Annexure-IV

Curriculum Under Autonomy

Department: Electrical Engineering

With effective from Academic Year 2023-2024

(Asansol Engineering College)

Department: Electrical Engineering
Curriculum Structure
(Effective from 2023-24 admission batch)

1st Year 1st Semester									
Sl. No.	**Broad Category**	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG	Major	EE101	Basic Electrical Engineering	3	0	0	3	3
2	ENGG	Minor	EC(EE)101	Analog and Digital Electronic Circuits	3	0	0	3	3
3	SCI	Multidisciplinary	M(EE)101	Engineering Mathematics – I	3	0	0	3	3
4	SCI	Multidisciplinary	PH(EE)101	Engineering Physics	3	0	0	3	3
5	SCI	Value Added Courses	HU104	Environmental Science	2	0	0	2	2
6	HUM	Value Added Courses	HU105	Indian Knowledge System	1	0	0	1	1
B. Practical									
7	ENGG	Major	EE191	Basic Electrical Engineering Laboratory	0	0	3	3	1.5
8	ENGG	Minor	EC(EE)191	Analog and Digital Electronic Circuits Laboratory	0	0	3	3	1.5
9	HUM	Ability Enhancement Courses	HU(EE)191	Technical Writing Skill	0	0	2	2	1
10	ENGG	Skill Enhancement Courses	PH(EE)191	Engineering Physics Laboratory	0	0	3	3	1.5
11	ENGG	Skill Enhancement Courses	ME(EE)191	Engineering Graphics and Design Laboratory	0	0	3	3	1.5
Total for Theory and Practical								**29**	**22**

1st Year 2nd Semester									
Sl. No.	**Broad Category**	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG	Major	EE201	Electrical Circuit Analysis	3	0	0	3	3
2	SCI	Multidisciplinary	M(EE)201	Engineering Mathematics – II	3	0	0	3	3
3	SCI	Multidisciplinary	CH(EE)201	Engineering Chemistry	2	0	0	2	2
4	HUM	Ability Enhancement Courses	HU201	Professional Communication	2	0	0	2	2
5	HUM	Value Added Courses	HU202	Values and Ethics	2	0	0	2	2
6	HUM	Value Added Courses	HU203	Constitution of India	1	0	0	1	1
B. Practical									
7	ENGG	Major	EE291	Electrical Circuit Analysis Laboratory	0	0	3	3	1.5
8	HUM	Ability Enhancement Courses	HU291	Professional Communication Laboratory	0	0	2	2	1
9	SCI	Skill Enhancement Courses	CH(EE)291	Engineering Chemistry Laboratory	0	0	2	2	1
10	ENGG	Skill Enhancement Courses	ME(EE)291	Workshop and Manufacturing Practices Laboratory	0	0	3	3	1.5
Total for Theory and Practical								**23**	**18**

2nd Year 3rd Semester									
Sl. No.	**Broad Category**	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG	Major	EE301	Electrical and Electronic Measurements	3	1	0	4	4
2	ENGG	Major	EE302	Signals and Systems	3	0	0	3	3
3	ENGG	Minor	EC(EE)301	Microprocessor and Microcontroller	2	0	0	2	2
4	ENGG	Minor	CS(EE)301	Programming for Problem Solving	2	0	0	2	2
5	HUM	Minor	HU(EE)301	Economics for Engineers	2	0	0	2	2
B. Practical									
6	ENGG	Major	EE391	Electrical and Electronic Measurements Laboratory	0	0	2	2	1
7	ENGG	Major	EE392	Signals and Systems Laboratory	0	0	3	3	1.5
8	ENGG	Minor	EC(EE)391	Microprocessor and Microcontroller Laboratory	0	0	2	2	1
9	ENGG	Minor	CS(EE)391	Programming for Problem Solving Laboratory	0	0	2	2	1
10	HUM	Ability Enhancement Courses	HU(EE)391	Technical Presentation	0	0	2	2	1
Total for Theory and Practical								**24**	**18.5**

2nd Year 4th Semester									
Sl. No.	**Broad Category**	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG	Major	EE401	Electrical Machines – I	3	0	0	3	3
2	ENGG	Major	EE402	Control Systems – I	3	0	0	3	3
3	ENGG	Major	EE403	Electromagnetic Field Theory	3	0	0	3	3
4	ENGG	Minor	EC(EE)401	Digital Signal Processing	2	0	0	2	2
5	ENGG	Minor	CS(EE)401	Data Structure and Algorithms	2	0	0	2	2
6	HUM	Ability Enhancement Courses	HU(EE)401	Principles of Management	2	0	0	2	2
B. Practical									
7	ENGG	Major	EE491	Electrical Machines – I Laboratory	0	0	3	3	1.5
8	ENGG	Major	EE492	Control Systems – I Laboratory	0	0	3	3	1.5
9	ENGG	Minor	EC(EE)491	Digital Signal Processing Laboratory	0	0	2	2	1
10	ENGG	Minor	CS(EE)491	Data Structure and Algorithms Laboratory	0	0	2	2	1
11	ENGG	Skill Enhancement Courses	ME(EE)491	Computer Aided Design	0	0	3	3	1.5
Total for Theory and Practical								**28**	**21.5**

3rd Year 5th Semester									
Sl. No.	**Broad Category**	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG	Major	EE501	Electrical Machines – II	3	0	0	3	3
2	ENGG	Major	EE502	Power System – I	3	0	0	3	3
3	ENGG	Major	EE503	Power Electronics	3	0	0	3	3
4	ENGG	Major	EE504A	Renewable Energy – I	2	0	0	2	2
			EE504B	Embedded System Design					
			EE504C	Utilization of Electric Power					
5	ENGG	Minor	CS(EE)501A	Database Management System	2	0	0	2	2
			CS(EE)501B	Computer Network					
			CS(EE)501C	Sensors and IoT					
B. Practical									
6	ENGG	Major	EE591	Electrical Machines – II Laboratory	0	0	3	3	1.5
7	ENGG	Major	EE592	Power System – I Laboratory	0	0	3	3	1.5
8	ENGG	Major	EE593	Power Electronics Laboratory	0	0	3	3	1.5
9	ENGG	Skill Enhancement Courses	EE594	Electrical Workshop	0	0	2	2	1
10	ENGG	Skill Enhancement Courses	EE595	Dissertation on Design and Development – I	0	0	3	3	1.5
11	ENGG	Minor	CS(EE)591A	Database Management System Laboratory	0	0	3	3	1.5
			CS(EE)591B	Computer Network Laboratory					
			CS(EE)591C	Sensors and IoT Laboratory					
Total for Theory and Practical								**30**	**21.5**

3rd Year 6th Semester									
Sl. No.	**Broad Category**	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG	Major	EE601	Electric Drives	3	0	0	3	3
2	ENGG	Major	EE602	Power System – II	3	0	0	3	3
3	ENGG	Major	EE603	PLC and Automation	2	0	0	2	2
4	ENGG	Major	EE604A	Line Commutated and Active Rectifiers	2	0	0	2	2
			EE604B	Energy Conservation and Audit					
			EE604C	Electrical Machine Design					
5	ENGG	Minor	CS(EE)601	Artificial Intelligence and Machine Learning	2	0	0	2	2
			ECS(EE)601	Bio-Medical Instrumentation					
			EC(EE)601	Analog and Digital Communication					
B. Practical									
6	ENGG	Major	EE691	Electric Drives Laboratory	0	0	3	3	1.5
7	ENGG	Major	EE692	Power System – II Laboratory	0	0	3	3	1.5
8	ENGG	Major	EE693	PLC and Automation Laboratory	0	0	2	2	1
9	ENGG	Skill Enhancement Courses	EE694	Dissertation on Design and Development - II	0	0	3	3	1.5
10	HUM	Ability Enhancement Courses	HU(EE)691	Soft Skill and Aptitude	0	0	2	2	1
11	PROJ	Internship*	EE681	Seminar on Industrial Training / Internship	0	0	0	0	2
Total for Theory and Practical								**25**	**20.5**

* Students have to complete Internship/Vocational Training at the Industry to earn Credit point subjected to appear in the Seminar and submission of Certificate(s).

4th Year 7th Semester									
Sl. No.	**Broad Category**	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG	Major	EE701	Control Systems – II	3	0	0	3	3
2	ENGG	Major	EE702	Electric Vehicles	3	0	0	3	3
3	ENGG	Major	EE703A	Power System - III	2	0	0	2	2
			EE703B	Introduction to Smart Grid					
			EE703C	Power Quality					
4	ENGG	Major	EE704A	Distributed Generation and Microgrids	2	0	0	2	2
			EE704B	Computer Applications in Power System					
			EE704C	HVDC Transmission Systems					
5	ENGG	Minor	CS(EE)701	Object Oriented Programming	3	0	0	3	3
			EC(EE)701A	Microelectronics and VLSI					
			EC(EE)701B	PCB Design and Manufacturing					
B. Practical									
6	ENGG	Major	EE791	Control Systems – II Laboratory	0	0	2	2	1
7	ENGG	Major	EE792	Electric Vehicles Laboratory	0	0	2	2	1
8	ENGG	Minor	CS(EE)791	Object Oriented Programming Laboratory	0	0	2	2	1
			EC(EE)791A	Microelectronics and VLSI Laboratory					
			EC(EE)791B	PCB Design and Manufacturing Laboratory					
9	PROJ	Project	EE781	Major Project – I	0	0	12	12	6
Total for Theory and Practical								**31**	**22**

4th Year 8th Semester									
Sl. No.	**Broad Category**	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG	Major	EE801A	Renewable Energy – II	2	0	0	2	2
			EE801B	Restructured Power Systems					
			EE801C	Power System Operation and Control					
2	ENGG	Major	EE802A	Flexible AC Transmission Systems	2	0	0	2	2
			EE802B	Remote Sensing and GIS					
			EE802C	Robotics Engineering					
3	ENGG	Major	EE803A	Advanced Electric Drives	2	0	0	2	2
			EE803B	Illumination Engineering					
			EE803C	High Voltage Engineering					
4	ENGG	Minor	EC(EE)801	Digital Image Processing	3	0	0	3	3
			ME(EE)801	Power Plant Engineering					
			ECS(EE)801	Process Control					
B. Practical									
5	ENGG	Minor	EC(EE)891	Digital Image Processing Laboratory	0	0	2	2	1
			ME(EE)891	Power Plant Engineering Laboratory					
			ECS(EE)891	Process Control Laboratory					
6	ENGG	Major	EE881	Grand Viva	0	0	0	0	2
7	PROJ	Project	EE882	Major Project – II	0	0	12	12	6
Total for Theory and Practical								**23**	**18**

Credit Distribution

Category	1st Semester	2nd Semester	3rd Semester	4th Semester	5th Semester	6th Semester	Total Credit to obtain UG Degree (Category Wise)	Credit Allocation as per NEP to obtain UG Degree	7th Semester	8th Semester	Total Credit (Category Wise)	Credit Allocation as per NEP
Major (Core)	4.5	4.5	9.5	12	15.5	14	**60**	**60**	12	8	**80**	**80**
Minor Stream	4.5	-	8	6	3.5	2	**24**	**24**	4	4	**32**	**32**
Multidisciplinary	6	5	-	-	-	-	**11**	**9**	-	-	**11**	**9**
Ability Enhancement Courses (AEC)	1	3	1	2	-	1	**8**	**8**	-	-	**8**	**8**
Skill Enhancement Courses (SEC)	3	2.5	-	1.5	2.5	1.5	**11**	**9**	-	-	**11**	**9**
Value Added Courses common for all UG	3	3	-	-	-	-	**6**	**6 to 8**	-	-	**6**	**6 to 8**
Internship	-	-	-	-	-	2	**2**	**2 to 4**	-	-	**2**	**2 to 4**
Research Project	-	-	-	-	-	-	**-**	**-**	6	6	**12**	**12**
Total Credit (Semester Wise)	**22**	**18**	**18.5**	**21.5**	**20**	**22**	**122**	**120**	**20**	**20**	**162**	**160**

Distribution of Subjects under Different Categories

Major Courses

Sl. No.	Name of the Subject	Subject Code	Semester	L:T:P	Credit
1.	Basic Electrical Engineering	EE101	1st	3:0:0	3
2.	Basic Electrical Engineering Laboratory	EE191	1st	0:0:3	1.5
3.	Electrical Circuit Analysis	EE201	2nd	3:0:0	3
4.	Electrical Circuit Analysis Laboratory	EE291	2nd	0:0:3	1.5
5.	Electrical and Electronic Measurements	EE301	3rd	3:1:0	4
6.	Signals and Systems	EE302	3rd	3:0:0	3
7.	Electrical and Electronic Measurements Laboratory	EE391	3rd	0:0:2	1
8.	Signals and Systems Laboratory	EE392	3rd	0:0:3	1.5
9.	Electrical Machines – I	EE401	4th	3:0:0	3
10.	Control Systems – I	EE402	4th	3:0:0	3
11.	Electromagnetic Field Theory	EE403	4th	3:0:0	3
12.	Electrical Machines – I Laboratory	EE491	4th	0:0:3	1.5
13.	Control Systems – I Laboratory	EE492	4th	0:0:3	1.5
14.	Electrical Machines – II	EE501	5th	3:0:0	3
15.	Power System – I	EE502	5th	3:0:0	3
16.	Power Electronics	EE503	5th	3:0:0	3
17.	Renewable Energy – I	EE504A	5th	2:0:0	2
	Embedded System Design	EE504B			
	Utilization of Electric Power	EE504C			
18.	Electrical Machines – II Laboratory	EE591	5th	0:0:3	1.5
19.	Power System – I Laboratory	EE592	5th	0:0:3	1.5
20.	Power Electronics Laboratory	EE593	5th	0:0:3	1.5
21.	Electric Drives	EE601	6th	3:0:0	3
22.	Power System – II	EE602	6th	3:0:0	3
23.	PLC and Automation	EE603	6th	2:0:0	2
24.	Line Commutated and Active Rectifiers	EE604A	6th	2:0:0	2
	Energy Conservation and Audit	EE604B			
	Electrical Machine Design	EE604C			
25.	Electric Drives Laboratory	EE691	6th	0:0:3	1.5
26.	Power System – II Laboratory	EE692	6th	0:0:3	1.5
27.	PLC and Automation Laboratory	EE693	6th	0:0:2	1
Total for Major Courses up to 3rd Year					**60**
28.	Control Systems – II	EE701	7th	3:0:0	3
29.	Electric Vehicles	EE702	7th	3:0:0	3
30.	Power System - III	EE703A	7th	2:0:0	2
	Introduction to Smart Grid	EE703B			
	Power Quality	EE703C			
31.	Distributed Generation and Microgrids	EE704A	7th	2:0:0	2
	Computer Applications in Power System	EE704B			
	HVDC Transmission Systems	EE704C			
32.	Control Systems – II Laboratory	EE791	7th	0:0:2	1
33.	Electric Vehicles Laboratory	EE792	7th	0:0:2	1

Major Courses (Contd.)

Sl. No.	Name of the Subject	Subject Code	Semester	L:T:P	Credit
34.	Renewable Energy – II	EE801A	8th	2:0:0	2
	Restructured Power Systems	EE801B			
	Power System Operation and Control	EE801C			
35.	Flexible AC Transmission Systems	EE802A	8th	2:0:0	2
	Remote Sensing and GIS	EE802B			
	Robotics Engineering	EE802C			
36.	Advanced Electric Drives	EE803A	8th	2:0:0	2
	Illumination Engineering	EE803B			
	High Voltage Engineering	EE803C			
37.	Grand Viva	EE881	8th	0:0:0	2
Total for Major Courses up to 4th Year					**80**

Minor Courses

Sl. No.	Name of the Subject	Subject Code	Semester	L:T:P	Credit
1.	Analog and Digital Electronic Circuits	EC(EE)101	1st	3:0:0	3
2.	Analog and Digital Electronic Circuits Laboratory	EC(EE)191	1st	0:0:3	1.5
3.	Microprocessor and Microcontroller	EC(EE)301	3rd	2:0:0	2
4.	Programming for Problem Solving	CS(EE)301	3rd	2:0:0	2
5.	Engineering Economics	HU(EE)301	3rd	2:0:0	2
6.	Microprocessor and Microcontroller Laboratory	EC(EE)391	3rd	0:0:2	1
7.	Programming for Problem Solving Laboratory	CS(EE)391	3rd	0:0:2	1
8.	Digital Signal Processing	EC(EE)401	4th	2:0:0	2
9.	Data Structure and Algorithms	CS(EE)401	4th	2:0:0	2
10.	Digital Signal Processing Laboratory	EC(EE)491	4rd	0:0:2	1
11.	Data Structure and Algorithms Laboratory	CS(EE)491	4rd	0:0:2	1
12.	Database Management System	CS(EE)501A	5th	2:0:0	2
	Computer Network	CS(EE)501B			
	Sensors and IoT	CS(EE)501C			
13.	Database Management System Laboratory	CS(EE)591A	5th	0:0:3	1.5
	Computer Network Laboratory	CS(EE)591B			
	Sensors and IoT Laboratory	CS(EE)591C			
14.	Artificial Intelligence and Machine Learning	CS(EE)601	6th	2:0:0	2
	Bio-Medical Instrumentation	ECS(EE)601			
	Analog and Digital Communication	EC(EE)601			
Total for Minor Courses up to 3rd Year					**24**
15.	Object Oriented Programming	CS(EE)701	7th	3:0:0	3
	Microelectronics and VLSI	EC(EE)701A			
	PCB Design and Manufacturing	EC(EE)701B			
16.	Object Oriented Programming Laboratory	CS(EE)791	7th	0:0:2	1
	Microelectronics and VLSI Laboratory	EC(EE)791A			
	PCB Design and Manufacturing Laboratory	EC(EE)791B			

Minor Courses (Contd.)

Sl. No.	Name of the Subject	Subject Code	Semester	L:T:P	Credit
17.	Digital Image Processing	EC(EE)801	8th	3:0:0	3
	Power Plant Engineering	ME(EE)801			
	Process Control	ECS(EE)801			
18.	Digital Image Processing Laboratory	EC(EE)891	8th	0:0:2	1
	Power Plant Engineering Laboratory	ME(EE)891			
	Process Control Laboratory	ECS(EE)891			
Total for Minor Courses up to 4th Year					**32**

Multidisciplinary Courses

Sl. No.	Name of the Subject	Subject Code	Semester	L:T:P	Credit
1.	Engineering Mathematics – I	M(EE)101	1st	3:0:0	3
2.	Engineering Physics	PH(EE)101	1st	3:0:0	3
3.	Engineering Mathematics – II	M(EE)201	2nd	3:0:0	3
4.	Engineering Chemistry	CH(EE)201	2nd	2:0:0	2
Total for Multidisciplinary Courses up to 3rd Year/4th Year					**11**

Ability Enhancement Courses

Sl. No.	Name of the Subject	Subject Code	Semester	L:T:P	Credit
1.	Technical Writing Skill	HU(EE)191	1st	0:0:2	1
2.	Professional Communication	HU201	2nd	2:0:0	2
3.	Professional Communication Laboratory	HU291	2nd	0:0:2	1
4.	Technical Presentation	HU(EE)391	3rd	0:0:2	1
5.	Principles of Management	HU(EE)401	4th	2:0:0	2
6.	Soft Skill and Aptitude	HU(EE)691	6th	0:0:2	1
Total for Ability Enhancement Courses up to 3rd Year/4th Year					**8**

Skill Enhancement Courses

Sl. No.	Name of the Subject	Subject Code	Semester	L:T:P	Credit
1.	Engineering Physics Laboratory	PH(EE)191	1st	0:0:3	1.5
2.	Engineering Graphics and Design Laboratory	ME(EE)191	1st	0:0:3	1.5
3.	Engineering Chemistry Laboratory	CH(EE)291	2nd	0:0:2	1
4.	Workshop and Manufacturing Practices Laboratory	ME(EE)291	2nd	0:0:3	1.5
5.	Computer Aided Design	ME(EE)491	4th	0:0:3	1.5
6.	Electrical Workshop	EE594	5th	0:0:2	1

Skill Enhancement Courses (Contd.)

Sl. No.	Name of the Subject	Subject Code	Semester	L:T:P	Credit
7.	Dissertation on Design and Development – I	EE595	5th	0:0:3	1.5
8.	Dissertation on Design and Development - II	EE694	6th	0:0:3	1.5
Total for Ability Enhancement Courses up to 3rd Year/4th Year					**11**

Value Added Courses

Sl. No.	Name of the Subject	Subject Code	Semester	L:T:P	Credit
1.	Environmental Science	HU104	1st	2:0:0	2
2.	Indian Knowledge System	HU105	1st	1:0:0	1
3.	Values and Ethics	HU202	2nd	2:0:0	2
4.	Constitution of India	HU203	2nd	1:0:0	1
Total for Value Added Courses up to 3rd Year/4th Year					**6**

Internship

Sl. No.	Name of the Subject	Subject Code	Semester	L:T:P	Credit
1.	Seminar on Industrial Training / Internship	EE681	6th	0:0:0	2
Total for Internship up to 3rd Year/4th Year					**2**

Research Project

Sl. No.	Name of the Subject	Subject Code	Semester	L:T:P	Credit
1.	Major Project – I	EE781	7th	0:0:12	6
2.	Major Project – II	EE882	8th	0:0:12	6
Total for Research Project for 4th Year					**12**

Recommended MOOCs courses for attaining the Honours for AICTE UG programmes as per MAKAUT

Dated: 05.08.2021

Massive Open Online Courses (MOOCs) scheme at MAKAUT, WB
(Applicable from the session 2020-21)

(Updated on 05.08.21)

All India Council for Technical Education (AICTE) has introduced Model Curriculum for Bachelor of Technology programme with 160 credits in the entire programme of 4 years, and additional 20 credits will be required to be achieved through Massive Open Online Courses (MOOCs) from different platform for the degree of Bachelor of Technology with Honours. These additional 20 credits will have to be acquired with online courses (MOOCs) as per AICTE. Students of B Tech program will have to complete additional 20 credits through MOOCs within 4 years of time. 16 credit points is applicable for 3 year UG programs. This creates an excellent opportunity for students to acquire the necessary additional skill set for employability through massive open online courses where the rare expertise of world famous experts from academics and industry are available. Maulana Abul Kalam Azad University of Technology, West Bengal (MAKAUT,WB) has thus decided to introduce AICTE model curriculum for its B.Tech Programmes and allow students to choose courses from any established online platform as per following revised guidelines from academic year 2020-21.

