sensors, electro chemical sensors, potentiometric sensors, amperometry 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: **Internet of Things**

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: explain the fundamentals of internet of Things and role of hardware and software components in IoT.
CO2: illustrate the interface of I/O devices, like sensors, actuators& communication modules.
CO3: describe the role of various internet protocols used for communication in IoT.
CO4: articulate the various security aspects of IoT.
CO5: explain the real-time applications of IoT in agriculture, home automation and healthcare.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL2	BL2	BL3	BL4

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	1	1	2	3	3	1	3	-
CO2	3	3	3	2	3	3	-	2	1	2	2	1	3	-
CO3	3	2	2	2	2	1	1	2	2	2	-	-	3	1
CO4	2	2	2	2	2	-	-	1	-	2	1	1	2	2
CO5	2	2	3	2	3	-	1	1	2	2	3	2	3	2

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, ArshdeepBahga, “Internet of Things, A Hands on Approach”, University Press
4. 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.

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

CO1: explain wireless sensor networks for a given application.

CO2: **assess** emerging research areas in the field of sensor networks.

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

CO4: discover the new protocols for WSN.

CO5: classify the operating system in this field.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL5	BL4	BL3	BL2

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	2	2	2	2	1	2	3	2	-
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	2	-	2	1	2	1	3	1	2	-	3	3	-
CO5	3	3	3	2	1	2	1	2	1	1	1	2	3	1

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-hoc Networks (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 TinyOS 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.

Subject Code: **HDIE-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

CO1: explain the importance of automation techniques in industries.
CO2: reproduce simple programs using PLC for industrial based applications.
CO3: compare different systems for industrial automation like PLC, DCS and SCADA.
CO4: analyze SCADA system, its hardware and software interfacing and applications.
CO5: give examples of the application of automation system in industry.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL2	BL1	BL2	BL4	BL2

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	2	2	2	2	1	2	3	2	-
CO2	3	2	2	1	2	3	1	2	2	-	2	3	1	3
CO3	3	3	3	-	1	2	1	2	1	1	1	2	3	1
CO4	3	3	3	2	1	2	1	2	1	1	1	2	3	1
CO5	3	-	1	-	1	2	2	2	-	2	1	3	3	-

Unit	Main Topics & Course Outline	Hour(s)
Unit-1	**Introduction:** Components of automation system, need and benefits of industrial automation, architecture of industrial automation, applications of automation in industries, different systems for industrial automation.	08
	Measurement Systems and Data Acquisition: Introduction to sensors and measurement systems, signal conditioning and processing, calibration.	08
	Programmable Logic Controller (PLC): Block diagram of PLC, Programming languages of PLC, Basic instruction sets, Design of alarm and interlocks, Networking of PLC, Overview of safety of PLC with case studies. Process Safety through use of PLCs, application of international standards in process safety control.	08
Unit-2	**Distributed control systems (DCS):** Introduction to DCS, PLC versus DCS, Block diagram and function of each component, control room for DCS, security and access control.	08
	Introduction to Supervisory Control and Data Acquisition (SCADA) system: Definition, elements: hardware and Software, communication, applications of IoT based SCADA systems.	08
	Communication systems: MAP/TOP protocol, types of bus: Field Bus, Rack Bus, PROFIBUS, FIPBUS, HART protocol its frame structure, programming, implementation advantages and limitation.	08

Recommended Books-

1. J.W. Webb and R.A. Reis, "Programmable Logic Controllers - Principles and Applications", Prentice Hall Inc., New Jersey, 5th Edition, 2002.
2. F. D. Petruzella, "Programmable Logic Controllers", McGraw Hill, New York, 4th Edition, 2010.

3. S. Bhanot, “Process Control—Principles and Applications”, Oxford University Press, 1st Edition, 2008.
4. P.B. Deshpande and R.H. Ash, “Elements of Process Control Applications”, ISA Press, New York, 1995.
5. C. D. Johnson, “Process Control Instrumentation Technology”, Prentice Hall, New Delhi, 8th Edition, 2005.
6. K. Kant, “Computer-based Industrial Control”, Prentice Hall, New Delhi, 2nd Edition, 2011.
7. G. Dunning, “Introduction to PLCs”, Tata McGraw Hill, 2005.

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

CO1: develop the project requiring individual and teamwork skills.
CO2: explain the recent advancements in industrial instrumentation.
CO3: compile the design calculations and implementations in the area of the project.
CO4: express their work effectively through writing and presentation.
CO5: show professional responsibilities and respect for ethics.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL3	BL2	BL6	BL2	BL2

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.