GUIDELINES FOR MOOCs

MOOCs (Massive Open Online Courses) have been inducted in University curriculum and academic activities in the following ways:

1. MOOCs for Honours Degree at Undergraduate Level
2. MOOCs for mandatory Coursework of Research Scholars for Ph.D. degree
3. MOOCs are also used for credit transfer as equivalent to theory courses of Curriculum under recommendation of BoS.
4. MOOCs for Mandatory Additional Requirements (MAR)

1 (A) MOOCs for B.Tech Honours Degree

For B.Tech Honours Degree, a B.Tech student will have to earn 20 credits from MOOCs from any established MOOCs platform addition to 160 credits for B.Tech degree.

The total of 20 credits that is required to attain eligibility for B.Tech Honours degree is distributed over four years in the following way:

1st year: 4-8 credits **2nd year: 4-8 credits**
3rd year: 4-8 credits **4th year: 4 credits**

A student of first year has to cover courses from at least three skills:

1. Computer Programing with Python /R
2. Soft skills
3. values and Ethics

Students of all streams are to be equipped with Programming skill in the language that is in high demand worldwide in the first year itself so that they can apply this skill in the subsequent semesters in their different areas including their core area of study.

Soft skill is very essential for grooming of the student and student must be exposed to it in the very

beginning of the 4 year long program.

Ethics is something that one should practice. Students are to be made aware of the ethics right in the beginning of the 4 year long program so that they can practice at least some of the ethical norms as applicable to Institutional environment and society, and be prepared to practice ethics in their working life.

All of the MOOCs courses are to be taken any MOOCs platform as per following scheme of credit points. There would not be any concept of fixed basket anymore. However, during choosing courses in the online platform students would essentially avoid the courses taught/offered through the curriculum in the offline / class room mode.

For NPTEL/Swayam platform: Credit points as specified in the platform
For other MOOCs platforms like Coursera, edX, Udemy, Simpilearn etc
Courses of 4 weeks to 7 weeks: 1 credit point
Courses of 8 weeks to 11 weeks: 2 credit point
Courses of 12 weeks to 15 weeks: 3 credit point
Courses of 16 weeks or more: 4 credit point
Where duration of MOOCs courses are available in hours
For every 8 hours of course: 1 credit point

However, for the courses with duration less than 8 hours, multiple courses could be taken together (preferably in the same area) to consider 1 credit point. But where duration is available in week, count of hours will not be applicable. The above structure is indicative only. And BoS/DC concerned may propose credit points of the courses offered through MOOCs platform based on the content and level beginner/ intermediate/ advanced) of the courses.

1 (B) MOOCs for B. Pharm Program

For B. Pharm Honours degree, **8 credits** will have to be obtained by students in addition to the credits specified for B.Pharm degree curriculum during entire period of 4 years. These credits have to be obtained through the MOOCs platforms.

1 (C) MOOCS for UG Architecture Degree

For B. Arch Honours degree, **8 credits** will have to be obtained by the students in addition to B. Arch Curriculum during entire period of 5 years from MOOCs platform.

1 (D) MOOCS for UG Architecture Degree

For Non-AICTE programs, a student will have to earn 16 credits from MOOCS in addition to 120 credits for UG degree.

The total of 16 credits that is required to attain eligibility for Honours degree is distributed over four years in the following way:

1st year: 4-8 credits **2nd year: 4-8 credits** **3rd year: 4 credits**

As mentioned earlier, Student has to cover courses in the first year:
MOOCs on R or Python Programming Language, MOOCs on Soft skill and MOOCs on Values & Ethics for the reason already mentioned.

The scheme of credit calculation would be same as mentioned above for different MOOCs platforms.

2. MOOCs for Research Scholars for Ph.D. degree

Research scholars have to take MOOCs as mandatory as a part of coursework for Ph.D. degree as per advice of the Research Supervisor. The credits for the course will be as per the assignment of credit for the course in the University website according to the length (in weeks) of the course, even if there is different credit assignment in the MOOCs platforms.

3. MOOCs for Credit Transfer

University had already introduced provision of credit transfer through MOOCs courses. Therefore, different courses of curriculum could be taken from MOOCs platform and credits could be transferred, if offered through online and credits are earned. However, to offer courses of curriculum through MOOCs platform like NETEL/SWAYAM/ Coursera/edX/Simplilearn etc, offering institute must get the course mapping (Mapping between the University course and that offered from the online platform) approved from the University for appropriate Credit Transfer Scheme.

If a student of the university is unable to attend a theory course due to attending internship or any other justified reason, the student may be allowed with special permission of the University to pursue equivalent MOOCs for against the theory course. However, content mapping to be completed preferably by BoS or appropriate authority is essential before opting the courses in MOOCs platform. More than one MOOCs courses may be necessary to be mapped to cover the syllabus of the theory course and the student has to complete all the MOOCs to cover the course. Credits earned in total in all the courses will be considered for equivalence and credit transfer.

Evaluation of the MOOCs course

Evaluation of the MOOCs courses would be done by the organization by whom it is being offered. In extraordinary circumstances, the modality of evaluation through certified personnel, online or offline, will be decided by the appropriate authority.

Uploading of MOOCs Data

Every Affiliated Institution has to upload the details of MOOCs data in respect of each student time to time in University's examinations portal and/or hard/soft copy as per instruction of the Controller of Examinations of the University. This is applicable for University's In-House Programs also.

4, MOOCs for Mandatory Additional Requirements (MAR)

MOOCs in MAR is provided for encouraging every student to enter in Digital Content form of Education from well-known Universities or organizations.

Students can choose any MOOCs course as per their interest area. There is no credit system for MOOCs in MAR as points could be earned as specified in the scheme and the MOOCs courses which are taken for earning credits for Honours degree will not be considered in MAR purpose.

The validity of uploaded certificates in the University portal is subject to acceptance of appropriate committee/expert review.

Colleges interested to deliver any course(s) online through MOOCs platform, should get vetted from the University regarding mapping of course for credit transfer/assessment process.

This notification supersedes all earlier instructions regarding MOOCs courses.

MOOC for First Year AICTE Programmes (Affiliated Colleges)

A. Category: Ethics

Course	Provider	Duration	Credits	Name of University / Institute	Status
Ethics in EngineeringPractice	NPTEL	8weeks	3	IIT Kharagpur	Active
A Life of Happinessand Fulfilment	Coursera	6 weeks	2	Indian School of Business	Active
Introduction toPhilosophy	Coursera	5 weeks	1	University of Edinburgh	Active
Ethical LeadershipThrough Giving Voice	Coursera	4 weeks	2	University of Virginia	Active

B. Category: Soft Skills

Course	Provider	Duration	Credits	Name of University / Institute	Status
Technical English for engineers	NPTEL	8 Weeks	3	IIT Madras	Active
Body Language: Key to Professional Success	NPTEL	4 Weeks	1	IIT Ropar	Active
Psychology at Work	Coursera	6 weeks	2	University of Western Australia	Active
Communication in the 21st Century Workplace	Coursera	4 weeks	1	University of California	Active
Successful Career Development	Coursera	7 weeks	2	University System of Georgia	Active
Working in Teams: A Practical Guide	edX	4 weeks	1	University of Queensland	Active
Communication theory: bridging academia and practice	Coursera	9 weeks	3	Higher School of Economics	Active
Write Professional Emails in English	Coursera	5 weeks	2	Georgia Institute of Technology	Active
Technical Writing	Coursera	5 weeks	1	Moscow Institute of Physics and Technology	Active
Interpersonal Communication for Engineering Leaders	Coursera	4 weeks	1	Rice University	Active

C. Category: Programming Skills

Course	Provider	Duration	Credits	Name of University / Institute	Status
Introduction to Programming with MATLAB	Coursera	9 weeks	3	Vanderbilt University	Active
Programming In C++	NPTEL	8 weeks	3	IIT Kharagpur	Active
Learn to Program: The Fundamentals	Coursera	7 weeks	2	University of Toronto	Active
Introduction to computer Science	Edx	4-5 weeks	2	Microsoft	Active
Introduction to Computer Science and Programming Using Python	Edx	Self Paced	4	MIT, USA	Active
Statistics and R	edX	Self Paced	4	Harvard University	Active
Introduction to Programming in C	Coursera	4 weeks	4	Duke University	Active
Java Programming: Solving Problems with Software	Coursera	4 weeks	4	Duke University	Active
Responsive Website Basics: Code with HTML, CSS, and JavaScript	Coursera	4 weeks	1	University of London Microsoft	Active
Introduction to HTML5	Coursera	3 weeks	1	University of Michigan	Active
HTML5 Coding Essentials and Best Practices	edX	6 weeks	2	W3C	Active
Problem solving through Programming In C	NPTEL	12 Weeks	4	IIT Kharagpur	Active
Joy of computing using Python	NPTEL	12 Weeks	4	IIT Ropar	Active
Programming, Data Structures and Algorithm Using Python	NPTEL	8 Weeks	3	CMI	Active
Foundation of Data Structures	edX	6 weeks	2	IIT Bombay	Active
Learn to Program: The Fundamentals	Coursera	7 weeks	3	University of Toronto	Active
Web Design for Everybody (Basics of Web Development and Coding) Specialization	Coursera	15weeks	4	University of Michigan	Active
Programming Basics	edX	9 weeks	3	IIT Bombay	Active

D. Category: Statistics

Course	Provider	Duration	Credits	Name of University / Institute	Status
Inferential Statistics	Coursera	7 weeks	2	University of Amsterdam	Active
Linear Regression and Modelling	Coursera	4 weeks	1	Duke University	Active

E. Category: Environmental Studies

Course	Provider	Duration	Credits	Name of University / Institute	Status
The Science of Well Being	Coursera	6 weeks	2	Yale University	Active
Ecology: Ecosystem Dynamics and Conservation	Coursera	5 weeks	1	American Museum of Natural History, Howard Hughes Medical Institute	Active
Effective Problem Solving and Decision Making	Coursera	4 weeks	1	University of California	Active
Moralities of Everyday Life	Coursera	6 weeks	2	Yale University	Active
Introduction to Logic	Coursera	10 weeks	3	Stanford University	Active
The Science of Everyday Thinking	edX	12 weeks	4	University of Queensland	Active
Digital Security and Human Rights	edx	3 weeks	1	Amnesty InternationalX	Active
Ethics in Engineering Practices	NPTEL	8 weeks	4		Active
Introduction to Philosophy: God, Knowledge, and Consciousness	edX	12 weeks	4	MIT	Active
Development of Sociology in India	NPTEL	4 Weeks	1	IIT Kanpur	Archived
Introduction to Logic	NPTEL	12 weeks	4	IIT Kanpur	Archived
Introduction to Problem-solving and Programming	NPTEL	12 weeks	4	IIT Kanpur	Archived
Speak English Professionally: In Person, Online & On the Phone	Course era	4 weeks	1	Georgia Tech	Active
Java Fundamentals for Android Development	edX	6 weeks	2	GalileoX	Active
Environmental Studies: A Global Perspective	edX	Self Paced	4	Curtin University	Active
Science, Technology and Society	NPTEL	12 weeks	4		Active
Critical Thinking &Problem Solving	edX	3 weeks	3	Rochester Institute of Technology	Active

List of MOOCs for UG Honours degree (AICTE Programmes)
Effective for Odd Semester of 2020-21
ELECTRICAL ENGINEERING

Course Name	Duration (Weeks)	Credit	Name of the Mooc websites	Availability of Course (Active/Inactive)
Fabrication Techniques for MEMs-based sensors: clinical Perspective	12	4	Swayam	Active
Introduction to computer vision with Watson and opencv	4	2	Coursera	Active
Solar Energy Basics	5	3	Coursera	Active
Introduction to the Internet of Things (IoT) and embedded system	4	2	Coursera	Active
IoT Networking and Fog Layer Devices	4	2	Edx	Active
Artificial Intelligence Search Methods For Problem Solving	12	4	Swayam	Active
Data Science for Engineers	8	3	Swayam	Active
Introduction to Machine Learning (IITM)	12	4	Swayam	Active
Python for Data Science	4	2	Swayam	Active
Introduction to cyber security	12	4	Swayam	Active
Statistics with Python Specialization	3	2	Coursera	Active
Artificial Intelligence (AI)	12	4	Edx	Active
Machine Learning with Python: from linear models to deep learning	15	4	Edx	Active
Deep learning and neural network for financial engineering	7	3	Edx	Active

Mandatory Additional Requirements (MAR) as per MAKAUT

Dated: 12.03.2019

Mandatory Additional Requirements for earning AICTE/non-AICTE UG Degree

In partial modification with the notice dated 11 June 2018 regarding Mandatory Additional Requirement (MAR) for earning UG degree, the following modifications/clarifications have been made, which would be effective from the present semester.

- Previously no division of activity points of MAR which are to be earned by the students, has been scheduled year wise. A student should acquire a total of minimum 100/75 activity points throughout 4 year/3 year curriculum which should be acquired by earning a minimum of 20 activity points and maximum of 30 activity points in each year of his/her study, which is necessary for uniform distribution of MAR activities throughout the entire period of the academic curriculum of the students.
- MAR activities for the students admitted up to the session 2018-19 and for the new session starting from 2019-20, will be in accordance with the following table.

Level of Entry in B.Tech Course	Total duration for earning Points	Minimum Points to be earned
1st Year starting from the academic year 2019-20 onwards	1st to 4th Year	100
2nd Year starting from the academic year 2019-20 onwards (Lateral Entry)	2nd to 4th Year	75

Table – I

Every student, who is admitted to the 4 years B.Tech program prior to the academic year 2019-20, is required to earn minimum number of Activity Points as per Table II in addition to the required academic grades, for getting MAKAUT, WB's B.Tech degree.

Current Semester	Total Minimum Number of Activity Points to be earned During the full course
2nd	100
4th	75
6th	50

Table –II

- The courses under MOOCs which have been already taken into consideration i.e., 20 credit courses for awarding B.Tech degree with Honours and 16 credit courses for non-AICTE courses are not to be considered again for awarding activity points for MAR.
- In addition to the existing activity point allotment for 12 weeks and 8 weeks MOOCs courses of short duration (4 weeks/2 weeks) can also be done. 10/5 activity points will be allotted, based on the short course duration of 4weeks/2 weeks respectively. The courses with duration ranging from 18-40 hours must also get proper weightage. (See the following table for details)

Weeks/Hours	Activity Points	Maximum Activity Points
12weeks/40hours	20	40
8weeks/30hours	16	
4weeks/20hours	10	
2weeks/10hours	5	

Table-III

- Any MOOCS already done or registered before the introduction of MAR system is not to be considered again for awarding activity points for MAR. Those courses should not be taken into consideration with retrospective effect.
- A student can also select MOOCs from the MOOCs basket/repository as designed by the University for earning activity points for MAR. But the same course cannot be counted for Honours. There should not be any overlapping of MOOCs with regard to MAR and Degree with Honours.
- If any student is unable to get certificate from MOOCs platform after auditing the course, the college will extend facility for awarding point after evaluation in consultation with the University.
- The activity points allotted per research publication (Vide Serial No.9 of Table-V) shall carry equal full weights among joint authors, if any, to encourage the students in research work.
- In addition to SWAYAM/NPTEL/Spoken Tutorial the names of all available MOOCs can be included. At present, SWAYAM/NPTEL/Spoken Tutorial have only been mentioned (Vide Serial No. 1 of Table V).
- In Serial No. 15 of Table-V, 'Student Chapter' should be read as 'Active Participation in Student Chapter', that is, whether the concerned student is an active member of the same.
- A student may earn activity point, being a member of other professional bodies and by participating as a resource person.
- A separate dedicated server is needed for huge data on students' evaluation on the part of the colleges. Digital versions of all certificates regarding MAR can be uploaded in the college.
- Every student should upload his/her MAR activity data/certificate in the social media, viz., Facebook/Instagram, which can be counted as part of the documentary evidence.
- Activities must be open-ended, that is, there can be many activities, other than the specified list by MAKAUT. College authorities may introduce new activities, with the prior approval of the University.
- The University has introduced new activities as part of MAR, which would encourage entrepreneurship ability of the students. Such activities are listed in the following table.

New MAR Activities (In addition to the existing list, Vide Serial No. 22, Table-V)

	Name of the Activity	**Points**	**Maximum Points Allowed**
	Self-Entrepreneurship Programme		
a)	To Organize Entrepreneurship Workshop and Programmes	10	20
b)	To take part in Entrepreneurship Workshop and get certificate	5	10
c)	Video Film-Making on Entrepreneurship	10	20
d)	Submit Business Plan on any Project	10	20
e)	To work for start-up/as entrepreneur	20	40

Table-IV

- There must be a Single Point of Contact (SPOC) in each college, who will keep correspondences with the University on MAR activities and his/her name is to be informed to the University. In addition, there should also be a nominated SPOC on behalf of the University for liaison with the colleges.

- Random sample visits and check-ups of individual institutes, as well as digital survey may be conducted from time to time to ensure proper implementation of MAR.
- The colleges should maintain MAR files for individual students, preferably in digital format, which can be inspected periodically by the University authorities.
- Different levels of activities in relief camps should carry different weightage for allotting activity points in MAR (Vide Serial No. 5 of Table-V).
- Institutions should not raise any subscription from the students in the name of MAR activities.

Notes:

1) Every student shall participate in the cio-curricular and extra-curricular activities and produce documentary proof to the designated Faculty Members appointed by the Head of the Department/Principal/Director in the respective college. Thereby the student should earn the required points before he/she appears for the Final Examinations.
2) A student's result of his/her Final Examinations will be withheld until he/she completes the minimum activity points by the end of his/her Degree Programme.
3) In every semester, every student is required to prepare a file containing documentary proofs of activities, done by him/her. This file will be duly verified and activity points will be assigned by the teachers as appointed above, at the end of every semester.
4) Each institution will form a three members committee, the composition of which is to be notified to the University. The committee will finalize the activity points for each student before entering them into the Online Point Entry System (at the URL, as specified by the COE of the University).
5) Every student has to earn at least 75, 100 or 125 activity points for 3, 4 or 5 year courses respectively. The points earned by the students will be reflected in their mark sheets.

Table V provides a List of Activity Heads and Sub-Activity Heads along with their capping of the activity points that can be earned by the students during the entire course duration.

Sl. No.	Name of the Activity	Points	Maximum Points Allowed
1.	MOOCs (SWAYAM, NPTEL, Spoken Tutorial, EdX, Coursera, etc.)	20 (per course)	40
2.	Tech Fest/Fest/Teachers' Day/Fresher's Welcome		
	a) Organizer	5	10
	b) Participant	3	6
3.	Rural Reporting	5	10
4.	Tree Plantation and up keeping (per tree)	1	10
5.	Participation in Relief Camps		
	a) Collection of funds/materials for the Relief Camp	5	40
	b) To be a part of the Relief Work team	20	
6.	Participation in Debate/Group Discussion/Tech Quiz/Quiz	10	20
7.	Publication of Wall Magazine in institutional level (magazine/article/internet)	10	20
8.	Publication in Newspaper, Magazine and Blogs	10	20
9.	Research Publication (per publication)	15	30
10.	Innovative Projects (other than course curriculum)	30	60

11.	Blood donation	8	16
	Blood donation camp organization	10	20
12.	Participation in Sports/Games		
	a) College level	5	10
	b) University level	10	20
	c) District level	12	24
	d) State level	15	30
	e) National/International Level	20	20
13.	Cultural Programme (Dance, Drama, Elocution, Music etc.)	10	20
14.	Member of Professional Society	10	20
15.	Student Chapter	10	20
16.	Relevant Industry Visit & Report	10	20
17.	Activities in different Clubs (Photography Club, Cine Club, Gitisansad)	5	10
18.	Participation in Yoga Camp (Certificate to be submitted)	5	10
19.	Adventure Sports with Certification	10	20
20.	Training to under-privileged/differently able	15	30
21.	Community Service & Allied Activities	10	20
22.	Self-Entrepreneurship Programme		
	a) To Organize Entrepreneurship Workshop and Programmes	10	20
	b) To take part in Entrepreneurship Workshop and get certificate	5	10
	c) Video Film-Making on Entrepreneurship	10	20
	d) Submit Business Plan on any Project	10	20
	e) To work for start-up/as entrepreneur	20	40

Table-V

Syllabus Under Autonomy

With effective from Academic Year 2023-2024

(R23)

Department: Electrical Engineering
Curriculum Structure
(Effective from 2023-24 admission batch)

1st Year 1st Semester									
Sl. No.	**Broad Category**	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG	Major	EE101	Basic Electrical Engineering	3	0	0	3	3
2	ENGG	Minor	EC(EE)101	Analog and Digital Electronic Circuits	3	0	0	3	3
3	SCI	Multidisciplinary	M(EE)101	Engineering Mathematics – I	3	0	0	3	3
4	SCI	Multidisciplinary	PH(EE)101	Engineering Physics	3	0	0	3	3
5	SCI	Value Added Courses	HU104	Environmental Science	2	0	0	2	2
6	HUM	Value Added Courses	HU105	Indian Knowledge System	1	0	0	1	1
B. Practical									
7	ENGG	Major	EE191	Basic Electrical Engineering Laboratory	0	0	3	3	1.5
8	ENGG	Minor	EC(EE)191	Analog and Digital Electronic Circuits Laboratory	0	0	3	3	1.5
9	HUM	Ability Enhancement Courses	HU(EE)191	Technical Writing Skill	0	0	2	2	1
10	ENGG	Skill Enhancement Courses	PH(EE)191	Engineering Physics Laboratory	0	0	3	3	1.5
11	ENGG	Skill Enhancement Courses	ME(EE)191	Engineering Graphics and Design Laboratory	0	0	3	3	1.5
Total for Theory and Practical								**29**	**22**

Course Name: Basic Electrical Engineering
Course Code: EE101
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Basic 12th standard Physics and Mathematics, Concept of components of electric circuit.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Define different terminologies pertaining to electrical and/or electro-magnetic circuits and energy storage.
- **CO2.** Illustrate the working principle and installation of basic electrical and/or electro-magnetic circuits.
- **CO3.** Analyse various DC and AC circuits.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	2	3	-	-	-	-	2
CO2	3	2	2	-	2	2	2	-	-	-	-	3
CO3	3	3	3	3	-	2	2	-	-	-	-	2

Course Content

Module 1: DC Circuits **9L**

Definition of electric circuit, linear circuit, non-linear circuit, bilateral circuit, unilateral circuit, Dependent source, node, branch, and mesh analysis, active and passive elements, Kirchhoff's laws, Source equivalence and conversion, Star-Delta Conversions.

Module 2: AC Fundamentals **9L**

Representation of sinusoidal waveforms, peak and rms values, Form Factor and Peak Factor, phasor representation, real power, reactive power, apparent power, power factor. Steady-state analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel). Three phase balanced circuits, voltage and current relations in star and delta connections.

Module 3: Electrical Machines **10L**

a) Transformer: Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency.

b) Rotating Machines:

i. **DC Machines:** Brief idea on constructional features, classifications, working principle of both motor and generator.

ii. **Three-Phase Induction Motor:** Basic concept of three phase circuit and production of rotating magnetic field. Working principle of three-phase induction motor.

Module 4: Electrical Installations **3L**

Earthing of Electrical Equipment, ideas of basic components – MCB, MCCB, ELCB, SFU, Types of Wires and Cables.

Module 5: Fundamentals of Energy Storage **5L**

Working principle and example of Hydrogen cell, Battery – Dry cell and Wet cell, Fuel cell and Hydro-statics.

Text Books:

1. P. Kothari & I. J. Nagrath, Basic Electrical Engineering, TMH.
2. V. Mittle & Arvind Mittal, Basic Electrical Engineering, TMH.
3. Ashfaq Hussain, Basic Electrical Engineering, Dhanpat Rai Publication.
4. Chakrabarti, Nath & Chanda, Basic Electrical Engineering, TMH.
5. C.L. Wadhwa, Basic Electrical Engineering, Pearson Education.

Reference Books:

1. E. Hughes, Electrical and Electronics Technology, Pearson, 2010.
2. V. D. Toro, Electrical Engineering Fundamentals, Prentice Hall India, 1989.

Course Name: Analog and Digital Circuits
Course Code: EC(EE)101
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Knowledge of Physics and Mathematics.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Describe the fundamental Analog and Digital Circuit elements.
- **CO2.** Construct various types of electronic circuits using analog and digital devices.
- **CO3.** Analyze different problems pertaining to analog and digital circuits.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	2	-	-	2	-	-	-	-	-	2
CO2	3	3	3	2	2	2	-	-	-	-	2	3
CO3	3	3	3	3	3	2	-	-	-	-	2	3

Course Content

Module 1: Diode and Transistors **5L**

Semiconductors, Intrinsic and Extrinsic Semiconductors, P-N Junction Diode – Characteristics, Forward and Reverse Biased, Zener Diode. Biasing technique, Q-point and its Stability, Self-Bias – CE configuration, Bias Compensation techniques, h-parameter model of transistors.

Module 2: Operational Amplifier **2L**

Ideal OPAMP, Differential amplifier, Constant current source, Level shifter, CMRR, Open and closed loop circuits, importance of feedback loop (positive and negative), inverting and non-inverting amplifiers.

Module 3: OPAMP Applications **5L**

Linear applications of op-amp – summing, subtracting, averaging amplifier, voltage to current converter, current to voltage converter, differentiator and integrator.

Module 4: Timer Circuits **4L**

555 Timer and its applications, monostable multivibrator, Astable multivibrator.

Module 5: Digital Techniques **6L**

Number systems - Binary, octal and hexadecimal numbers. Binary codes, Logic Gates, Boolean algebra - Conversion and operations. De Morgan's laws, Truth tables, Karnaugh's map, Min term, Max term, SOP, POS, Synthesis of Boolean functions, Quine Mccluskey method.

Module 6: Combinational Circuit Design **6L**

Half Adder, Full Addar, Encoder, Decoder, Multiplexer, De Multiplexer, Parity generator – Checker, Seven-segment display, Analysis and Design Procedure - Multiplexer, Decoder, Encoder.

Module 7: Sequential Circuit Design **5L**

Flip Flops – SR, D, T and JK Flip-flops, Master slave Flip Flops, Counters.

Module 8: ADC and DAC **1L**

Parameters of D/A and A/D Converters. Logic families – TTL their operation and specifications.

Text Books:

1. J. B. Gupta – Electronic Devices and circuits, S .K. KATARIA & SONS.
2. Gayakwad R. A. – OpAmps and Linear IC‘s, PHI
3. A. Anand Kumar – Fundamentals of Digital Circuits, PHI
4. A. K. Maini – Digital Electronics, Wiley-India

Reference Books:

1. Boylested & Nashelsky – Electronic Devices and Circuit Theory, Pearson/PHI.
2. Rashid – Microelectronic Circuits-Analysis and Design, Thomson (Cenage Learning)
3. D. Ray Chaudhuri – Digital Circuits-Vol-I & II, 2/e- Platinum Publishers
4. Floyed & Jain – Digital Fundamentals, Pearson press.

Course Name: Engineering Mathematics – I
Course Code: M(EE)101
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: The students to whom this course will be offered must have the concept of (10+2) algebra and calculus.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Recall the properties and formula related to Matrix Algebra, Differential Calculus and Laplace Transforms.
- **CO2.** Determine the solutions of the problems related to Matrix Algebra, Differential Calculus and Laplace Transforms.
- **CO3.** Apply the appropriate mathematical tools of Matrix Algebra, Matrix Algebra, Differential Calculus and Laplace Transforms.
- **CO4.** Analyze different engineering problems linked with Matrix Algebra, Matrix Algebra, Differential Calculus and Laplace Transforms.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	2
CO2	3	2	-	-	-	-	-	-	-	-	-	2
CO3	3	2	2	-	-	-	-	-	-	-	-	2
CO4	2	3	2	2	-	-	-	-	-	-	-	2

Course Content

Module 1: Matrix Algebra **10L**

Echelon form and Normal (Canonical) form of a matrix; Inverse and rank of a matrix; Consistency and inconsistency of system of linear equations, Solution of system of linear equations; Eigenvalues and eigenvectors, Cayley-Hamilton theorem.

Module 2: Differential Calculus **12L**

Function of several variables, Concept of limit, continuity and differentiability; Partial derivatives, Total derivative and its application; Chain rules, Derivatives of implicit functions Euler's theorem on homogeneous function, Jacobian. Maxima and minima of functions of two variables

Module 3: Laplace Transform (LT): **14L**

Improper integrals; Beta and Gamma functions and their properties.
Definition and existence of LT, LT of elementary functions, First and second shifting properties, Change of scale property, LT of $tf(t)$, LT of $\frac{f(t)}{t}$, LT of derivatives of $f(t)$, LT of integral of $f(t)$, Evaluation of improper integrals using LT, LT of periodic and step functions, Inverse LT: Definition and its properties, Convolution theorem (statement only) and its application to the evaluation of inverse LT, Solution of linear ODE with constant coefficients (initial value problem) using LT.

Text Books:

1. Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
2. Kreyszig, E., Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

Reference Books:

1. Guruprasad, S. A text book of Engineering Mathematics – I, New age International Publishers.
2. Ramana, B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
3. Veerarajan, T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
4. Bali, N.P. and Goyal, M., A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
5. Apostol, M., Calculus, Volumes 1 and 2 (2nd Edition), Wiley Eastern, 1980.
6. Kumaresan, S., Linear Algebra – A Geometric approach, Prentice Hall of India, 2000.

Course Name: Engineering Physics
Course Code: PH(EE)101
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Knowledge of Physics up to 12th standard.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Explain basic principles of laser and optical fibers.
- **CO2.** Understand the properties of Nano material.
- **CO3.** Understand the macro state for thermodynamic system, thermodynamic probability and phase space.
- **CO4.** Analyze different crystallographic structures according to their co-ordination number and packing factors.
- **CO5.** Justify the need of a quantum mechanics as remedy to overcome limitations imposed by classical physics.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	-	-	-	-	-	-	2
CO2	3	3	2	2	-	-	-	-	-	-	-	2
CO3	3	3	2	2	-	-	-	-	-	-	-	1
CO4	3	2	2	2	-	-	-	-	-	-	-	2
CO5	3	2	3	3	-	-	-	-	-	-	-	1

Course Content

Module 1: Modern Optics **12L**

a) Laser: Concepts of various emission and absorption processes, Einstein A and B coefficients and equations, working principle of laser, metastable state, population inversion, condition necessary for active laser action, optical resonator, illustrations of Ruby laser, He-Ne laser, Semiconductor laser, applications of laser, related numerical problems. 6L

b) Fibre Optics: Principle and propagation of light in optical fibers (Step index, Graded index, single and multiple modes) - Numerical aperture and Acceptance angle, Basic concept of losses in optical fiber, related numerical problems. 3L

c) Holography: Theory of holography, viewing of holography, applications 3L

Module 2: Solid State Physics **6L**

a) Crystal Structure: Structure of solids, amorphous and crystalline solids (definition and examples), lattice, basis, unit cell, Fundamental types of lattices – Bravais lattice, simple cubic, fcc and bcc lattices, Miller indices and miller planes, co-ordination number and atomic packing factor, Bragg's equation, applications, numerical problems. 3L

b) Semiconductor: Physics of semiconductors, electrons and holes, metal, insulator and semiconductor, intrinsic and extrinsic semiconductor, p-n junction. 3L

Module 3: Quantum Mechanics **8L**

a) Quantum Theory: Inadequacy of classical physics-concept of quantization of energy, particle concept of electromagnetic wave (example: photoelectric and Compton Effect; no derivation required, origin of modified and unmodified lines), wave particle duality; phase velocity and group velocity; de Broglie hypothesis; Davisson and Germer experiment,

related numerical problems. 4L

b) Quantum Mechanics 1: Concept of wave function, physical significance of wave function, probability interpretation; normalization of wave functions-Qualitative discussion; uncertainty principle, relevant numerical problems, Introduction of Schrödinger wave equation (only statement). 4L

Module 4: Physics of Nanomaterials 4L

Reduction of dimensionality, properties of nanomaterials, Quantum wells (two dimensional), Quantum wires (one dimensional), Quantum dots (zero dimensional); Quantum size effect and Quantum confinement. Carbon allotropes. Application of nanomaterials (CNT, graphene, electronic, environment, medical).

Module 5: Statistical Mechanics 6L

Concept of energy levels and energy states, phasespace, microstates, macrostates and thermodynamic probability, MB, BE, FD, statistics (Qualitative discussions)-physical significance, conception of bosons, fermions, classical limits of quantum statistics, Fermi distribution at zero and non-zero temperature, Concept of Fermi level, relevant problems, Position of Fermi level for a semiconductor (intrinsic and extrinsic) - Qualitative discussion.

Recommended Text Books for Engineering Physics:

a) Modern Optics:

1. A text book of Light - K.G. Mazumder & B.Ghoshs (Book & Allied Publisher)
2. A text book of Light - Brijlal & Subhramanium, (S. Chand publishers)
3. Modern Optics - A. B. Gupta (Book & Allied Publisher)
4. Optics - Ajay Ghatak (TMH)
5. Optics - Hecht
6. Optics - R. Kar, Books Applied Publishers
7. Physical Optics Möler
8. Concepts of Modern Physics - Arthur Beiser, McGraw Hill

b) Solid State Physics:

1. Solid state physics - Puri & Babbar (S. Chand publishers)
2. Materials Science & Engineering - Kakani Kakani
3. Solid state physics - S. O. Pillai
4. Introduction to solid state physics - Kittel (TMH)
5. Solid State Physics and Electronics - A. B. Gupta and Nurul Islam (Book & Allied Publisher)
6. Problem in Solid state physics - S.O. Pillai (a. b.)

c) Quantum Mechanics:

1. Introduction to Quantum Mechanics-S. N. Ghoshal (Calcutta Book House)
2. Quantum Mechanics-Bagde and Singh (S. Chand Publishers)
3. Perspective of Quantum Mechanics-S. P. Kuilla (New Central Book Agency)
4. Quantum Mechanics-Binayak Datta Roy (S. Chand Publishers)
5. Quantum Mechanics-Bransden (Pearson Education Ltd.)
6. Perspective of Modern Physics-A. Beiser (TMH)
7. Quantum mechanics -A.K. Ghatak and S Lokenathan
8. Modern Physics -E.E. Anderson
9. Physics Volume 2 - Haliday, Resnick & Krane, Published by Wiley India

d) Physics of Nanomaterials:

1. Nanostructure and Nanomaterials, B.K. Parthasarathy
2. Introduction to Nanotechnology, B.K. Parthasarathy
3. Essentials of Nanotechnology, Rishabh Anand
4. Nanomaterials Handbook (Advanced Materials and Technologies) - YuryGogotsi (Editor).
5. Nanotechnology-Rakesh Rathi (S. Chand Publishers)
6. Integrated Electronics-Millman Halkias (TMH)
7. Nanotechnology-Rakesh Rathi (S. Chand Publishers)
8. Nanoscience-H. E. Schaefer (Springer)

e) Statistical Mechanics:

1. Fundamental of Statistical Mechanics: B. B. Laud
2. Introduction to statistical mechanics: R. K. Pathria
3. Fundamental of Statistical and Thermal Physics: F. Reif
4. Advanced Engineering Physics - S. P. Kuila New Central Book Agency (P) Ltd.
5. Statistical Mechanics by Singh and Singh.
6. Statistical Mechanics by Satyaprakash.

Text Books:

1. Refresher courses in physics (Vol. 1, Vol. 2 & Vol. 3)-C. L. Arora (S. Chand Publishers)
2. Basic Engineering Physics - Amal Chakraborty (Chaya Prakashani Pvt. Ltd.)
3. Perspective & Concept of Modern Physics - Arthur Baiser
4. Principles of engineering physics – Md. N Khan and S Panigrahi.
5. Basic Engineering Physics - Sujoy Bhattacharya, Saumen Pal (MG)
6. Engineering Physics (Vol. 1, Vol. 2)-S.P. Kuila (S. Chand Publishers)
7. Engineering Physics - A. S. Vasudeva

Course Name: Environmental Science
Course Code: HU104
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: 10+2.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand the natural environment and its relationships with human activities.
- **CO2.** Apply the fundamental knowledge of science and engineering to assess environmental and health risk.
- **CO3.** Understand environmental laws and regulations to develop guidelines and procedures for health and safety issues.
- **CO4.** Acquire skills for scientific problem-solving related to air, water, noise and land pollution.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	-	-	2	3	3	-	-	1	2
CO2	3	3	3	1	1	2	3	3	-	-	1	2
CO3	3	3	3	2	1	2	3	3	-	-	1	2
CO4	1	1	1	1	2	2	3	3	-	-	1	2

Course Content

Module 1: Resources and Ecosystem **6L**

a) Resources: 2L
Types of resources, resistance to resources, Human resource, Population Growth models: Exponential Growth, logistic growth.

b) Ecosystem: 3L
Components of ecosystem, types of ecosystem, Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems, Food chain, Food web.

c) Energy and Environment: 1L
Conventional energy sources, coal and petroleum, Green energy sources, solar energy, tidal energy, geothermal energy, biomass.

Module 2: Environmental Degradation **9L**

a) Air Pollution and its impact on Environment: 3L
Air Pollutants, primary & secondary pollutants, Criteria pollutants, Smog, Photochemical smog and London smog, Greenhouse effect, Global Warming, Acid rain, Ozone Layer Depletion.

b) Water Pollution and its impact on Environment: 3L
Water Pollutants, Oxygen demanding wastes, heavy metals, BOD, COD, Eutrophication, Hardness, Alkalinity, TDS and Chloride, Heavy metal poisoning and toxicity.

c) Land Pollution and its impact on Environment: 2L
Solid wastes, types of Solid Waste, Municipal Solid wastes, hazardous wastes, bio-medical wastes, E-wastes

d) Noise Pollution and its impact on Environment: 1L
Types of noise, Noise frequency, Noise pressure, Noise intensity, Noise Threshold limit, Effect of noise pollution on human health.

Module 3: Environmental Management **6L**

a) Environmental Impact Assessment: 1L
Objectives of Environmental management, Components of Environmental Management, Environmental Auditing, Environmental laws and Protection Acts of India.

b) Pollution Control and Treatment: 2L
Air Pollution controlling devices, Catalytic Converter, Electrostatic Precipitator, etc., Waste Water Treatment, Noise pollution control.

c) Waste Management: 3L
Solid waste management, Open dumping, Land filling, incineration, composting, E-waste management, Biomedical Waste management.

Module 4: Disaster Management **3L**

a) Study of some important disasters: 2L
Natural and Man-made disasters, earthquakes, floods drought, landside, cyclones, volcanic eruptions, tsunami, Global climate change. Terrorism, gas and radiations leaks, toxic waste disposal, oil spills, forest fires.

b) Disaster management Techniques: 1L
Basic principles of disasters management, Disaster Management cycle, Disaster management policy, Awareness generation program.

Text Books:

1. Basic Environmental Engineering and Elementary Biology (For MAKAUT),
2. Gourkrishna Dasmohapatra, Vikas Publishing.
3. Basic Environmental Engineering and Elementary Biology, Dr. Monindra Nath Patra & Rahul Kumar Singha, Aryan Publishing House.
4. Textbook of Environmental Studies for Undergraduate Courses, Erach Barucha for UGC, Universities Press

Reference Books:

1. A Text Book of Environmental Studies, Dr. D.K. Asthana & Dr. Meera Asthana, S.Chand Publications.
2. Environmental Science (As per NEP 2020), Subrat Roy, Khanna Publisher

Course Name: Indian Knowledge System
Course Code: HU105
Contact: 1L:0T:0P
Total Contact Hours: 12
Credit: 1

Prerequisite: None.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Recall and state thought process of social setting in ancient India to identify the roots and details of some contemporary issues faced by Indians.
- **CO2.** Identify and inspect the importance of our surroundings& culture to design & formulate sustainable developmental solutions.
- **CO3.** Understanding the issues related to 'Indian' culture, tradition and its composite character to apply the same in the socio-technological developments in present scenario.
- **CO4.** Relate and assess Indian Knowledge System in the health care, architecture, agriculture and other systems.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	2	3	-	3	-	2	3	1	-	2
CO2	-	-	2	-	-	3	3	2	3	3	-	-
CO3	-	-	2	-	-	3	3	1	3	1	-	2
CO4	-	-	2	-	-	3	3	2	3	-	-	-

Course Content

Module 1: An overview of Indian Knowledge System (IKS) 3L

Importance of Ancient Knowledge – Definition of IKS – Classification framework of IKS – Unique aspects of IKS.
The Vedic corpus: Vedas and Vedangas – Distinctive features of Vedic life.
Indian philosophical systems: Different schools of philosophy.

Module 2: Salient features of the Indian numeral system 3L

Importance of decimal representation – The discovery of zero and its importance – Unique approaches to represent numbers.
Highlights of Indian Astronomy: Historical development of astronomy in India.

Module 3: Indian science and technology heritage 3L

Metals and metalworking – Mining and ore extraction – Physical structures in India – Irrigation and water management – Dyes and painting technology – Surgical Techniques – Shipbuilding.

Module 4: Traditional Knowledge in Different Sectors 3L

Traditional knowledge and engineering, Traditional medicine system, Traditional Knowledge in agriculture, Traditional societies depend on it for their food and healthcare needs.

Text Book:

1. Introduction to Indian knowledge system: concepts and applications – Mahadevan B.Bhat, Vinayak Rajat, Nagendra Pavana R.N., PHI.

Reference Books:

1. Traditional Knowledge system in India, Amit Jha, Atlantic Publishers.
2. S. N. Sen and K. S. Shukla, *History of Astronomy in India,* Indian National Science Academy, 2nd edition, New Delhi, 2000.

Course Name: Basic Electrical Engineering Laboratory
Course Code: EE191
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Basic Physics and applied physics, Basic Mathematics, Basic concept of Electric Circuit.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Identify various electrical equipment and safety measures.
CO2. Evaluate performance characteristics of different electrical and/or electro-magnetic equipment.
CO3. Interpret the observations of experiments conducted.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	2	-	2	-	3	3	-	3
CO2	3	3	-	3	2	-	2	3	3	3	-	3
CO3	3	3	3	3	2	3	2	3	3	3	-	3

List of Experiments:

1. Basic safety precautions – earthing, introduction to measuring instruments – Voltmeter, Ammeter, Multimeter, Wattmeter, Real life Resistor, Capacitor, Inductor.
2. Characteristics of Fluorescent, lamp.
3. Characteristics of Tungsten and Carbon filament lamps.
4. Study of R-L-C series circuit.
5. Verification of Line and Phase voltage and current in a three-phase circuit.
6. Demonstration of cut-out sections of machines: DC Machine (commutator-brush arrangement), Induction Machine (squirrel cage rotor).
7. Measurement of primary and secondary voltage and current of single-phase transformer – Open Circuit and Short Circuit Test.
8. Starting and Reversing of a DC shunt motor
9. Speed control of a DC shunt motor.
10. Test on single-phase Energy Meter.
11. Characteristics of Charging and Discharging of a Dry-Cell.
12. Innovative experiments.

Course Name: Analog and Digital Electronic Circuits Laboratory
Course Code: EC(EE)191
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Knowledge of Physics and Mathematics.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Demonstrate different electronic components.
- **CO2.** Apply electronic components to realize the real-time electronic circuits.
- **CO3.** Interpret the observations of experiments conducted.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	2	-	-	-	3	3	2	3
CO2	3	3	3	3	2	-	-	-	3	3	3	3
CO3	3	3	3	3	2	2	3	-	3	3	3	3

List of Experiments:

1. Design of voltage regulator circuit using zener diode
2. Design of Integrator using OPAMP IC 741
3. Study of timer circuit using NE555 and configuration for monostable & astable multivibrator.
4. Realization of basic gates using Universal logic gates.
5. Design a circuit for BCD to 7-segment display.
6. Construction of simple Encoder & Decoder circuits using logic gates.
7. Construction of simple Multiplexer & De Multiplexer circuits using logic gates.
8. Design of Half Adder & Full Adder Circuit using Logic Gates.
9. Realization of RS, D, JK and T flip-flops using logic gates.
10. Realization of A/D and D/A converter.
11. Innovative Experiments (Software simulation by Multisim or Labview).

Course Name: Technical Writing Skill
Course Code: HU(EE)191
Contact: 0L:0T:2P
Credit: 1

Prerequisite: A basic knowledge of listening and speaking skills and the ability to infer meaning from audio-video/online lessons and Communication Competence.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Develop advanced verbal and nonverbal communication skills through Power Point presentation.
- **CO2.** Demonstrate interpersonal skills through Group Discussion both for organizational communication and campus recruitment drive.
- **CO3.** Recognize and apply the knowledge of public speaking.
- **CO4.** Industry ready professionals by various personality development programs.
- **CO5.** Understand and write a detailed technical report as per organizational needs.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	3	-	3	2	-	-	3	3	1	3
CO2	3	3	-	-	-	3	-	-	3	3	-	3
CO3	2	2	2	-	-	2	1	-	3	3	1	3
CO4	2	-	-	-	1	3	-	-	3	3	1	3
CO5	1	2	-	-	2	2	-	2	3	3	1	3

List of Experiments:

Module 1: Presentation **2L+6P**

a) Teaching Presentation as a Skill
b) Speaking Strategies and Skills
c) Media and Means of Presentation
d) Extended Practice and Feedback

Module 2: Effective Presentation **2L+6P**

a) Rules of making micro presentation.
b) Assignment on micro presentation.
c) Need for expertise in oral presentation.
d) Assignment on Oral presentation.
e) Macro Presentation in Groups.

Module 3: Writing a Technical Report **2L+6P**

a) Organizational Needs for Reports and types
b) Report Formats
c) Report Writing Practice Sessions and Workshops

Module 4: Speaking Skills **2L+6P**

a) The Need for Speaking: Content and Situation-based speaking
b) Public Speaking Activities: [Just a Minute, Paired Role Play, Situational Speaking Exercises]
c) The Pragmatics of Speaking—Pronunciation practice and learner feedback.

Text / Reference Books:

1. Technical communication By Meeenakshi Raman and Sangeeta Sharma; Oxford Publication.

Course Name: Engineering Physics Laboratory
Course Code: PH(EE)191
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Knowledge of Physics up to 12th standard.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Demonstrate experiments allied to their theoretical concepts
- **CO2.** Conduct experiments using LASER, Optical fiber.
- **CO3.** Participate as an individual, and as a member or leader in groups in laboratory sessions actively.
- **CO4.** Analyse experimental data from graphical representations, and to communicate effectively them in Laboratory reports including innovative experiment.
- **CO5.** Design solutions for real life challenges.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	3	3	-	-	-	-	-	-	-
CO2	2	3	2	3	3	-	-	-	-	-	-	-
CO3	2	3	2	3	3	-	-	-	-	-	-	-
CO4	2	2	3	2	3	-	-	-	-	-	-	-
CO5	2	2	3	2	3	-	-	-	-	-	-	-

List of Experiments:

General idea about Measurements and Errors (One Mandatory):

i) Error estimation using Slide calipers/ Screw-gauge/travelling microscope for one experiment.

Experiments on Classical Physics (Any 4 to be performed from the following experiments):

1. Study of Torsional oscillation of Torsional pendulum & determination of time using various load of the oscillator.
2. Determination of Young's moduli of different materials.
3. Determination of Rigidity moduli of different materials.
4. Determination of wavelength of light by Newton's ring method.
5. Determination of wavelength of light by Laser diffraction method.
6. Optical Fibre-numerical aperture, power loss.

Experiments on Quantum Physics (Any 2 to be performed from the following experiments):

7. Determination of Planck's constant using photoelectric cell.
8. Verification of Bohr's atomic orbital theory through Frank-Hertz experiment.
9. Determination of Stefan's Constant.
10. Study of characteristics of solar cell.

Perform at least one of the following experiments:

11. Determination of Q factor using LCR Circuit.
12. 12.Study of I-V characteristics of a LED/LDR

** *In addition it is recommended that each student should carry out at least one experiment beyond the syllabus/one experiment as Innovative experiment.*

Probable experiments beyond the syllabus:

1. Study of dispersive power of material of a prism.
2. Study of viscosity using Poiseuille's capillary flow method/using Stoke's law.
3. Determination of thermal conductivity of a bad/good conductor using Lees-Charlton / Searle apparatus.
4. Determination of the angle of optical rotation of a polar solution using polarimeter.
5. Any other experiment related to the theory.

Recommended Text Books for Engineering Physics Lab:

1. **Waves and Oscillations:** Vibration, Waves and Acoustics- Chattopadhyay and Rakshit Classical & Modern.
2. **Optics:** A text book of Light- K.G. Mazumder & B.Ghosh (Book & Allied Publisher)
3. **Quantum Mechanics-I:** Introduction to Quantum Mechanics-S. N. Ghoshal (Calcutta Book House)
4. **Solid State Physics:** Solid State Physics and Electronics-A. B. Gupta and Nurul Islam (Book & Allied Publisher)

Text Books:

1. Practical Physics by Chatterjee & Rakshit (Book & Allied Publisher)
2. Practical Physics by K.G. Mazumder (New Central Publishing)
3. 3. Practical Physics by R. K. Kar (Book & Allied Publisher)

Course Name: Engineering Graphics and Design Laboratory
Course Code: ME(EE)191
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Basic knowledge of geometry.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Learn the basics of drafting.
- **CO2.** Understand the use of drafting tools which develops the fundamental skills of industrial drawings.
- **CO3.** Apply the concept of engineering scales, dimensioning and various geometric curves necessary to understand design of machine elements.
- **CO4.** Analyse the concept of projection of line, surface and solids to create the knowledge base of orthographic and isometric view of structures and machine parts.
- **CO5.** Evaluate the design model to different sections of industries as well as for research and development.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	2	-	-	-	-	-	-	-	-
CO2	2	-	-	2	-	-	-	-	-	-	-	-
CO3	3	-	-	2	-	-	-	-	-	-	-	-
CO4	3	-	-	3	-	-	-	-	-	-	-	-
CO5	3	2	-	3	2	-	-	-	-	-	-	-

List of Experiments:

Basic Engineering Graphics: 3P
Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Perspective; Reading a Drawing; Sectional Views; Dimensioning & Tolerances; True Length, Angle; intersection, Shortest Distance.

Module 1: Introduction to Engineering Drawing 6P
Principles of Engineering Graphics and their significance, Usage of Drawing instruments, lettering, Conic sections including Rectangular Hyperbola (General method only); Cycloid, Epicycloid and Involute; Scales – Plain, Diagonal and Vernier Scales.

Module 2: Orthographic and Isometric Projections 6P
Principles of Orthographic Projections – Conventions – Projections of Points and lines inclined to both planes; Projections of planes on inclined Planes - Auxiliary Planes; Projection of Solids inclined to both the Planes- Auxiliary Views; Isometric Scale, Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa.

Module 3: Sections and Sectional Views of Right Angular Solids 6P
Drawing sectional views of solids for Prism, Cylinder, Pyramid, Cone and project the true shape of the sectioned surface, Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw sectional orthographic views of objects from industry and dwellings (foundation to slab only).

Computer Graphics: **3P**

Engineering Graphics Software; -Spatial Transformations; Orthographic Projections; Model Viewing; Co-ordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing; Animation; Spatial Manipulation; Surface Modeling; Solid Modeling.

Module 4: Overview of Computer Graphics **3P**

Demonstration of CAD software [The Menu System, Toolbars (Standard, Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), Zooming methods, Select and erase objects].

Module 5: CAD Drawing, Customization, Annotations, layering **6P**

Set up of drawing page including scale settings, ISO and ANSI standards for dimensioning and tolerance; Using various methods to draw straight lines, circles, applying dimensions and annotations to drawings; Setting up and use of Layers, changing line lengths (extend/lengthen); Drawing sectional views of solids; Drawing annotation, CAD modeling of parts and assemblies with animation, Parametric and nonparametric solid, surface and wireframe modeling, Part editing and printing documents.

Module 6: Demonstration of a simple team design project **3P**

Illustrating Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; Meshed topologies for engineering analysis and tool-path generation for component manufacture, use of solid-modeling software for creating associative models at the component and assembly levels.

Text Books:

1. Bhatt N.D., Panchal V.M. & Ingle P.R, (2014), Engineering Drawing, Charotar Publishing House
2. K. Venugopal, Engineering Drawing + AutoCAD, New Age International publishers

Reference Books:

1. Pradeep Jain, Ankita Maheswari, A.P. Gautam, Engineering Graphics & Design, Khanna Publishing House
2. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication.
3. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
4. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.

1st Year 2nd Semester									
Sl. No.	**Broad Category**	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG	Major	EE201	Electrical Circuit Analysis	3	0	0	3	3
2	SCI	Multidisciplinary	M(EE)201	Engineering Mathematics – II	3	0	0	3	3
3	SCI	Multidisciplinary	CH(EE)201	Engineering Chemistry	2	0	0	2	2
4	HUM	Ability Enhancement Courses	HU201	Professional Communication	2	0	0	2	2
5	HUM	Value Added Courses	HU202	Values and Ethics	2	0	0	2	2
6	HUM	Value Added Courses	HU203	Constitution of India	1	0	0	1	1
B. Practical									
7	ENGG	Major	EE291	Electrical Circuit Analysis Laboratory	0	0	3	3	1.5
8	HUM	Ability Enhancement Courses	HU291	Professional Communication Laboratory	0	0	2	2	1
9	SCI	Skill Enhancement Courses	CH(EE)291	Engineering Chemistry Laboratory	0	0	2	2	1
10	ENGG	Skill Enhancement Courses	ME(EE)291	Workshop and Manufacturing Practices Laboratory	0	0	3	3	1.5
Total for Theory and Practical								**23**	**18**

Course Name: Electrical Circuit Analysis
Course Code: EE201
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: The students to whom this course will be offered must have the concept of Basic electrical engineering, Laplace transform, First order ordinary differential equation and Second order ordinary differential equation.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Explain the application of circuit components.
- **CO2.** Apply different methods to solve network problems.
- **CO3.** Analyze various complex problems pertaining to different circuit combinations.
- **CO4.** Evaluate circuit problems using different tools.
- **CO5.** Design different electrical circuits to develop prototype.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	3	2	–	–	–	–	2	3
CO2	3	3	3	3	3	2	–	–	–	–	2	3
CO3	3	3	3	3	3	2	–	–	–	–	2	3
CO4	3	3	3	3	3	2	–	–	–	–	3	3
CO5	3	3	3	3	3	2	–	–	3	3	3	3

Course Content

Module 1: Network Theorems **6L**

Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem, Millman's Theorem Solution of Problems with DC and AC sources.

Module 2: Coupled Circuits **4L**

Magnetic coupling, Polarity of coils, Polarity of induced voltage, Concept of Self and Mutual inductance, Coefficient of coupling, Modeling of coupled circuits, Solution of problems.

Module 3: Laplace Transform in Circuit Analysis **8L**

The Laplace's transform, Initial value theorem and final value theorem, Transient phenomena of Electrical circuits (RL, RC, RLC) with the Laplace transform, Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for standard inputs, inverse Laplace transform, Laplace transformation of special signal waveforms.

Module 4: Resonance **5L**

Properties Series and Parallel Resonant Circuits, Expression of Half Power Frequencies in RLC Series Resonating Circuits and Relationship between f0, f1 and f2, Quality Factor, Bandwidths, Variation of resistant, inductive and capacitive reactance with frequency and Applications.

Module 5: Graph Theory **3L**

Concept of Tree, Branch, Tree link, Incidence Matrix, Cut Set Matrix, Tie Set Matrix of electric circuits.

Module 6: Two Port Network **6L**

Open circuit Impedance and Short circuit Admittance parameter, Transmission parameter, Hybrid

Parameter, Conditions of Reciprocity and Symmetry, Inter-relationship between the parameters of Two Port Network, Different types of interconnection of Two Port Networks, Solution of problems.

Module 7: Filter **4L**

Analysis and synthesis of Low pass, High pass, Band pass, Band reject, All pass filters (first and second order only) using operational amplifier.

Text Books:

1. Sudhakar, "Circuits & Networks: Analysis & Synthesis", 2nd Edition, Tata McGraw Hill.
2. D. Roy Choudhury, "Networks and Systems", New Age International Publications, 1998.
3. W. H. Hayt and J. E. Kemmerly, "Engineering Circuit Analysis", McGraw Hill Education, 2013.
4. C. K. Alexander and M. N. O. Sadiku, "Electric Circuits", McGraw Hill Education, 2004.
5. D. Chattopadhyay and P. C. Rakshit, "Electrical Circuits".

Reference Books:

1. M. E. Van Valkenburg, "Network Analysis", Prentice Hall, 2006.
2. K. V. V. Murthyand and M. S. Kamath, "Basic Circuit Analysis", Jaico Publishers, 1999.
3. Sivanandam, "Electric Circuits Analysis",
4. V. K. Chandna, "A Text Book of Network Theory & Circuit Analysis", Cyber Tech References.
5. Kuo F. F., "Network Analysis & Synthesis", John Wiley & Sons.

Course Name: Engineering Mathematics – II
Course Code: M(EE)201
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: The students to whom this course will be offered must have the concept of (10+2) algebra and calculus.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Recall the properties and formula related to Fourier series, Fourier Transformations and Numerical Methods.
- **CO2.** Determine the solutions of the problems related to matrix algebra, probability and Numerical Methods.
- **CO3.** Apply the appropriate mathematical tools of matrix algebra, probability and Numerical Methods.
- **CO4.** Analyze different engineering problems linked with matrix algebra, probability and Numerical Methods.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	–	–	–	–	–	–	–	–	–	2
CO2	3	2	–	–	–	–	–	–	–	–	–	2
CO3	3	2	2	–	–	–	–	–	–	–	–	2
CO4	2	3	2	2	–	–	–	–	–	–	–	2

Course Content

Module 1: Numerical Methods **12L**

Introduction to error analysis, Calculus of finite difference.

a) **Interpolation:** Newton forward and backward interpolation, Lagrange's interpolation.
b) **Numerical integration:** Trapezoidal rule, Simpson's 1/3 rule.
c) **Numerical solution of ordinary differential equation:** Euler method, Modified Euler method, Fourth order Runge-Kutta method.

Module 2: Fourier series and Fourier Transform **13L**

a) **Fourier series:** Dirichlet's Conditions; Euler's Formula for Fourier Series; Fourier Series for functions of period 2π; Sum of Fourier series (examples); Theorem for the convergence of Fourier series (statement only); Fourier series of a function with its periodic extension; Half range Fourier series: Construction of half range Sine series and half range Cosine Series; Parseval's identity (statement only) and related problems.
b) **Fourier Transform:** Fourier Transform, Fourier Cosine Transforms, Fourier Sine Transforms (problems only); Properties of Fourier Transform: Linearity, Shifting, Change of Scale, Modulation (problems only); Fourier Transform of Derivatives (problems only); Convolution Theorem (statement only), Inverse of Fourier Transform (problems only).

Module 3: Calculus of Complex Variable **13L**

Functions of a Complex Variable Analytic Functions (definition and examples); Cauchy-Riemann Equations (statement onlyand related problems); Sufficient condition for a function to be analytic (statement only and related problems).

Cauchy's Theorem (statement only and related problems); Cauchy's Integral Formula(statement only and related problems); Cauchy's Integral Formula for the derivative of an analytic

function(statement only and related problems); Cauchy's Integral Formula for the successive derivatives of an analytic function (statement only and related problems); Taylor's series and Laurent's series (problems only).

Zero of an Analytic Function and its order (definition and related problems); Singularities of an Analytic Function: Isolated Singularity and Non-isolated Singularity (definition and related problems); Essential Singularities, Poles (Simple Pole and Pole of Order m) and Removable Singularities (definition and related problems); Determination of singularities and their nature (problems only); Residue (definition and examples); Determination of the residue of a given function; Cauchy's Residue theorem (statement only and related problems).

Text Books:

1. Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
2. Kreyszig, E., Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

Reference Books:

1. Guruprasad, S. A text book of Engineering Mathematics – I, New age International Publishers.
2. Ramana, B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
3. 3.Veerarajan, T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
4. Bali, N.P. and Goyal, M., A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
5. Apostol, M., Calculus, Volumes 1 and 2 (2nd Edition), Wiley Eastern, 1980.
6. Kumaresan, S., Linear Algebra – A Geometric approach, Prentice Hall of India, 2000.

Course Name: Engineering Chemistry
Course Code: CH(EE)201
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: 10+2.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand the basic principles of elements, organic reactions drug synthesis and computational chemistry.
- **CO2.** Apply the knowledge of different engineering materials, advanced polymers, and nanomaterials to solve complex engineering problems.
- **CO3.** Analyse and evaluate water quality parameters and its treatment.
- **CO4.** The knowledge of free energy, energy storage device, fuels and corrosion to design environment friendly and sustainable devices.
- **CO5.** Apply the knowledge of different instrumental techniques to analyse unknown engineering materials.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	–	–	–	–	–	2	2
CO2	3	3	3	3	–	–	2	–	–	–	2	2
CO3	3	3	–	–	–	–	3	–	–	–	3	2
CO4	3	3	3	2	–	–	3	–	–	–	3	2
CO5	3	3	3	3	2	–	–	–	–	–	2	2

Course Content

Module 1: Elements and their properties **6L**

a) Elements and their properties: 3L
Bohr's theory for one electron system, Hydrogen spectrum, Quantum numbers, Atomic orbitals, Pauli's exclusion principle, Hund's rule, exchange energy, Aufbau principle, Electronic configuration and Magnetic properties.

b) Periodic Table for Engineers: 3L
Modern Periodic table, Periodic properties, study of advanced functional materials like Silicones, Silicates, Zeolite and alloys like steel, mischmetall, Neodymium alloy and their applications.

Module 2: Energy devices and Semiconductors **6L**

a) Use of free energy in chemical equilibria: 3L
Laws of Thermodynamics, Enthalpy, Entropy, Spontaneity, Electrochemical Cell, Dry Cell, Mercury Cell, Lead Storage batteries, Fuel Cells, Solar Cells, Nernst equation and applications, Electrochemical sensors.

b) Crystals and Semiconductors: 3L
Crystals and their defects, Stoichiometric and Non-stoichiometric defects, Band theory and Doping, n-type and p-type semiconductors, Superconductors.

Module 3: Industrial Applications of Chemistry **8L**

a) Advanced Polymeric materials: 3L
Classification, Engineering Plastics, conducting polymers, bio polymers, polymer composites.

b) Industrial corrosion: 2L
Classification, Effects of corrosion, Preventive measures.

c) Analysis of Water Quality: 1L
Water quality parameters.

d) Fuels and their applications: 2L
Classification of Fuels, Calorific Values, Solid fuels; coal qualifications, Liquid Fuels; Knocking, Cetane and Octane number, composition and uses of gaseous fuels; water gas, Bio Gas, CNG, LPG.

Module 4: Organic Reaction Products and their spectroscopic analysis 4L

a) Organic Reactions: 2L
Substitution, Elimination and Addition reactions.

b) Drug designing and synthesis: 1L
Paracetamol, Aspirin.

c) Spectroscopic Analysis: 1L
UV – Visible Spectra, IR spectra.

Text Books:

1. Fundamentals of Engineering Chemistry, Dr. Sudip Bandopadhyay & Dr. Nirmal Hazra, latest edition, Chhaya Prakashani Pvt. Ltd.
2. Chemistry –I, Gourkrishna Das Mohapatro, 3rd Edition,Vikas Publications, 2016.
3. A text book of Engineering Chemistry, 2nd Edition, Dr. Rajshree Khare, S.K. Kataria & Sons, 2022.
4. Engineering Chemistry, N Acharjee & P. Dhar, Latest Edition, U. N. Dhar & Sons Pvt. Ltd., 2020.
5. Physical Chemistry, P.C. Rakshit, 7th edition, Sarat Book House, 2018.

Reference Books:

1. Engineering Chemistry, Jain & Jain, 16th Edition, Dhanpat rai Publishing Company, 2016.
2. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S.Krishna, 2019.
3. Text book of Engineering Chemistry, Jaya Shree Anireddy, 1st Edition, Wiley, 2018.

Course Name: Professional Communication
Course Code: HU201
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: Basic (10+2) level of knowledge of English grammar, vocabulary reading and writing skills.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Define, describe and classify the modalities and nuances of communication in a workplace context.
- **CO2.** Review, appraise and understand the modes, contexts and appropriacy of communicating across cultures and societies.
- **CO3.** Identify, interpret and demonstrate the basic formats, templates of business and official communication.
- **CO4.** Identify, compare and illustrate reading strategies and basic writing strategies.
- **CO5.** Interpret, analyze and evaluate semantic-structural, interpersonal and multicultural dynamics in business communication.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	–	–	–	–	–	2	1	1	2	3	–	2
CO2	–	–	–	–	–	1	1	2	2	3	–	3
CO3	–	–	–	–	–	3	3	1	1	3	2	3
CO4	–	–	–	–	–	3	3	1	–	3	–	3
CO5	–	–	–	–	–	2	2	2	2	3	–	3

Course Content

Module 1: Verbal and Nonverbal communication **4L**

Definition, Relevance and Effective Usage.
Components of Verbal Communication: Written and Oral Communication.
Components of Non-verbal Communication: Kinesics, Proxemics, Chronemics, Haptics Paralanguage
Barriers to Effective Communication.

Module 2: Workplace Communication Essentials and Cross Cultural Communication **4L**

Communication at the Workplace—Formal and Informal Situations.
Language in Use – Jargon, Speech Acts/Language Functions, Syntactical and Grammatical Appropriacy.
Cultural Contexts in Global Business: High Context and Low Context Cultures.
Understanding Cultural Nuances and Stereotyping.
Achieving Culturally Neutral Communication in Speech and Writing.

Module 3: Reading Strategies and Basic Writing Skills **4L**

Reading: Purposes and Nature of Reading.
Reading Sub-Skills – Skimming, Scanning, Intensive Reading.
Reading General and Business Texts (Reading for Comprehension and Detailed Understanding).
Basic Writing Skills – Paragraph and Essay writing, writing technical document.
Writing Technicalities – Paragraphing, Sentence Structure and Punctuation.

Module 4: Report Writing **4L**

Nature and Function of Reports
Types of Reports
Researching for a Business Report
Format, Language and Style
Report Documentation

Module 5: Employment Communication **8L**

a) Writing Business Letters - (Enquiry, Order, Sales, Complaint, Adjustment, Job Application, Offer). 2L

b) Creating an Employee Profile – Preparing a CV or Résumé.
Creating a Digital/Online Profile – LinkedIn (Résumé/Video Profile). 2L

c) Writing Other Interoffice Correspondence – E-mails: types, convention, and etiquette, Memo, Notices and Circulars. 2L

d) Preparing Meeting Documentation—Drafting Notice and Agenda of Meetings, Preparing Minutes of Meetings. 2L

Text Books:

1. Meenakshi Raman and Sangeetha Sharma. Technical Communication. 3rd edition. New Delhi: Oxford University Press, 2015.
2. Mark Ibbotson. Cambridge English for Engineering. Cambridge: Cambridge University Press, 2008.
3. Mark Ibbotson. Professional English in Use: Engineering. Cambridge: Cambridge UP, 2009.

Reference Books:

1. Lesikar. Business Communication: Connectingina Digital World. New Delhi: Tata McGraw–Hill, 2014.
2. John Seeley. Writing Reports. Oxford: Oxford University Press, 2002.
3. Diana Booher. E-writing: 21st Century Tools for Effective Communication. Macmillan, 2007.
4. Michael Swan. Practical English Usage. Oxford: OUP, 1980.

Course Name: Values and Ethics
Course Code: HU202
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: Nil.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand the core values that shape the ethical behaviour of an engineer and Exposed awareness on professional ethics and human values.
- **CO2.** Understand the basic perception of profession, professional ethics, various moral issues and uses of ethical theories.
- **CO3.** Understand various social issues, industrial standards, code of ethics and role of professional ethics in engineering field.
- **CO4.** Aware of responsibilities of an engineer for safety and risk benefit analysis, professional rights and responsibilities of an engineer.
- **CO5.** Acquire knowledge about various roles of engineers in variety of global issues and able to apply ethical principles to resolve situations that arise in their professional lives.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	–	–	–	–	–	2	–	3	–	1	2	1
CO2	–	2	–	–	–	1	–	2	3	3	3	2
CO3	–	–	–	–	–	3	3	2	3	1	3	2
CO4	–	2	–	–	–	3	3	–	3	–	3	2
CO5	–	–	–	–	–	3	–	–	–	–	2	–

Course Content

Module 1: Value: Definition- Importance and application of Value in life 4L

Formation of Value- Process of Socialization- self and integrated personality.
Types of values-Social, Psychological, Aesthetic, Spiritual, and Organizational-Value crisis in contemporary society: individual, societal cultural and management level.

Module 2: Effects of Technological Growth 4L

Rapid Technological growth and depletion of resources, Reports of the Club of Rome.
Problems of Technology transfer – Technology assessment impact analysis.
Human Operator in Engineering projects and industries – Problems of man, machine- interaction- Impact of assembly line and automation – Human centred Technology.

Module 3: Impact of Ethics on Business Policies and Strategies 4L

Utilitarianism - Criticism of Utilitarianism - Impact on Business Culture - Role of CEO in shaping Business Culture – Ethical Leadership – Characteristics.

Module 4: Types of Ethical issues 2L

Internal Ethics of Business – Hiring Employees – Promotion - Wages – Job discrimination – its nature and extent- Exploitation of Employees – Discipline and Whistle Blowing.

Module 5: Markets and consumer Protection 4L

Consumer rights – Unethical Practices in Marketing – Ethics of Competition and Fair Prices –

Ethics in Advertising and False Claims – Environmental Protection and Ethics – Pollution Control – Ecological ethics.

Module 6: Social Responsibilities of Business 6L

Definition and case study of Corporate Compliance; Responsibilities towards Customers, shareholders, employees – Social Audit – Objectives and Need for Social Audit – Methods of Social Audit – Benefits – Obstacles – Social Audit in India.

Text Books:

1. A. N. Tripathi, Human values in the Engineering Profession, Monograph published by IIM, Calcutta 1996.
2. S. K. Chakraborty: Values and Ethics in Organization, OUP.

Reference Books:

1. U.C.Mathur, Corporate Governance & Business Ethics, Macmillan, 2005.
2. Fernando. A. C., Business Ethics – An Indian Perspective, Pearson Publication, 2009.
3. Prem Vir Kapoor, Professional Ethics & Human Values, Khanna Publishing House, New Delhi.

Course Name: Constitution of India
Course Code: HU203
Contact: 1L:0T:0P
Total Contact Hours: 12
Credit: 1

Prerequisite: Nil.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** To Identify and explore the basic features and modalities of Indian constitution.
- **CO2.** To Differentiate and relate the functioning of Indian parliamentary system at the centre and state level.
- **CO3.** To Differentiate the various aspects of Indian Legal System and its related bodies.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	–	–	–	–	–	2	–	3	–	1	–	–
CO2	–	–	–	–	–	1	–	2	–	3	–	–
CO3	–	–	–	–	–	3	–	2	–	1	–	–

Course Content

Module 1: History of Making of the Indian Constitution 3L
History. Drafting Committee, (Composition and Working).
Philosophy of the Indian Constitution: Preamble Salient Features.

Module 2: Fundamental Rights, Fundamental Duties, Directive Principles of State Policy 6L
The Right to Equality
The Right to Freedom: I (Article 19)
The Right to Freedom: II (Articles 20, 21 and 22)
The Right against Exploitation
The Right to freedom of Religion
Cultural and Educational rights
The Right to Property
The Right to Constitutional Remedies
Fundamental Duties

Module 3: Organs of Governance 3L
Parliament – Composition – Qualifications and Disqualifications – Powers and Functions – Executive – President – Governor – Council of Ministers – Judiciary, Appointment and Transfer of Judges, Qualifications – Powers and Functions

Text / Reference Books:

1. Indian Constitution by D.D.Basu, The Publisher, LexisNexis.
2. Constitution of India by Subhas C Kasyap, Vitasta Publishing.
3. The Constitution of India, P.M Bakshi, Universal Law Publishing Co.Ltd, New Delhi, 2003.
4. Indian Constitution Text Book – Avasthi, Avasthi, Publisher: LAKSHMI NARAIN AGARWAL.
5. Introduction to the Constitution of India, Brij Kishore Sharma, PHI.

Course Name: Electrical Circuit Analysis Laboratory
Course Code: EE291
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Concepts of Basic Electrical Engineering.

Course Outcomes: After successful completion of the course, student will be able to

- **CO6.** Identify electrical components to study the responses of the circuit at different operating conditions.
- **CO7.** Analyze different complex electrical networks.
- **CO8.** Justify results of the experiment with theoretical solutions.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	-	-	3	2	3	3
CO2	3	3	3	3	3	2	-	-	3	3	3	3
CO3	3	3	3	3	3	2	-	-	3	3	3	3

List of Experiments:

1. Experimental verification of electrical circuit problems using Kirchhoff's voltage and current law.
2. Experimental verification of electrical circuit problems using Superposition Theorem.
3. Experimental verification of electrical circuit problems using Thevenin's Theorem.
4. Experimental verification of electrical circuit problems using Norton's Theorem.
5. Experimental verification of electrical circuit problems using Maximum Power Transfer Theorem.
6. Verification of Series/Parallel Resonance circuit.
7. Transient response of series R-L, R-C and R-L-C circuits with verification of time constant.
8. Transient response of parallel R-L and R-C and R-L-C circuits with verification of time constant.
9. Measurement of power factor of different electrical circuits using oscilloscope.
10. Study the effect of inductance on step response of series RL circuit.
11. a) Determination of Impedance (Z) parameter of two port network.
    b) Determination of Admittance (Y) parameter of two port network.
12. Frequency response of LP and HP filters.
13. Frequency response of BP and BR filters.
14. Innovative Experiments.

Course Name: Professional Communication Laboratory
Course Code: HU291
Contact: 0L:0T:2P
Credit: 1

Prerequisite: Basic knowledge of LSRW skills.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Recognize, identify and express advanced skills of Technical Communication in English through Language Laboratory.
- **CO2.** Understand, categorize, differentiate and infer listening, speaking, reading and writing skills in societal and professional life.
- **CO3.** Articulate and present the skills necessary to be a competent Interpersonal communicator.
- **CO4.** Deconstruct, appraise and critique communication behaviours.
- **CO5.** Adapt, negotiate and facilitate with multifarious socio-economical and professional arenas with effective communication and interpersonal skills.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	2	-	-	1	1	-	2	3	-	2
CO2	-	-	2	2	-	3	3	-	2	3	-	3
CO3	-	-	2	2	-	3	3	2	2	3	-	3
CO4	-	-	-	-	-	3	3	2	2	3	-	3
CO5	-	-	2	2	-	3	3	2	2	3	-	3

List of Experiments:

Module 1: Introduction to the Language Lab

a. The Need for a Language Laboratory
b. Tasks in the Lab
c. Writing a Laboratory Note Book

Module 2: Active Listening

a. What is Active Listening?
b. Listening Sub-Skills—Predicting, Clarifying, Inferencing, Evaluating, Note-taking
c. Listening in Business Telephony

Module 3: Speaking

a. Speaking—Accuracy and Fluency Parameters
b. Pronunciation Guide—Basics of Sound Scripting, Stress and Intonation
c. Fluency-focussed activities—JAM, Conversational Role Plays, Speaking using Picture/Audio Visual inputs
d. Accuracy-focussed activities—Identifying Minimal Pairs, Sound Mazes, Open and Closed Pair Drilling, Student Recordings (using software)
e. Group Discussion: Principles and Practice
f. Giving a Presentation—Learning Presentation Basics and Giving Micro Presentations

Module 4: Lab Project Work

a. Writing a Book Review
b. Writing a Film Review
c. Scripting a Short Presentation (2 minutes)

d. Making a short video CV (1-2 minutes)

References:

1. 1.IIT Mumbai, Preparatory Course in English syllabus
2. IIT Mumbai, Introduction to Linguistics syllabus
3. Sasikumar et al. A Course in Listening and Speaking. New Delhi: Foundation Books, 2005.
4. Tony Lynch, Study Listening. Cambridge: Cambridge UP, 2004.

Course Name: Engineering Chemistry Laboratory
Course Code: CH(EE)291
Contact: 0L:0T:2P
Credit: 1

Prerequisite: 10+2.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Operate different types of instruments for estimation of small quantities chemicals used in industries and scientific and technical fields.
- **CO2.** Analyse and determine the composition and physical property of liquid and solid samples when working as an individual and also as a team member.
- **CO3.** Analyse different parameters of water considering environmental issues.
- **CO4.** Synthesize drug and sustainable polymer materials.
- **CO5.** Design innovative experiments applying the fundamentals of modern chemistry.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	3	1	-	2	3	-	-	-	-	1
CO2	2	2	1	1	-	1	-	-	-	1	-	1
CO3	-	-	-	-	-	-	-	-	3	3	2	2
CO4	2	1	2	2	-	-	1	-	-	-	-	2
CO5	3	3	3	3	1	1	1	1	-	-	2	2

List of Experiments:

1. Determination of the concentration of the electrolyte through conductance measurement.
2. Determination of water quality measurement techniques.
3. Determination of the concentration of the electrolyte through pH measurement.
4. Estimation of Cu in brass
5. Estimation of Fe2O3 in Cement
6. Isolation of graphene from dead dry batteries and their use for temporary soldering.
7. Synthesis of Silver Nanoparticles doped organic thin film for organic transistors.
8. Estimation of corrosion in a given sample metal.
9. Preparation of Si-nano crystals for future memory devices.
10. Green Synthesis of ZnO based Polymer Nano composites.
11. Synthesis of polymers for electrical devices and PCBs.
12. Determination of Partition Coefficient of acetic acid between two immiscible liquids.
13. Drug design and synthesis
14. Rheological properties of the Newtonian fluids
15. Innovative Experiments

Course Name: Workshop and Manufacturing Practices Laboratory
Course Code: ME(EE)291
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Physics and Mathematics (10+2 Level).

Course Outcomes: After successful completion of the course, student will be able to

CO1. Gain basic knowledge of Workshop Practice and Safety useful for our daily living.
CO2. Understand the use of Instruments of a pattern shop like Hand Saw, Jack Plain, Chisels etc.
CO3. Apply and performing operations like such as Marking, Cutting etc. used in manufacturing processes.
CO4. Analyse the various operations in the Fitting Shop using Hack Saw, various files, Scriber, etc. to understand the concept of tolerances applicable in all kind of manufacturing.
CO5. Get hands on practice of in Welding and apply various machining processes which give a lot of confidence to manufacture physical prototypes in project works.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	2	-	2	2	-	-
CO2	3	-	-	-	-	-	2	-	2	2	-	-
CO3	3	-	-	-	-	-	2	-	2	2	-	-
CO4	3	-	-	-	-	-	2	-	2	2	-	-
CO5	3	2	2	-	-	-	2	-	2	2	-	-

List of Experiments:

i) Theoretical discussions: 3P

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods
2. Fitting operations & power tools
3. Carpentry
4. Welding (arc welding & gas welding), brazing
5. Electrical & Electronics
6. Metal casting
7. CNC machining, Additive manufacturing, 3D Printing
8. Plastic moulding & Glass Cutting

ii) Workshop Practice:

At least 6 modules should be covered

Module 1: Machine shop 6P

Typical jobs that may be made in this practice module:

a) To make a pin from a mild steel rod in a lathe.
b) To make rectangular and vee slot in a block of cast iron or mild steel in a shaping and / or milling machine.

Module 2: Fitting shop 6P

Typical jobs that may be made in this practice module: To make a Gauge from MS plate.

Module 3: Carpentry Shop **6P**

Typical jobs that may be made in this practice module: To make wooden joints and/or a pattern or like.

Module 4: Welding and Soldering shop **6P**

Typical jobs that may be made in this practice module:

a) Arc Welding: To join two thick (approx 5mm) MS plates by manual metal arc welding.
b) Gas Welding: To join two thin mild steel plates or sheets by gas welding.
c) House wiring, soft Soldering

Module 5: Smithy and Casting **6P**

Typical jobs that may be made in this practice module:

a) A simple job of making a square rod from a round bar or similar.
b) One/ two green sand moulds to prepare, and a casting be demonstrated.

Module 6: CNC Machining and Laser Cutting **6P**

Typical jobs that may be made in this practice module:

a) At least one sample shape on mild steel plate should be made using CNC Milling / CNC Lathe Machine
b) At least one sample shape on glass should be made using laser cutting machine.

Module 7: 3D Printing **6P**

a) Exposure to a 3D printing machine,
b) 3D printing of at least one sample model using available materials.

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

Text Books:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., Elements of Workshop Technology‖, Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
2. Rao P.N., Manufacturing Technology‖, Vol. I and Vol. II, Tata McGrawHill House, 2017.

Reference Books:

1. Gowri P., Hariharan and A. Suresh Babu, Manufacturing Technology – I, Pearson Education, 2008.
2. Roy A. Lindberg, ―Processes and Materials of Manufacture‖, 4th edition, Prentice Hall India, 1998.
3. Kalpakjian S. and Steven S. Schmid, Manufacturing Engineering and Technology, 4th edition, Pearson Education India Edition, 2002.
4. Manufacturing Science by A. Ghosh and A.K. Mallick, Wiley Eastern.
5. Principles of Metal Cutting/Principles of Machine Tools by G.C. Sen and A. Bhattacharya, New Central Book Agency, Kolkata.

2nd Year 3rd Semester									
Sl. No.	**Broad Category**	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG	Major	EE301	Electrical and Electronic Measurements	3	1	0	4	4
2	ENGG	Major	EE302	Signals and Systems	3	0	0	3	3
3	ENGG	Minor	EC(EE)301	Microprocessor and Microcontroller	2	0	0	2	2
4	ENGG	Minor	CS(EE)301	Programming for Problem Solving	2	0	0	2	2
5	HUM	Minor	HU(EE)301	Economics for Engineers	2	0	0	2	2
B. Practical									
6	ENGG	Major	EE391	Electrical and Electronic Measurements Laboratory	0	0	2	2	1
7	ENGG	Major	EE392	Signals and Systems Laboratory	0	0	3	3	1.5
8	ENGG	Minor	EC(EE)391	Microprocessor and Microcontroller Laboratory	0	0	2	2	1
9	ENGG	Minor	CS(EE)391	Programming for Problem Solving Laboratory	0	0	2	2	1
10	HUM	Ability Enhancement Courses	HU(EE)391	Technical Presentation	0	0	2	2	1
Total for Theory and Practical								**24**	**18.5**

Course Name: Electrical and Electronic Measurement
Course Code: EE301
Contact: 3L:1T:0P
Total Contact Hours: 48
Credit: 4

Prerequisite: Concepts of Basic Electrical Engineering.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand the operating principles of electrical and electronic measuring instruments.
- **CO2.** Identify and measure various physical parameters using appropriate measuring instruments.
- **CO3.** Measure various electrical parameters.
- **CO4.** Understand statistical data analysis and computerized data acquisition.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	1	-	-	-	-	-	-	-
CO4	-	3	2	-	2	-	-	-	-	-	-	-

Course Content

Module 1: Analog Measurement Systems 6L

Instruments Characteristics:

Static Characteristics- Definition of accuracy, Precision, Resolution and sensitivity of analog and digital meters, classification of errors in measurement. Dynamic Characteristics- Speed of response, Band width. 2L

Analog Instruments:

Classification, General features, Construction, Principle of operation and torque equation of Moving coil and Moving iron, Electrodynamometer, Induction instruments, Electrostatic instruments, Extension of instrument ranges and multipliers. Disadvantages of shunt and multipliers. Galvanometer: Principle of operation, Advantage, Disadvantage, Error and Application. 4L

Module 2: Circuit Parameters, Voltage and Frequency 5L

Measurement of resistance:

Measurement of medium resistance by using Wheatstone bridge, low resistance by using Kelvin double bridge. Other methods – Substitution method, Ammeter-Voltmeter method and Megger for measurement of medium and high resistances. 3L

Measurement of inductance, capacitance and frequency:

Measurement of Inductance-Maxwell bridge and Anderson bridge, Measurement of Capacitance-Schering bridge and Anderson bridge, Measurement of Frequency-Wien bridge. 2L

Module 3: Electrical Power and Energy Measurement 6L

Instrument Transformer:

Use of Instrument transformers, Principle of operation of Current & Potential transformer, errors. 2L

Measurement of Power:

Principle of operation of Electro-dynamic & Induction type wattmeter. wattmeter errors. 2L

Measurement of Energy:

Basic circuit diagram and principle of operation, calibration and testing of energy meter. 2L

Module 4: Electronic Instruments 7L

Electronic Instruments:

Basic concept of analog Electronic Voltmeter, functional block diagram of Digital Voltmeter and Multimeter, working principle of digital frequency meter by using functional block diagram, True RMS meters, Clamp-on meters. 4L

Cathode Ray oscilloscope (CRO):

Basic working principle of Analog CRO using functional block diagram, concept of dual beam and dual trace CRO. Measurement of voltage, current, frequency & phase by CRO. Double beam CRO. Basic concept Digital Storage Oscilloscope. 3L

Text Books:

1. A course in Electrical & Electronic Measurements & Instrumentation, A.K. Sawhney, Dhanpat Rai & sons.
2. Electrical and Electronic Measurement & Instruments, J.B Gupta, S.K. Kataria & Sons.
3. Electronic Instruments, H.S. Kalsi, Tata Mc-Graw hill, 2nd Edition.
4. D.V.S. Moorthy, Transducers & Instrumentation", 2nd/e, Prentice Hall of India Pvt Ltd, 2010.

Reference Books:

1. Sensors & Transducers, D. Patranabis, PHI, 2nd edition.
2. Digital Instrumentation, A.J. Bouwens, Tata Mc-Graw hill.
3. Modern Electronic instrumentation & Measuring instruments, A.D. Heltric & W.C. Copper, Wheeler Publication.
4. Instrument transducers, H.K.P. Neubert, Oxford University press

Course Name: Signals and Systems
Course Code: EE302
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Concepts in electrical and electronics circuits, Knowledge in algebra and calculus with problem solving capability (studied in Mathematics), Fundamental concepts on Laplace Transformation (studied in Mathematics).

Course Outcomes: After successful completion of the course, student will be able to

CO1. Understand mathematical description and representation of continuous and discrete time signals and systems.

CO2. Understand the basic concept random variables & random signals and develop the ability to find correlation, spectral densities and response of LTI systems to random inputs.

CO3. Develop input output relationship for linear shift invariant system and understand the convolution operator for continuous and discrete time system.

CO4. Demonstrate the transform-domain signals and systems and analyze its responses.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	2	-	-	-	-	-	-	-	2
CO2	3	2	-	2	2	-	-	-	-	-	-	2
CO3	3	1	-	2	1	-	-	-	-	-	-	2

Course Content

Module 1: Introduction to signal and systems **8L**

Continuous and discrete time signals: Classification of Signals – Periodic aperiodic even – odd – energy and power signals – Deterministic and random signals – complex exponential and sinusoidal signals –periodicity –unit impulse – unit step – Transformation of independent variable of signals: time scaling, time shifting. System properties: Linearity, Causality, time invariance and stability. Dirichlet's conditions, Determination of Fourier series coefficients of signal.

Module 2: Signal Transformation **8L**

Fourier transformation of continuous and discrete time signals and their properties. Laplace transformation- analysis with examples and properties. Parseval's theorem; Convolution in time (both discrete and continuous) and frequency domains with magnitude and phase response of LTI systems.

Module 3: Laplace Transform **4L**

Analysis and characterization of LTI systems using Laplace transform: Computation of unit step, ramp, impulse responses and transfer function using Laplace transform.

Module 4: Sampling Theorem **4L**

Representation of continuous time signals by its sample –Types of sampling, Sampling theorem. Reconstruction of a Signal from its samples, aliasing –sampling of band pass signals.

Module 5: Z-Transforms **7L**

Basic principles of z-transform - z-transform definition –, Relationship between z-transform and Fourier transform, region of convergence – properties of ROC – Properties of z-transform – Poles

and Zeros – inverse z-transform using Contour integration - Residue Theorem, Power Series expansion and Partial fraction expansion.

Module 6: Random Signals & Systems 5L

Definitions, distribution & density functions, mean values & moments, function of two random variables, concepts of correlation, random processes, spectral densities, response of LTI systems to random inputs.

Text Books:

1. A.V.Oppenheim, A.S.Willsky and S.H.Nawab -Signals & Systems, Pearson
2. S.Haykin & B.V.Veen, Signals and Systems- John Wiley
3. A.Nagoor Kani- Signals and Systems- McGraw Hill
4. P.Ramesh Babu & R.Anandanatarajan- Signals and Systems 4/e- Scitech

Reference Books:

1. J.G.Proakis & D.G.Manolakis- Digital Signal Processing Principles, Algorithms and Applications, PHI.
2. C-T Chen- Signals and Systems- Oxford
3. E WKamen &BS Heck- Fundamentals of Signals and Systems Using the Web and Matlab- Pearson
4. B.P.Lathi- Signal Processing & Linear Systems- Oxford
5. M.J.Roberts, Signals and Systems Analysis using Transform method and MATLAB, TMH
6. S Ghosh- Signals and Systems- Pearson
7. M.H.Hays- Digital Signal Processing, Schaum's outlines, TMH
8. Ashok Ambardar, -Analog and Digital Signal Processing- Thomson.
9. Phillip, Parr & Riskin- Signal, Systems and Transforms- Pearson

Course Name: Microprocessor and Microcontroller
Course Code: EC(EE)301
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: Knowledge in Digital Electronics.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand the hardware functionality of Intel 8051 and ARM
- **CO2.** Create the essential knowledge on operating modes of I/O ports, Timers/Counters, control registers and various types of interrupts of 8085,8086, 8051.
- **CO3.** Analyse various interfacing techniques with different supporting chips.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2		1	-	-	-	-	1	-	-	-
CO3	2	2	2	-	-	-	-	-	-	1	-	-

Course Content

Module 1: 8085 Microprocessor **3L**
8085 Architecture, Pin details, Familiarization of basic Instruction Set & Programming, addressing modes, Timing Diagram, memory segmentation, Interrupts & Direct Memory Access, Memory interfacing

Module 2: 8086 Microprocessor **3L**
8086 Architecture, Pin details timing diagram, instruction set, Familiarization of basic Instruction Set & Programming, addressing modes, Interrupts & Direct Memory Access, Memory interfacing.

Module 3: 8051 Microcontroller Architecture **3L**
Features of MCS51, Architecture of 8051, pin diagram, memory organization, external memory interfacing, register in MCS51 series.

Module 4: Instruction set of 8051 microcontroller **3L**
Addressing modes and instructions set, assembly programing, Parallel I/O interrupts ports, timer /counter and serial communication.

Module 5: Introduction to ARM Processor **3L**
Introduction to RISC processor – Comparison between CISC and RISC - Overview of ARM Architecture, Different modes of ARM processor, Program status register.

Module 6: ARM Instruction Set **3L**
Data transfer instruction – Arithmetic instruction - Logical Instruction, Multiply instruction, Branch instruction, Load/Store instruction, Swap instruction.

Module 7: Programming using ARM Processor **3L**
Solving a simple equation, generation of square wave form, Memory operations.

Module 8: Support IC chips **3L**
8255A: features, architecture, I/O addressing group A and group B controls operating modes,

control word, example of determine the control word, interfacing with 8051 I/O devices interfacing with 8251 using 8255A. 8253: Pin diagram, block diagram, control word register, operational modes 8252 microcontroller: Block Diagram, Pin Details, Modes of operation, control word(s) format.

Text Books:

1. Andrew N Sloss, Dominic Symes , Chris Wright, " ARM System Developer's Guide.
2. Mohammad Ali Mazidi, Janice Gillispie Mazidi, " The 8051 Microcontroller and Embedded.
3. Microprocessor architecture, programming and application with 8085 – R. Gaonkar, Penram International.
4. The 8051 microcontroller and Embedded systems - Mazidi, Mazidi and McKinley, Pearson.

Reference Books:

1. Kenneth J. Ayla, “The 8051 Micro controller", Thomson learning, 3rd Edition, 2010.
2. D Karuna Sagar, “Microcontroller 8051, Oxford: Alpha Science, 2011.
3. P.V Guruprasad, “Arm Architecture System on Chip and More ", Apress, 2013.

Course Name: Programming for Problem Solving
Course Code: CS(EE)301
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: Number system, Boolean Algebra.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Understand the fundamental concept of Computer and mathematical knowledge and apply them in designing solution to engineering problem.

CO2. Understand the basic concept of C programming and use of data types/operators/input/output function for developing and implementing complete program leading to solution of mathematical and engineering problem.

CO3. Use conditional branching, iteration, recursion and formulate algorithms and programs in solving mathematical/ scientific/ engineering problem leading to lifelong learning.

CO4. Understand the concept of arrays, pointers, file and dynamic memory allocation and apply it for problem solving and also create new data types using structure, union and enum.

CO5. Understand how to decompose a problem into functions and assemble into a complete program by means of modular programming possibly as a team.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	-	-	-	-	-	-	-
CO2	2	2	3	2	-	-	-	-	-	-	-	-
CO3	2	3	2	2	-	-	-	-	-	-	-	3
CO4	3	2	2	2	3	-	-	-	-	-	-	-
CO5	2	2	2	2	-	-	-	-	3	2	-	-

Course Content

Module 1: Fundamentals of Computer **6L**

History of Computer, Generation of Computer, Classification of Computers, Basic structure of Computer System, Primary & Secondary Memory, Processing Unit, Input & Output devices.
Number System: basic of Binary, Octal, Decimal and Hexadecimal number systems; Representation and interchanging of number in different number systems. Introduction to complements system, Representation of signed and unsigned numbers in singed magnitude singed 1's complement system and signed 2's complement system.
Arithmetic – Addition and Subtraction (using1's complement and 2's complement).
Representation of Characters-ASCII Code
Basics of Compiler, Interpreter and Assembler
Problem solving – Basic concept of Algorithm. Representation of algorithm using flow chart and pseudo code. Some basic examples.

Module 2: Introduction to C Programming **4L**

Overview of Procedural vs Structural language; History of C Programming Language.
Variable and Data Types: The C characterise identifiers.
And keywords, data type & sizes, variable names, declaration, statements.
Operators & Expressions: Arithmetic operators, relational operators, logical operators, increment and decrementoperators, bitwiseoperators, assignmentoperators, conditionaloperators,

specialoperators – typeconversion, C expressions, precedence and associativity.
Input and Output: Standard input and output, formatted output–print f, formatted input scan f.

Module 3: Branch and Loop 3L

Branching: Concept of Statement and Blocks in C, Simple if, if -else, nested if-else and if-else ladder.
Switch Case: break andcontinue; switch-case, concept of goto and labels
Loops – while, for, do while

Module 4: Program Structures 3L

Function: Basics of Functions, function types, function prototypes, formal and actual parameter, function calling, functions returning values, functions not returning values. Recursion and Recursive Function.
Storage Class in C: Storage Class-auto, external, static and register storage class, scope rules and life time of variables
C pre-processor: Pre-processing directive and macro, parameterized macro.

Module 5: Array and Pointer 5L

Arrays: One dimensional arrays, Two-dimensional arrays, Passing an array to a function
Pointers: Pointers, Pointer andArray, Pointer and functions.
Strings: Character array and string, array of strings, Passing a string to a function, String related functions, Pointer and String.
Dynamic memory allocation: Malloc, calloc, realloc and free with example.

Module 6: Structures, Unions and Enum 2L

Basic of structures, arrays of structures, structures and pointers, bit fields. Basics of union and enum, difference between structure and union.

Module 7: File in C 2L

Files handling- opening and closing a file in different mode, formatted and unformatted files, Command line arguments, f open, f close, f get c, f put c, f print f, f scan f function.

Text Books:

1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.
2. KanetkarY. – LetusC, BPBPublication,15th Edition.

Reference Books:

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.
2. K R Venugopal & S R Prasad – MASTERING C, TMH, 2nd Edition.

Course Name: Economics for Engineers
Course Code: HU(EE)301
Contact: 2L:0T:0P
Total Contact Hours: 24
Credits: 2

Prerequisite: NIL

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Identify various uses for scares resources.
- **CO2.** Understand key economic concepts and implement in real world problems.
- **CO3.** Apply critical thinking skills to analyze financial data and their impacts.
- **CO4.** Evaluate business performance through cost accounting principles.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	3	-	1	-	-	-	2	-	1	-	2
CO2	-	-	-	-	-	-	3	-	-	-	-	2
CO3	-	1	-	2	2	3	-	-	1	-	1	2

Course Content

Module 1: Introduction to Economics **2L**
Meaning, Nature and Scope of Economics

Module 2: Theory of Demand and Supply **4L**
Concept of demand, Determinants of demand, Individual and Market Demand, Exception to the law of demand. Concept of Supply, Shift in Demand and Supply Curve, Movement along the demand and supply curve, Determinants of equilibrium price and quantity, Elasticity of Demand and Supply.

Module 3: Theory of Production and Costs **6L**
concept of Production function, types of pf Production function, Laws of return to scale and variable Proportion, Cost Function, Types of Cost Function, Different Cost curves, Relation between Average and marginal cost, Relationship between Short Run costs and Long Run costs, Profit maximization.

Module 4: Macroeconomic Aggregates and Concepts **3L**
GDP, GNP. Concepts of National Income. Concept of Business Cycle.

Module 5: Inflation **2L**
Concept, Causes and Remedies of Inflation.

Module 6: Accounting **4L**
Basic concept of Journal, Preparation of Income Statement, and Balance Sheet.

Module 7: Cost Volume Profit Analysis **3L**
Contribution, P/V Ratio, Break-Even Point, Margin of Safety, Short term decision making: Make or Buy, Shut-down point, Export Pricing, Opportunity and Sunk cost.

Reference Books:

1. Economics by Lipsey and Chrystal.

2. Modern Economic Theory by K.K. Dewett.
3. Principle of Economics by H.L. Ahuja.
4. Engineering Economics by R.PaneerSeelvan.
5. Modern Accountancy by Hanif &Mukherjee.

Course Name: Electrical and Electronic Measurements Laboratory
Course Code: EE391
Contact: 0L:0T:2P
Credit: 1

Prerequisite: Concepts of different measuring system.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Conduct experiment to measure of Resistance, Inductance, Capacitance, Power and Energy.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	3	-	-	-	-	3	2	-	1

List of Experiments:

1. Measurement of power in polyphase circuit.
2. Measurement of power using instrument transformer.
3. Measurement of capacitance using Schering Bridge technique as well as LCR meter.
4. Calibration of Digital Energy Meter.
5. Testing of energy Meter
6. Measurement of capacitance using Anderson Bridge technique as well as LCR meter.
7. Measurement of low resistance using Kelvin Double bridge.
8. Measurement of high resistance and insulation resistance using Megger.
9. Current measurement using shunt, CT and Hall Sensor
10. Measurement of inductance by Maxwell bridge
11. Measurement of frequency by Wien Bridge.
12. Innovative Experiments (Software simulation by Multisim or Labview).

Course Name: Signals and Systems Laboratory
Course Code: EE392
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Concepts of Basic Electrical Engineering and Engineering Mathematics.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Analyse the time domain and frequency domain signals.
- **CO2.** Implement the concept of Fourier series and Z-Transform.
- **CO3.** Find cross correlation, autocorrelation of sequence & impulse response, step response of a system.
- **CO4.** Design frequency response of the system.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	2	-	-	-	3	1	1	3
CO2	3	2	1	3	2	-	-	-	3	1	1	2
CO3	3	2	-	2	2	-	-	-	3	1	1	2
CO4	3	2	3	3	2	-	-	-	3	1	1	3

List of Experiments:

1. Introduction to MATLAB: To define & use variables, vectors, Matrices & its functions in MATLAB. To study various arithmetic operators and mathematical functions in MATLAB. To create & use m-files.
2. Write a MATLAB program to plot the following continuous time and discrete time Signals.
   i. Step Function
   ii. Impulse Function
   iii. Exponential Function
   iv. Ramp Function
   v. Sine Function.
3. Write a MATLAB program to obtain linear convolution of the given sequences.
4. Write a MATLAB program to perform amplitude-scaling, time-scaling and time-shifting on a given signal.
5. Write a MATLAB program to obtain Cross correlation of sequence x(n) and y(n) & autocorrelation of a sequence x(n) of the given sequences & verify the property.
6. Write a MATLAB program to generate Fourier series of a Square Wave.
7. Write a MATLAB program to Calculate and plot using Z-Transform of a given signal.
8. Write a MATLAB program to find the impulse response and step response of a system from its difference equation. Compute and plot the response of a given system to a given input.
9. Write a MATLAB program to plot magnitude and phase response of a given system.
10. Checking linearity/non-linearity of a system using SIMULINK. Build a system that amplifies a sine wave by a factor of two.

Course Name: Microprocessor and Microcontroller Laboratory
Course Code: EC(EE)391
Contact: 0L:0T:2P
Credit: 1

Prerequisite: Knowledge in Digital Electronics.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Able to handle arithmetic and Logical operations, using assembly language programming in 8085 & 8086 Trainer Kits.
- **CO2.** Able to Program using arithmetic, logical and bit manipulation instructions of 8051.
- **CO3.** Able to validate the interfacing technique of 8255 Trainer kit with 8085 and 8086 through Subroutine Call and IN/OUT instructions like glowing LEDs accordingly, to control stepper motor rotation, interfacing Seven Segment Display and to display a string etc.
- **CO4.** Able to program and verify Timer/Counter and Interrupt handling in 8051.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	3	1	1	1	1	1	1	3
CO2	3	3	3	1	3	1	1	1	1	1	1	3
CO3	3	3	3	3	3	2	2	1	1	1	2	3
CO4	3	3	3	3	3	2	2	1	1	2	1	3

List of Experiments:

Demonstration Programs for 8085 Trainer Kit

1. Familiarization with 8085 register level architecture, the basic instruction sets (data transfer, arithmetic, logical, branching) and the trainer kit components including the memory map.
2. Familiarization with the process of storing, executing and viewing the contents of memory as well as registers in the trainer kit 8085 and simulator through small assignments.
3. Programming using 8085 kit and simulator for: Addition, Subtraction, Multiplication by repeated addition method, Square, Complement, look up table, copying a block of memory, Shifting, Packing and unpacking of BCD numbers, Addition of BCD numbers, Binary to ASCII conversion.

Demonstration Programs for 8086 Trainer Kit

4. Addition, Subtraction, Multiplication & division of two 16-bit numbers using 8086 trainer kit.
5. Factorial of two 16-bit numbers using 8086 trainer kit.
6. Smallest and Largest number from an array of numbers, Ascending order, Descending Order, String Matching, Multiplication using shift and add method using 8086 trainer kit.

Interfacing with 8086

7. Interfacing Stepper motor with 8086 trainer kit using 8255.
8. Interfacing Seven Segment Display using 8086 trainer kit and to display a string.

Interfacing with 8051

9. Programming using arithmetic, logical and bit manipulation instructions of 8051.

10. Program and verify Timer/Counter in 8051.
11. Program and verify Interrupt handling in 8051.

Additional Programs

12. Read a character from a keyboard and display it on Screen.
13. Display a string on screen.
14. To check for a Password.

Course Name: Programming for Problem Solving Laboratory
Course Code: CS(EE)391
Contact: 0L:0T:2P
Credit: 1

Prerequisite: Number system, Boolean Algebra

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand and propose appropriate command or function in running system or developing program for engineering and mathematical problems depending on the platform used even in changed environment leading to their lifelong learning.
- **CO2.** Identify and propose appropriate data type, arithmetic operators, input/output functions and also conditional statements in designing effective programs to solve complex engineering problem using modern tools.
- **CO3.** Design and develop effective programs for engineering and mathematical problems using iterative statements as well as recursive functions using modular programming approach possibly as a team maintaining proper ethics of collaboration.
- **CO4.** Explain and organize data in arrays, strings and structures and manipulate them through programs and also define pointers of different types and use them in defining self-referential structures and also to construct and use files for reading and writing to and from leading to solution of engineering and mathematical problem.
- **CO5.** Prepare laboratory reports on interpretation of experimental results and analyze it for validating the same maintaining proper ethics of collaboration.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	-	-	-	-	-	-	-	3
CO2	3	3	3	3	3	-	-	-	-	-	-	-
CO3	3	3	3	3	-	-	-	3	3	-	-	-
CO4	3	3	3	3	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	-	3	-	3	-	-

List of Experiments:

Module 1: Familiarization with some basic commands of DOS and Linux. File handling and Directory structures, file permissions, creating and editing simple C program in different editor and IDE, compilation and execution of C program. Introduction to Code block.

Module 2: Problem based on

a) Basic data types
b) Different arithmetic operators.
c) Print f( ) and scan f( ) functions.

Module 3: Problem based on conditional statements using

a) if-else statements
b) different relational operators
c) different logical operators

Module 4: Problem based on

a) for loop
b) while loop
c) do-while loop

Module 5: Problem based on

a) How to write a menu driven program using switch-case statement
b) How to write a function and passing values to a function
c) How to write a recursive function.

Module 6: Problem based on

a) How to use array (both I-Dand2-D).
b) How to pass an array to a function.

Module 7: Problem based on manipulation of strings in different way.

Module 8: Problem based on

a) How to handle compound variables in C
b) How to handle file in C
c) How to use command line argument in C

Text Books:

1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
2. KanetkarY. – LetusC, BPB Publication, 15th Edition

Reference Books:

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.
2. K R Venugopal & S R Prasad – MASTERING C, TMH, 2nd Edition

2nd Year 4th Semester									
Sl. No.	**Broad Category**	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG	Major	EE401	Electrical Machines – I	3	0	0	3	3
2	ENGG	Major	EE402	Control Systems – I	3	0	0	3	3
3	ENGG	Major	EE403	Electromagnetic Field Theory	3	0	0	3	3
4	ENGG	Minor	EC(EE)401	Digital Signal Processing	2	0	0	2	2
5	ENGG	Minor	CS(EE)401	Data Structure and Algorithms	2	0	0	2	2
6	HUM	Ability Enhancement Courses	HU(EE)401	Principles of Management	2	0	0	2	2
B. Practical									
7	ENGG	Major	EE491	Electrical Machines – I Laboratory	0	0	3	3	1.5
8	ENGG	Major	EE492	Control Systems – I Laboratory	0	0	3	3	1.5
9	ENGG	Minor	EC(EE)491	Digital Signal Processing Laboratory	0	0	2	2	1
10	ENGG	Minor	CS(EE)491	Data Structure and Algorithms Laboratory	0	0	2	2	1
11	ENGG	Skill Enhancement Courses	ME(EE)491	Computer Aided Design	0	0	3	3	1.5
Total for Theory and Practical								**28**	**21.5**

Course Name: Electrical Machines – I
Course Code: EE401
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Concept of Basic Electrical Engineering, Electrical Circuit Analysis.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Describe the concept of magnetic circuits.
- **CO2.** Demonstrate the operation of different types of dc machines and its applications.
- **CO3.** Analyse the connections of transformers and its applications.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	2	-	-	2	3	3
CO2	3	3	3	3	3		-	-	2	-	3	3
CO3	3	1	2	-	-	3	-	2	2	-	3	3

Course Content

Module 1: Magnetic Circuits 6L

Review of magnetic circuits - MMF, flux, reluctance, inductance. Amperes' Law and Biot Savarts' Law. Visualization of magnetic fields produced by a bar magnet and a current carrying coil - through air and through a combination of iron and air. Review of magnetic hysteresis and magnetic circuits.

Module 2: Transformers 16L

Construction and operation of single-phase transformers, equivalent circuit and phasor diagram, voltage regulation, losses and efficiency. Per unit representation of single-phase transformers. Testing - open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses. Single-phase Auto transformer – Comparison of weight, copper loss with 2-winding transformer, equivalent circuit, applications. Three-phase transformer - construction, types of connection and their comparative features, Parallel operation of single-phase and three-phase transformers. Scott-connected transformer and open-delta connection – working principle, connection diagram, practical application. Effect of nonlinear B-H curve of magnetic core material, harmonics in magnetization current, Effect of unbalanced loading and neutral shifting - Tertiary windings. Tap-changing methods, Tap changers – Off load and On-load type. Special Transformer - Pulse transformer, Grounding transformer.

Module 3: DC Machines 14L

Single conductor generating and motoring action. DC machine construction and armature winding. Generated voltage and torque equation. OCC and Load characteristics of DC generators. Armature reaction and its minimization – Interpole and Compensating winding. Commutation method – concept of reactance voltage. Operating characteristics of DC motors. Starting, Braking and Speed Control techniques used for DC motors. Test on DC machines – Brake Test, Hopkinson's Test and Swinburne Test.

Text Books:

1. Electrical Machinery, P.S. Bhimra, 6th Edition, Khanna Publishers.
2. Electric machines, D.P. Kothari & I.J Nagrath, 3rd Edition, Tata Mc Graw-Hill Publishing Company Limited.

3. Electrical Machines, P.K. Mukherjee & S. Chakrabarty, Dhanpat Rai Publication.

Reference Books:

1. Electric Machinery & Transformers, Bhag S. Guru and H.R. Hiziroglu, 3rd Edition, Oxford University press.
2. Electrical Machines, R.K. Srivastava, Cengage Learning
3. Theory of Alternating Current Machinery, Alexander S Langsdorf, Tata Mc Graw Hill Edition.
4. The performance and Design of Alternating Current Machines, M. G. Say, CBS Publishers & Distributors.
5. Electric Machinery & transformer, Irving L Koskow, 2nd Edition, Prentice Hall India.

Course Name: Control Systems – I
Course Code: EE402
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Concept of Basic Electrical Engineering, Circuit Theory and Engineering Mathematics.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Calculate mathematical model and transfer function of the physical systems.
- **CO2.** Analyze the linear systems in time domain.
- **CO3.** Illustrate the linear systems in frequency domain.
- **CO4.** Design simple compensators and controllers for the given specifications.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	-	2	-	-	-	-	-	-	2
CO2	2	2	2	-	2	-	-	-	-	-	-	2
CO3	2	3	2	-	2	-	-	-	-	-	-	2
CO4	2	2	3	-	2	-	-	-	-	-	-	2

Course Content

Module 1: Systems and their Representations **6L**

Basic elements in control systems - open loop & closed loop - Transfer functions of mechanical, electrical and analogous systems. Block diagram reduction - signal flow graphs.

Module 2: Time Domain Analysis **6L**

Standard test signals, Time response of first and second order system, Time domain specifications, Steady state error, error constants, generalized error coefficient.

Module 3: Stability Analysis and Root Locus **6L**

Stability - concept and definition, Characteristic equation – Location of poles – Routh Hurwitz criterion - Root locus techniques: construction, properties and applications.

Module 4: Frequency Response Analysis **5L**

Bode plot - Polar plot - Correlation between frequency domain and time domain specifications.

Module 5: Stability in Frequency Domain **5L**

Relative stability, Gain margin, Phase margin, stability analysis using frequency response methods, Nyquist stability criterion.

Module 6: Control Systems Design **8L**

Introduction to design problem and philosophy. Introduction to time domain and frequency domain design specification and its physical relevance. Effect of gain on transient and steady state response. Effect of addition of pole on system performance. Effect of addition of zero on system response. Introduction to compensator. Design of Lag, lead lag-lead compensator in time domain & frequency domain using Bode plot. Design of P, PI, PD and PID controllers in time domain and frequency domain for first, second order systems.

Text Books:

1. Modern Control Engineering, K. Ogata, 4th Edition, Pearson Education.
2. Norman S. Nise, "Control System Engineering", John Wiley & Sons, 6th Edition, 2011.
3. Benjamin C Kuo "Automatic Control System" John Wiley & Sons, 8th Edition, 2007.

Reference Books:

1. M. Gopal, "Control Systems-Principles And Design", Tata McGraw Hill – 4th Edition, 2012.
2. R.C. Dorf & R.H. Bishop, "Modern Control Systems", Pearson Education, 11th Edition, 2008.
3. I. J. Nagrath and M.Gopal," Control System Engineering", New Age International Publishers, 4th Edition, 2006.
4. Graham C. Goodwin, Stefan F. Graebe, Mario E. Sagado, "Control System Design", Prentice Hall, 2003.

Course Name: Electromagnetic Field Theory
Course Code: EE403
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Knowledge of waves, equations, fields from 1st year Physics and Basic Electrical Engineeirng.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Explain electromagnetic wave propagation using fundamentals of electrostatics, magnetostatics and electromagnetic theory.
- **CO2.** Aapply vector calculus in problems of electrostatics and magnetostatics and attainment of electromagnetic wave equation.
- **CO3.** Analyze the physics of various kinds of electric and magnetic materials
- **CO4.** Justify the emergence of magnetic field under time varying electric field using Maxwell's 4th equation.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	3	2	-	-	-	-	-	-	-	-	-	2
CO3	2	-	-	-	-	-	-	-	-	-	-	2
CO4	3	3	2	-	-	-	-	-	-	-	-	2

Course Content

Module 1: Co-ordinate systems **3L**

Cartesian coordinates, Circular cylindrical coordinates, Spherical coordinates and their transformation. Differential length, area and volume in different coordinate systems. Solution of problems**.**

Module 2: Vector Calculus **3L**

Vector operators, Gradient, Divergence, Curl-Physical significance, Scalar and Vector field, Gauss's divergence theorem (statement only), Stoke's theorem (statement only), expression of gradient, divergence, curl in spherical and cylindrical coordinate system.

Module 3: Electrostatics **11L**

3.01: Coulomb's law in vector form, Electrostatic field and its curl, Gauss's law in integral form and conversion into differential form, Electric potential and potential gradient, Concept of Electric dipole, flux lines and Energy density in electrostatic field, Equation of continuity, Extend to Poisson's & Laplace's equation, Application of Gauss's law. Application of Laplace's equation. Application to parallel plate, spherical and cylindrical capacitors (equivalent 1D problem). 7L

3.02: Concept of Polarization, the relation between D, E and P, Polarizability, Electronic, Ionic, Orientation & Space charge polarization (no derivation), behavior of Dielectric under alternating field (qualitative discussion only), Dielectric losses. 4L

Module 4: Magnetostatics **10L**

4.01: Lorentz force (concept in Hall effect), Biot-Savart law (non-existence of magnetic monopole), Magnetic vector and scalar potential. Ampere's circuital law, force on a small current element placed in a magnetic field. force due to parallel and anti-parallel current carrying wire and definition of Ampere. Magnetic torque and moments, Magnetization in material, Magnetic boundary

condition, Concept of Magnetic energy, Magnetostriction, Solution of problems. 6L

4.02: Relation between Magnetic Inducation, Magnetic field, Magnetization. Bohr magneton, susceptibility, Diamagnetism, Paramagnetism & Ferromagnetism-Hysteresis, Hard ferromagnets, Comparison and applications of permanent magnets (storage devices) and Soft ferromagnets (Permalloys, Ferrites etc.) 4L

Module 5: Time-varying field and Maxwell's equations 9L

5.01: Faraday's law-integral and differential form, Transformer and motional emf, Concept of displacement current, Maxwell's field equations with physical significance, Solution of problems. 4L

5.02: Wave equation in free space, transverse nature of electromagnetic wave.in conducting medium, Wave propagation in lossy dielectric, Plane waves in loss less dielectric, Plane wave in free space, Plane wave in good and dielectric conductor, Skin effect, Skin depth, Power and Poynting vector. Solution of problems. 5L

Text Books:

1. Vector analysis- Murray R Spigel (Schaum's outline)
2. Introduction to Electrodynamics- David J Griffiths (PHI learning Private Ltd.)
3. Barkley Physics course- E M Purcell (McGraw-Hill Book company)
4. Electromagnetic theory & Electrodynamics- Satya Prakash (Kedarnath Ramnath publication)
5. Electricity & Magnetism- D. Chattopadhyay & P.C. Rakshit (Central publication)
6. Electromagnetic field theory fundamentals, Guru &Hizroglu, 2nd edition, Cambridge University Press.
7. Electromagnetic with application, Krause, 5th Edition, TMH

Reference Books:

1. Electricity & Magnetism-B.Ghosh (Books & Allied Pub)
2. Elements of Electromagnetic Fields, S.P. Seth, Dhanpat Rai & Sons
3. Elements of Electromagnetic, Mathew N.O. Sadiku, 4th edition, Oxford University press.
4. Engineering Electromagnetic, W.H. Hyat& J.A. Buck, 7th Edition, TMH
5. Theory and problems of Electromagnetic, Edminister, 2nd Edition, TMH

Course Name: Digital Signal Processing
Course Code: EC(EE)401
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: Concept of Circuit Theory, various signals and systems, Laplace Transform, Z-Transform, knowledge of arithmetic of complex numbers and elementary calculus.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Interpret the properties of discrete time signals in time domain and frequency domain.
- **CO2.** Demonstrate the transform- domain signal and analyze the frequency response.
- **CO3.** Design and implement IIR filtering operations with the real time constraints.
- **CO4.** Develop a FIR filter for specific digital signal applications.
- **CO5.** Explain finite word length effects and digital filters.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	-	-	-	-	-	-	2
CO2	2	3	3	-	2	-	-	-	-	-	-	-
CO3	3	1	3	3	1	-	2	-	-	-	-	2
CO4	2	2	3	3	3	-	2	-	-	-	-	-
CO5	3	3	2	2	3	-	2	-	-	-	-	2

Course Content

Module 1: Discrete-time Signals and Systems **4L**

Concept of discrete-time signal, basic idea of sampling and reconstruction of signal, sampling theorem, sequences, periodic, energy, power, unit-sample, unit step, unit ramp and complex exponentials, arithmetic operations on sequences, impulse response, concept of convolution, graphical, analytical and overlap-add methods to compute convolution supported with examples properties of convolution, interconnection of LTI systems with physical interpretations, stability and causality conditions, recursive and non-recursive systems.

Module 2: Z-Transforms **3L**

Definition, mapping between s-plane and Z-plane, unit circle, convergence and ROC, properties of Z-transform, Z-transform on sequences with examples and exercises, characteristic families of signals along with ROC, convolution, correlation and multiplication using Z-transform, initial value theorem, Perseval's relation, inverse Z-transform by contour integration, power series and partial fraction expansions with examples and exercises.

Module 3: Frequency Analysis of Signals and Systems **3L**

DTFT- Frequency domain sampling - DFT-Properties-Frequency analysis of signals using DFT-FFT Algorithm-Radix-2 FFT algorithms-Applications of FFT.

Module 4: Theory and Design of Analog Filters **3L**

Design techniques for analog low pass filter -Butterworth and Chebyshev approximations, frequency transformation, Properties.

Module 5: Design of IIR Digital Filters **3L**

IIR filter design – Bilinear and Impulse Invariant Transformation techniques - Spectral

transformation of digital filters.

Module 6: Design of FIR Digital Filters 3L

FIR Filter Design - Phase and group delay - Design characteristics of FIR filters with linear phase – Frequency response of linear phase FIR filters – Design of FIR filters using Rectangular, Hamming, Hanning, Bartlett and Blackmann window functions.

Module 7: Realization of Digital Filters 2L

Direct Forms I and II, Cascade, Parallel and Lattice structures.

Module 8: Digital Signal Processors 3L

General-purpose digital signal processors - Fixed point and floating-point DSP - Finite word length effects - MAC, filter operation in different DSP architectures - typical implementation of DSP algorithms.

Text Books:

1. John G. Proakis, D.G. Manolakis and D.Sharma, "Digital Signal Processing Principles, Algorithms and Applications", 4th edition, Pearson Education, 2012.
2. Sanjit K. Mitra, "Digital Signal Processing", 4th edition, TMH, 2013.
3. P. Rameshbabu, "Digital Signal Processing", Scitech Publications (India).
4. S.Salivahanan, A.Vallabraj & C. Gnanapriya, "Digital Signal Processing", TMH Publishing Co.
5. A. Nagoor Kani, "Digital Signal Processing", McGraw Hill.

Reference Books:

1. Oppenhiem V.A.V and Schaffer R.W, "Discrete – time Signal Processing", 3rd edition, Pearson new international edition, 2014.
2. Sophocles J. Orfanidis, "Introduction to Signal Processing" 2nd edition, Prentice Hall, Inc, 2010.
3. Chi-Tsong Chen, "Digital Signal Processing; Spectral Computation and Filter Design", Oxford University Press.

Course Name: Data Structure and Algorithms
Course Code: CS(EE)401
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: Basic Mathematics, Programming language.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Use different kinds of data structures which are suited to different kinds of applications, and some are highly specialized to specific tasks.
- **CO2.** Manage large amounts of data efficiently, such as large databases and internet indexing services.
- **CO3.** Use efficient data structures which are a key to designing efficient algorithms.
- **CO4.** Use some formal design methods and programming languages which emphasize on data structures, rather than algorithms, as the key organizing factor in software design.
- **CO5.** Store and retrieve data stored in both main memory and in secondary memory.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	2	-	-	-	-	-	-	-	2
CO2	3	3	2	3	-	-	-	-	-	-	-	2
CO3	3	-	3	-	-	-	-	-	-	-	-	2
CO4	-	3	-	2	-	-	-	-	-	-	-	2
CO5	-	3	-	2	-	-	-	-	-	-	-	2

Course Content

Module 1: Introduction – Concepts of data structures **5L**

a) Data and data structure b) Abstract Data Type and Data Type. Algorithms and programs, basic idea of pseudo-code. Algorithm efficiency and analysis, time and space analysis of algorithms – order notations. Array: Different representations – row major, column major. Sparse matrix - its implementation and usage. Array representation of polynomials. Linked List: Singly linked list, circular linked list, doubly linked list, linked list representation of polynomial and applications.

Module 2: Stack and Queue **5L**

Stack and its implementations (using array, using linked list), applications. Queue, circular queue, dequeue. Implementation of queue- both linear and circular (using array, using linked list), applications. Recursion: Principles of recursion – use of stack, differences between recursion and iteration, tail recursion. Applications - The Tower of Hanoi, Eight Queens Puzzle.

Module 3: Trees **8L**

Basic terminologies, forest, tree representation (using array, using linked list). Binary trees - binary tree traversal (pre-, in-, post- order), threaded binary tree (left, right, full) - non-recursive traversal algorithms using threaded binary tree, expression tree. Binary search tree- operations (creation, insertion, deletion, searching). Height balanced binary tree – AVL tree (insertion, deletion with examples only). B- Trees – operations (insertion, deletion with examples only). Huffman tree.

Graphs: Graph definitions and Graph representations/storage implementations – adjacency matrix, adjacency list, adjacency multi-list. Graph traversal and connectivity – Depth-first search (DFS), Breadth-first search (BFS) – concepts of edges used in DFS and BFS (tree-edge, back-edge, cross-edge, forward-edge), applications. Minimal spanning tree – Prim's algorithm

Module 4: Sorting Algorithm 6L

Internal sorting and external sorting Bubble sort and its optimizations, insertion sort, shell sort, selection sort, merge sort, quick sort, heap sort (concept of max heap), radix sort. Tree Sort technique. Searching: Sequential search, binary search, interpolation search. Hashing: Hashing functions, collision resolution techniques

**** For better understanding, partial theoretical parts may be covered in laboratory before the conduction of experiments***

Text Books:

1. Data Structures Using C, by Reema Thereja, OXFORD Publications
2. Data Structures and Algorithms Using C by Amitava Nag and Joyti Prakash Singh, VIKASH Publication
3. Data Structures by S. Lipschutz.

Reference Books:

1. Data Structures Using C, by E. Balagurusamy E. Mc graw Hill)
2. Data Structures Using C and C++, by Moshe J. Augenstein, Aaron M. Tenenbaum

Course Name: Principles of Management
Course Code: HU(EE)401
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: NA.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** To recall and identify the relevance of management concepts.
- **CO2.** To apply management techniques for meeting current and future management challenges faced by the organization.
- **CO3.** To compare the management theories and models critically to solve real life problems in an organization.
- **CO4.** To apply principles of management in order to execute the role as a manager in an organization.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	3	-	3	-
CO2	-	-	-	-	-	2	-	3	3	-	3	3
CO3	-	-	-	-	-	-	-	-	2	-	3	3

Course Content

Module 1: Management Concepts **4L**

Definition, roles, functions and importance of Management, Evolution of Management thought-contribution made by Taylor, Fayol, Gilbreth, Elton Mayo, McGregor, Maslow.

Module 2: Planning and Control **4L**

Planning: Nature and importance of planning, -types of planning, Levels of planning - The Planning Process. –MBO, SWOT analysis, McKinsey's7S Approach. Organizing for decision making: Nature of organizing, span of control, Organizational structure line and staff authority. Basic control process -control as a feedback system – Feed Forward Control – Requirements for effective control – control.

Module 3: Group Dynamics **4L**

Types of groups, characteristics, objectives of Group Dynamics. Leadership: Definition, styles & functions of leadership, qualities for good leadership, Theories of leadership

Module 4: Work Study and work measurement **4L**

Definition of work study, Method Study Steps, Tools and Techniques used in the Method Study and Work Measurement Time Study: Aim & Objectives. Use of stopwatch procedure in making Time Study. Performance rating, allowances and its types. Calculation of Standard Time. Work sampling.

Module 5: Marketing Management **2L**

Functions of Marketing, Product Planning and development, Promotional Strategy

Module 6: Quality management **6L**

Quality definition, Statistical quality control, acceptance sampling, Control Charts – Mean chart, range chart, cchart, pchart, np chart, Zero Defects, Quality circles, , Kaizen & Six Sigma , ISO-9000 Implementation steps, Total quality management.

Text Books:

1. Essentials of Management, by Harold Kooritz& Heinz Weihrich TataMcGrawMohammad Ali Mazidi, Janice Gillispie Mazidi, " The 8051 Microcontroller and Embedded.
2. Production and Operations Management-K.Aswathapa,K .ShridharaBhat,Himalayan Publishing House.

Reference Books:

1. Organizational Behavior, by Stephen Robbins Pearson Education, NewDelhi New era Management, Daft, 11th Edition, CengageLearning D Karuna Sagar, "Microcontroller 8051, Oxford: Alpha Science, 2011.
2. Principles of Marketing, Kotlar Philip and Armstrong Gary, Pearsonpublication.

Course Name: Electrical Machines – I Laboratory
Course Code: EE491
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Concept of Basic Electrical Engineering Laboratory, Electrical Measurement Laboratory.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Conduct different tests on Transformers and D.C. Machines.
CO2. Analyze the characteristics of Transformers, D.C. Machines.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	3	-	-	-	-	3	2	-	1
CO2	2	-	-	3	-	-	-	-	3	2	-	1

List of Experiment (At least *ten* experiments to be performed):

1. Heat-run test of a single-phase transformer.
2. Regulation and Efficiency of single-phase transformer by direct loading method.
3. Parallel operation of two single-phase transformer and find out the load sharing.
4. Efficiency of a single-phase transformer by Back-to-Back test.
5. Polarity test and vector grouping of a three-phase transformer.
6. Identification of different parts of a D.C. machine.
7. Voltage build-up of a D.C. shunt generator and find out critical resistance and critical speed.
8. Brake test of D.C. series motor.
9. Brake Test of D.C. shunt motor.
10. Swinburne test of a D.C. shunt motor.
11. Load test of Differentially Compound D.C. Motor
12. Innovative Experiments.

Course Name: Control Systems – I Laboratory
Course Code: EE492
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Concept of Simulation Software and Control System.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Analyse the time domain and frequency domain response of LTI system using software/hardware.
- **CO2.** Evaluate the stability of LTI system in time and frequency domain by using MATLAB/ SciLab
- **CO3.** Design compensators, controllers to meet desired performance of system.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	3	2	-	-	-	3	-	-	2
CO2	2	2	-	3	2	-	-	-	3	-	-	2
CO3	2	2	-	3	2	-	-	-	3	-	-	2

List of Experiment:

1. Familiarization with MATLAB/Scilab control system toolbox, MATLAB simulink tool box and PSPICE.
2. Determination of Step response for first order and Second order system with unity feedback on CRO and calculation of control system specification like Time constant, % peak overshoot, settling time etc. from the response.
3. Simulation of Step response and Impulse response for Type-0, Type-1 and Type-2 system with unity feedback using MATLAB / Scilab / PSPICE.
4. Determination of Root locus, Bode plot, Nyquist plot using MATLAB/Scilab control system tool box for 2nd order system and determination of different control system specification from the plot.
5. Determination of PI, PD and PID controller action of first order simulated process.
6. Determination of approximate transfer functions experimentally from Bode plot.
7. Evaluation of steady state error, setting time, percentage peak overshoot, gain margin, phase margin with addition of Lead.
8. To study the position control system using servomotor.

Reference Books:

1. MATLAB and Simulink for Engineers, Agam Kumar Tyagt, Oxford.
2. Modeling and Simulation Using MATLAB - Similink, Dr. S. Jain, Wiley India.
3. MATLAB and Its Application in Engineering, Raj K Bansal, A.K. Goel and M.K. Sharma, Pearson.
4. MATLAB programming for Engineers, S.J. Chapman, 3rd Edition, Cengage.

Name: Data Structures and Algorithms Laboratory
Course Code: CS(EE)491
Contact: 0L:0T:2P
Credit: 1

Prerequisite: Basic Mathematics, Programming language.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand the concept of dynamic memory management, data types, basic data structures, and complexity analysis
- **CO2.** Introduce the concept of data structures through ADT.
- **CO3.** Choose the appropriate linear and non-linear data structure and algorithm design method for a specified application design.
- **CO4.** Analyze the complexity of the problems.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	-	-	-	-	-	-	-	-
CO2	2	3	1	3	-	-	-	-	-	-	-	-
CO3	3	3	3	3	2	-	-	-	2	-	-	3
CO4	3	2	1	3	2	-	-	-	-	-	-	1

List of Experiment:

1. Experiments should include but not limited to Implementation of array operations.
2. Stack and Queues: adding, deleting, elements circular Queue: Adding& deleting elements
3. Merging Problem:
4. Evaluation of expressions operations on Multiple stacks & queues:
5. Implementation of linked list: inserting, deleting, inverting a linked list
6. Implementation of stacks and queues
7. Using linked lists: Polynomial addition, Polynomial multiplication
8. Sparse Matrices: Multiplication, addition
9. Recursive and Non Recursive traversal Trees
10. Threaded binary tree traversal. AVL tree implementation
11. Application of Trees. Application of sorting and searching algorithms
12. Hash tables implementation: searching, inserting and deleting, searching and sorting techniques.
13. Innovative Experiments.

Text Books:

1. Data Structures Using C, by Reema Thereja, OXFORD Publications
2. Data Structures and Algorithms Using C by Amitava Nag and Joyti Prakash Singh, VIKASH Publication
3. Data Structures by S. Lipschutz.

Reference Books:

1. Data Structures Using C, by E. Balagurusamy E. Mc graw Hill)
2. Data Structures Using C and C++, by Moshe J. Augenstein, Aaron M. Tenenbaum

Paper Name: Computer Aided Design
Paper Code: ME(EE)491
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Basic Electrical Engineering, Fundamentals of static and dynamic machines, concepts of power systems.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Read electrical drawing for any system to understand the working of the system and its components.

CO2. Find the important points in the circuit diagrams or layout for troubleshooting and maintenance.

CO3. Use graphic software to draw the circuit for various types of electrical systems.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	3	-	-	-	-	3	3	-	1
CO2	2	-	-	3	-	-	-	-	3	3	-	1
CO3	2	-	-	3	-	-	-	-	3	3	-	1

List of Experiments*:

1. Necessity and its application in Engineering Field and familiarization with designing software like AUTOCAD and Automation studio.
2. Awareness of different operating functions and command in AUTOCAD and Automation Studio.
3. To draw a sheet of electrical symbols for representation of Electrical machines, Equipment, accessories, switching and protection equipment.
4. Draw figures of different electrical equipment and simple electrical circuits (as instructed by the supervisor).
5. To draw different circuit combination of the experiments performed in machine and power system laboratories.
6. To draw the internal view of DC as well AC motors.
7. To draw the internal view of 3 phase transformer.
8. To draw the circuit of a simple layered power electronic circuit (as per the sample provided by the supervisor).
9. To draw a plan for simple power distribution system with 3 Alternators.
10. To draw electrical wiring with accessories on a single storied building (2 BHK) plan, showing Energy meter, Main switch, Distribution Board, Light points, Socket outlets etc.
11. Schematic diagram for a 3-phase induction motor control circuit operated with DOL starter at different location.
12. Complete wiring diagram of the previous drawing (showing overload and short circuit protection).
13. Innovative Experiments.

* **At least *ten* experiments to be performed.**

3rd Year 5th Semester									
Sl. No.	**Broad Category**	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG	Major	EE501	Electrical Machines – II	3	0	0	3	3
2	ENGG	Major	EE502	Power System – I	3	0	0	3	3
3	ENGG	Major	EE503	Power Electronics	3	0	0	3	3
4	ENGG	Major	EE504A	Renewable Energy – I	2	0	0	2	2
			EE504B	Embedded System Design					
			EE504C	Utilization of Electric Power					
5	ENGG	Minor	CS(EE)501A	Database Management System	2	0	0	2	2
			CS(EE)501B	Computer Network					
			CS(EE)501C	Sensors and IoT					
B. Practical									
6	ENGG	Major	EE591	Electrical Machines – II Laboratory	0	0	3	3	1.5
7	ENGG	Major	EE592	Power System – I Laboratory	0	0	3	3	1.5
8	ENGG	Major	EE593	Power Electronics Laboratory	0	0	3	3	1.5
9	ENGG	Skill Enhancement Courses	EE594	Electrical Workshop	0	0	2	2	1
10	ENGG	Skill Enhancement Courses	EE595	Dissertation on Design and Development – I	0	0	3	3	1.5
11	ENGG	Minor	CS(EE)591A	Database Management System Laboratory	0	0	3	3	1.5
			CS(EE)591B	Computer Network Laboratory					
			CS(EE)591C	Sensors and IoT Laboratory					
Total for Theory and Practical								**30**	**21.5**

Course Name: Electrical Machines – II
Course Code: EE501
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Knowledge of Physics up to B. Tech. 1st year Physics-I course and Electrical Machines – I.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Describe the concept of rotating magnetic fields.
CO2. Demonstrate the operation of AC Machines.
CO3. Analyse performance characteristics of ac machines.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	-	-	-	-	-	-	-	2
CO2	3	3	2	3	2	-	-	-	-	-	-	3
CO3	3	3	3	3	2	-	-	-	2	-	-	3

Course Content

Module 1: Fundamentals of AC machine windings 4L

Physical arrangement of windings in stator, relationship between electrical and mechanical degree, single-turn coil – active portion and overhang; full-pitch coils, fractional pitched coils and its arrangement, factors pertaining to the windings.

Module 1: Induction Machines 13L

Induction motor as a transformer, Concept of rotating magnetic field, Power stages in 3-phase induction motor and their relation, torque-slip characteristics. Determination of equivalent circuit parameters, Separation of losses, Efficiency, Concept of Deep bar and Double cage rotor. Starting braking and speed control of three phase induction motor. Space harmonics: Crawling and Cogging, Industrial applications of 3-phase induction motor. Construction and operating principle of single-phase Induction Motor, Double-revolving field theory. Development of equivalent circuit, Determination of equivalent circuit parameters, Methods of starting using auxiliary winding, Selection of capacitor value during starting and running. Speed-Torque characteristics, Phasor diagram, Condition of Maximum torque. Application of single-phase motors. Brief idea on Induction Generator and Linear Induction Motor and its Applications.

Module 2: Synchronous Machines 15L

Construction of 3-phase Synchronous Machines, Advantages of Stationary armature and Rotating field system. Methods of excitation systems. Armature reaction at various p.f, concept of Synchronous reactance. Phasor diagrams of alternator at different p.f. loads. Open circuit characteristics, Short circuit characteristics and determination of synchronous reactance. Voltage regulation of alternator by synchronous impedance method. Two reaction theory, phasor diagram of salient pole generator at different loads. Power angle characteristics of Synchronous machines. Short circuit ratio (SCR) – concept and significance. Method of control of Active & Reactive Power of an alternator. Reasons and advantages of Parallel operation. Synchronization alternators and Load sharing. Methods of starting of Three-Phase Synchronous Motor. Effect of variation of excitation – V curves and inverted V curves. Hunting and its prevention. Applications of synchronous motor, Synchronous condenser.

Module 3: Fractional HP Machines **4L**

Constructional features and performance characteristics of Universal Series Motors, Compensated and uncompensated motors. Principle and construction of switched reluctance motor, Permanent magnet machines, Brushless DC machines, Hysteresis motor, Stepper Motor.

Text Books:

1. Electrical Machines, Nagrath & Kothary, TMH
2. The performance and design of Alternating Current machines, M. G. Say, C.B.S Publishers & Distributors
3. Electrical Machinery, P.S. Bhimra, Khanna Publishers.
4. Electrical Machines, Ashfaq Husain, Dhanpat Rai & Co.
5. Electrical Machines, S.K.Bhattacharya, T.M.H Publishing Co. Ltd.

Reference Books:

1. Electrical Machines, Theory & Applications, M.N. Bandyopadhyay, PHI
2. Electrical Technology, H.Cotton, C.B.S. Publisher New Delhi
3. Electric Machinery & Transformes, Irving L. Kosow, PHI
4. Electric Machinery, A.E.Fitzgerald, Charles Kingsley, Jr. & Stephen D. Umans, 6^{th} Edition, Tata McGraw Hill Edition.
5. Problems in Electrical Engineering, Parker smith, 9th Edition, CBS publishers & distributors.

Course Name: Power System – I
Course Code: EE502
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Concepts of basic electrical engineering, circuit theory and electrical machine.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Illustrate the concepts of power system components and its associated terms.
- **CO2.** Classify different types of power generation.
- **CO3.** Analyze performances of power system.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	3	2	2	-	-	-	-	1
CO2	3	2	2	2	1	3	3	-	-	-	2	3
CO3	2	3	3	3	2	3	2	-	-	-	2	3

Course Content

Module 1: Generation Transmission and Distribution 4L
Introduction to Thermal, Hydro-Electric, Nuclear, Solar and Wind Power Generation. Basic concept of electrical supply system. Introduction to Smart Grid.

Module 2: Mechanical Design of Overhead Transmission Line 6L
Design of Conductors, Line supports: Towers, Poles, Insulators: Types, Voltage distribution across a suspension insulator string, String efficiency, arching shield and rings, Methods of improving voltage distribution across Insulator strings, Electrical tests on line Insulators Sag, Tension and Clearance, Effect of Wind and Ice on Sag, Stringing Chart Dampers.

Module 3: Electrical Design of Overhead Transmission Line 8L
Choice of frequency, Choice of voltage, Types of conductors, Inductance and Capacitance of a single phase and three phases' symmetrical and unsymmetrical configurations. Skin Effect, Proximity Effect, Bundle conductors. Transposition. Concept of GMD and GMR. Influence of Earth on conductor capacitance.

Module 4: Corona 3L
Principle of Corona formation, Critical disruptive voltage, Visual critical corona discharge potential, Corona loss, advantages & disadvantages of Corona. Methods of reduction of Corona.

Module 5: Cables 5L
Types of cables, cable components, capacitance of single core and 3 core cables, dielectric stress, optimum cable thickness, grading, dielectric loss and loss angle.

Module 6: Performance of Lines 8L
Short, medium (nominal T, π) and long lines and their representation. Calculation of ABCD constants, Voltage regulation, Ferranti effect, Power equations and line compensation, Power Circle diagrams.

Module 7: Tariff 2L
Variable Load on Power Stations. Introduction of Tariff, different types of tariff. Indian Electricity

Rule – 1956 and 2003: General Introduction.

Text Books:

1. Electrical Power System, Subir Roy, Prentice Hall
2. Power System Engineering, Nagrath & Kothery, TMH
3. Elements of Power System Analysis, C.L. Wadhwa, New Age International.
4. Electrical Power System, Ashfaq Hussain, CBS Publishers & Distributors
5. Principles of Power System, V. K. Mehta and Rohit Mehta, S. Chand.

Reference Books:

1. Electric Power Transmission & Distribution, S. Sivanagaraju, S. Satyanarayana, Pearson Education.
2. A Text book on Power System Engineering, Soni, Gupta, Bhatnagar & Chakrabarti, Dhanpat Rai & Co.
3. Power System Protection and Switchgear, Badri Ram, TMH
4. Electric Power Distribution System Engineering, 2nd Edition, T. Gonen, CRC Press.
5. www.powermin.nic.in/acts notification/pdf/ier1956.pdf.

Course Name: Power Electronics
Course Code: EE503
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Concept of Basic Electronics, Electrical Circuit Analysis, Analog Electronics.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Demonstrate the characteristics of different power electronic switches along with their turn-on, turn-off, triggering and protection circuits.
- **CO2.** Analyse various power converter circuits.
- **CO3.** Understand the use of power converters in commercial and industrial applications

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	-	-	-	-	-	-	-	-
CO2	2	3	2	-	-	-	-	-	-	-	-	-
CO3	2	-	2	2	1	-	-	-	-	-	-	-

Course Content

Module 1: Power Electronic Switching Devices **8L**

Advances in Power Electronics Power Semiconductor Switches: Rectifier diodes, fast recovery diodes, Schottky barrier diode, BJT, Power MOSFET, SCR, TRIAC, IGBT, IGCT and GTO. Ratings, Static and Dynamic Characteristics, triggering and switching characteristics and cooling. SCR turn–on and turn-off methods, Triggering circuits, SCR Commutation circuits, SCR Series and Parallel operation, Snubber Circuit.

Module 2: Uncontrolled and Controlled Rectifiers **8L**

Single-Phase and Three-Phase Uncontrolled rectifiers.
Phase controlled Rectifiers: Principle of operation of single phase and three phase semi-controlled, full controlled converters with R, R-L and RLE loads. Effects of source inductance on the performance of converters. Performance parameters of converters, Dual converters, Solution of problems.

Module 3: DC-DC Converters **5L**

Principle of operation, control strategies, Step up and Step-down choppers, Buck, Boost, Buck - Boost Converters, Quadrant operation of DC-DC converters.

Module 4: Inverters **8L**

Inverters: Principle of operation of single-phase inverter, 120° and 180° conduction mode of operation of three phase inverter, performance parameters of inverters, PWM techniques, sinusoidal PWM, modified Sinusoidal PWM - multiple PWM Voltage and Current Sources Inverter.

Module 5: Cycloconverters and AC Voltage Regulators **4L**

AC Voltage Controllers, Single phase and three phase Cyclo-conveters.

Module 6: Applications **3L**

UPS (Online and Offline), SMPS, Battery Chargers. Electric Vehicle, FACTS.

Text Books:

1. L. Umanand, Power Electronics: Essentials and Applications.
2. M. H. Rashid, Power Electronics, PHI/ Pearson Education.
3. P. S. Bhimra, Power Electronics, Khanna Publications.
4. K. Hari Babu: Power Electronics

Reference Books:

1. C.W. Lander, Power Electronics, McGraw Hill.
2. B. K. Bose, Modern Power Electronics, JAICO.
3. Mohan, N Undeland, TM & Robbins, WP- Power Electronics, John Wiley & Sons.

Course Name: Renewable Energy – I
Course Code: EE504A
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: Basic Electronics, Fundamental Concepts of Electrical Machines, Mathematics, Physics.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Identify the fundamental principle solar and wind power generation.
- **CO2.** Classify different features of solar cells and wind generators.
- **CO3.** Apply solar and wind power integration with existing network.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	3	-	-	-	-	-	1	1
CO2	3	3	2	2	2	-	-	-	-	-	2	2
CO3	3	3	2	-	2	-	-	-	-	-	-	-

Course Content

Module 1: Solar Radiation **4L**

The sun to earth transaction of solar energy, Study of wavelength of solar radiation spectra, Spectrum of electromagnetic radiation, Concept of extraterrestrial radiation, solar constant, air mass, beam, diffused and total solar radiation, Spectral distribution of solar spectrum, Solar geometry covering all parameter related to the position of the sun with respect to observer; Instruments for measurement of solar energy (Pyranometer/Pyrheliometer/ sunshine recorder/Lux meter), Depletion of solar radiation – absorption, scattering; beam radiation, diffuse and Global radiation; measurement of solar radiation; solar time – local apparent time (LAT) .

Module 2: Solar photovoltaic System **6L**

P-N junction, Space charge region, Energy band Diagram, P-N junction potential, width of depletion region, carrier movements and current densities, generation of photovoltage, light generated current, I-V equation of solar cells, Solar cell characteristics, Losses in solar cells, Design specification of solar cells, Types of solar cells, Solar PV module and array, Shading impact: Bypass diode, blocking diode, Maximum Power Point Tracking (MPPT) algorithms, Converter Control.

Module 3: Solar Thermal Power Generation **5L**

Principles of heat and mass transfer, Basic of Solar Thermal Conversion, Efficiency and Testing of flat plate collectors, Analysis of Parabolic trough, central receivers, parabolic dish collectors, Concept of solar pond, solar water heater, solar passive heating and cooling system, Solar industrial heating system, solar refrigeration and air conditioning, solar cookers, solar furnaces, solar green house, solar dryer, solar distillation.

Module 4: Introduction to Wind Power **4L**

History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind Turbine Aerodynamics, Wind Turbine Types and their construction, Major applications of Wind Power, Environmental Aspects of wind power, merits and demerits, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent-Magnet Synchronous Generators, Power electronics converters.

Module 5: Different configurations of Solar and Wind Power 5L

Standalone PV system configurations (with different types of loads e.g. DC, with battery and DC, AC/DC, battery and AC/DC), Grid connected system without energy storage, Load characteristics, Applications of PV System: Direct coupled, Grid connected, Stand alone, Hybrid system, PV System Economics. Constant Speed Constant Frequency (CSCF), Variable Speed Constant Frequency System (VSCF), Variable Speed Variable Frequency System (VSVF).

Text Books:

1. C. S. Solanki Solar Photovoltaics, PHI Learning, 2011
2. G. M. Masters, "Renewable and Efficient Electric Power Systems", John Wiley and Sons, 2004.
3. J N Roy, D.N Bose,Photo Voltaic Science And Technology, Cambridge University,Press (2018)
4. S. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill, 1984.
5. H. Siegfried and R. Waddington, "Grid integration of wind energy conversion systems" John Wiley and Sons Ltd., 2006.

Reference Books:

1. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004.
2. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes", John Wiley & Sons, 1991.
3. Rao S. and B. B. Parulekar, Energy Technology, Khanna Publishers, 2005.

Paper Name: Embedded System Design
Paper Code: EE504B
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: Concept of Digital Electronics, Microprocessor and Microcontrollers.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** To familiarize with concepts related to the fundamental principles embedded systems design, explain the process and apply it.
- **CO2.** To understand knowledge of the advanced Embedded technology both for hardware and software.
- **CO3.** To understand Hardware/Software design techniques for microcontroller-based embedded systems and apply techniques in design problems.
- **CO4.** To develop Embedded System programming in C and assembly language using Integrated Development Environments and using debugging technique.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	1	-	-	-	-	1	-	1
CO2	3	2	2	-	1	-	1	1	2	1	1	-
CO3	3	2	1	2	1	1	-	-	2	1	-	1
CO4	3	2	2	1	1	1	1	1	2	1	-	1

Course Content

Module 1: Introduction to Embedded System **8L**

Basics of Embedded computer Systems, Microprocessor and Microcontroller difference, Hardware architecture and software components of embedded system List of various applications [Mobile phones, RFID, WISENET, Robotics, Biomedical Applications, Brain machine interface etc.], Difference between embedded computer systems and general-purpose computer Systems. Characteristics of embedded systems, Classifications of embedded system.

Module 2: Hardware Software Co-Design **9L**

Co-Design Types: Microprocessors/Microcontrollers/DSP based Design, FPGA/ASIC/pSOC based Design, Hybrid Design. Methodology: i) System specifications; ii) co-specifications of hardware and software; iii) System Design Languages (capturing the specification in a single Description); iv) System modelling/simulation; v) Partitioning (optimizing hardware/software partition); vi) Co-verification (simulation interaction between custom hardware and processor), Co-implementation; vii) Embedded Systems Design development cycle.

Module 3: Real Time Operating System (RTOS) **5L**

Introduction, Types, Process Management, Memory Management, Interrupt in RTOS, Task scheduling, Basic design using RTOS; Basic idea of Hardware and Software testing in Embedded Systems. Programming concepts and embedded programming in C.

Text Books:

1. Embedded system Design: Peter Marwedel, Springer
2. Embedded Systems - Raj Kamal
3. Embedded Systems - K. Shibu

Reference Books:

1. M. A. Mazidi, J. G. Mazidi and R. D. McKinlay, “The8051 Microcontroller and Embedded Systems: Using Assembly and C”, Pearson Education, 2007.
2. R. Kamal, “Embedded System”, McGraw Hill Education, 2009.
3. K. J. Ayala, “8051 Microcontroller”, Delmar Cengage Learning, 2004. R18 B. Tech EE Page 111 of 128

Paper Name: Utilization of Electric Power
Paper Code: EE504C
Contact: 2L:0T:0P
Credit: 2

Prerequisites: Basic Electrical Engineering and Electrical Machines.

Course Outcome: After successful completion of the course students will be able to

- **CO1.** Demonstrate the working of traction motor and their control under different working conditions.
- **CO2.** Anlyze illumination level for a given application and select the suitable specification for installation.
- **CO3.** Illustrate the working of Electric Heating, welding processes.
- **CO4.** Explain the process of electrolysis.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-
CO3	-	-	3	3	-	-	-	-	-	-	-	-
CO4	-	-	2	3	-	-	-	-	-	-	-	-

Course Content

Module – 1: Electric Traction **9L**

Requirement of an ideal traction system, Supply system for electric traction, Train movement (speed time curve, simplified speed time curve, average speed and schedule speed), Mechanism of train movement (energy consumption, tractive effort during acceleration, tractive effort on a gradient, tractive effort for resistance, power and energy output for the driving axles, factors affecting specific energy consumption, coefficient of adhesion).

Electric traction motor & their control:

Parallel and series operation of Series and Shunt motor with equal and unequal wheel diameter, effect of sudden change of in supply voltage, Temporary interruption of supply, Tractive effort and horse power. Use of AC series motor and Induction motor for traction.

Traction motor control:

DC series motor control, Multiple unit control, Braking of electric motors, Electrolysis by current through earth, current collection in traction system, Power electronic controllers in traction system.

Module – 2: Illumination **6L**

The nature of radiation, Polar curve, Law of illumination, Photometry (Photovoltaic cell, distribution photometry, integrating sphere, brightness measurement).

Types of Lamps:

Conventional and energy efficient, Basic principle of light control, Different lighting scheme and their design methods, Flood and Street lighting.

Module – 3: Electric Heating and Welding **4L**

Types of heating, Resistance heating, Induction heating, Arc furnace, Dielectric heating, Microwave heating.

Module – 4: Electrolytic Processes **3L**

Basic principles, Faraday's law of Electrolysis, Electro deposition, Extraction and refining of Metals, Power supply of Electrolytic processes.

Text Books:

1. T. Starr, “Generation, Transmission and Utilization of Electrical Power”, Pitman.
2. J. B. Gupta, “Utilization of Electric Power & Electric Traction”, S. K. Kataria & Sons.
3. C. L. Wadhawa, “Generation Distribution and Utilization of Electrical Energy”, New Age International Publishers.

Reference Books:

1. H. Partab, “Art and Science of Utilization of Electrical Energy”, Dhanpat Rai & Sons.
2. E. Openahaw Taylor, Orient Longman, “Utilisation of Electric Energy”.

Course Name: Database Management System
Course Code: CS(EE)501A
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: Mathematics, Data Structure, Operating System.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand Database Management System, explain fundamental elements of a database management system, compare the basic concepts of relational data model, entity-relationship model, file organization and use appropriate index structure.
- **CO2.** Apply efficient query optimization techniques, suitable transaction management, concurrency control mechanism and recovery management techniques
- **CO3.** Evaluate a database design and improve the design by normalization
- **CO4.** Design entity-relationship diagrams to represent simple database application scenarios, translate entity-relationship diagrams into relational tables, populate a relational database and formulate SQL queries on the data.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	3	-	-	-	-	2	-	-	-
CO2	2	3	3	3	-	-	-	-	-	-	-	-
CO3	1	3	3	3	-	-	-	-	2	-	-	-
CO4	2	3	3	3	-	-	-	-	2	1	-	2

Course Content

Module 1: Introduction **2L**
Concept & Overview of DBMS, Data Models, Database Languages, Database Administrator, Database Users, Three Schema architecture of DBMS.

Module 2: Entity-Relationship Model **3L**
Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R features.

Module 3: Relational Model **3L**
Structure of relational Databases, Relational Algebra, Relational Calculus, Extended Relational Algebra Operations, Views, Modifications of the Database.

Module 4: SQL and Integrity Constraints **5L**
Concept of DDL, DML, DCL. Basic Structure, Set operations, Aggregate Functions, Null Values, Domain Constraints, Referential Integrity Constraints, assertions, views, Nested Sub queries, Database security application development using SQL, Stored procedures and triggers.

Module 5: Relational Database Design **4L**
Functional Dependency, Different anomalies in designing a Database., Normalization using functional dependencies, Decomposition, Boyce-Codd Normal Form, 3NF, Normalization using multi-valued dependencies, 4NF, 5NF.

Module 6: Internals of RDBMS **4L**
Physical data structures, Query optimization: join algorithm, statistics and cost bas optimization.

Transaction processing, Concurrency control and Recovery Management: transaction model properties, state serializability, lock base protocols, two phase locking.

Module 6: File Organization & Index Structures 3L

File & Record Concept, placing file records on Disk, Fixed and Variable sized Records, Types of Single-Level Index (primary, secondary, clustering), Multilevel Indexes, Dynamic Multilevel Indexes using B tree and B+ tree.

Text Books:

1. Henry F. Korth and Silberschatz Abraham, "Database System Concepts", Mc.Graw Hill.
2. Elmasri Ramez and Novathe Shamkant, "Fundamentals of Database Systems", Benjamin Cummings Publishing. Company.

Reference Books:

1. Raghu Ramakrishnan and Johannes Gehrke, Database Management Systems (3/e), McGraw Hill.
2. Peter Rob and Carlos Coronel, Database Systesm- Design, Implementation and Management (7/e), Cengage Learning.

Course Name: Computer Network
Course Code: CS(EE)501B
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: Basic Digital Communication, Computer Architecture and Operating System.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand the network model and architecture.
- **CO2.** Apply different networking concepts for implementing network solution.
- **CO3.** Analyze different networking functions and features for indentifying optimal solutions.
- **CO4.** Evaluate and implement routing algorithms for implanting solution for the real life problems.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	-	-	-	-	-	-	-	-
CO2	2	3	3	2	-	-	-	-	-	-	-	-
CO3	2	3	2	2	-	-	-	-	-	-	-	2
CO4	2	3	2	2	-	-	-	-	-	-	-	2

Course Content

Module 1: Overview of Data Communication and Networking 4L
Introduction; Data communications: components, data representation (ASCII, ISO etc.), direction of data flow (simplex, half duplex, full duplex); network criteria, physical structure (type of connection, topology), categories of network (LAN, MAN, WAN); Internet: brief history, Protocols and standards; Reference models: OSI and TCP/IP.

Module 2: Physical Level 3L
Overview of data (analog & digital), signal (analog & digital), transmission (analog & digital) & transmission media (guided & unguided); Circuit switching: time division & space division switch, TDM bus; Telephone Network.

Module 3: Data link Layer 5L
Types of errors, framing, error detection & correction methods; Flow control; Protocols: Stop & wait ARQ, GoBack- N ARQ, Selective repeat ARQ, HDLC; Point to Point Protocol, LCP, NCP, Token Ring; Reservation, Polling, Multiple access protocols: Pure ALOHA, Slotted ALOHA, CSMA, CSMA/CD, CSMA/CA Traditional Ethernet, fast Ethernet,

Module 4: Network Layer 4L
Internetworking & devices: Repeaters, Hubs, Bridges, Switches, Router, Gateway; Addressing: IP addressing, subnetting; Routing: techniques, Routing Protocols, ARP, IP, ICMP, IPV6.

Module 5: Transport Layer 5L
Process to Process delivery; UDP; TCP; Congestion Control: Open Loop, Closed Loop choke packets; Quality of service: techniques to improve QoS: Leaky bucket algorithm, Token bucket algorithm.

Module 6: Application Layer 3L

DNS, SMTP, SNMP, FTP, HTTPS, Firewalls, IP Filtering.

Text Books:

1. B. A. Forouzan – "Data Communications and Networking (5th Ed.)" – TMH
2. W. Stallings – "Data and Computer Communications (5th Ed.)" – PHI/ Pearson Education

Reference Books:

1. A. S. Tanenbaum – "Computer Networks (4th Ed.)" – Pearson Education/PHI
2. Black, Data & Computer Communication, PHI
3. Zheng & Akhtar, Network for Computer Scientists & Engineers, OUP

Course Name: Sensors and IoT
Course Code: CS(EE)501C
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: Operating System, Wireless Sensor Networks, Computer Networks, Cryptography, Communication Technology, Python Programming Language, and Cloud computing.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand the basic concepts of Sensors, IoT and its architectures.
- **CO2.** Understand the working principle of different types of sensors and transducers.
- **CO3.** Analyze the connectivity between smart sensors and IoT devices.
- **CO4.** Apply the concepts of IoT to design different smart tools.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1	3	2	1	1	1	1	1	1
CO2	2	2	1	2	2	1	1	1	1	2	1	1
CO3	2	1	1	1	3	2	1	1	1	1	1	1
CO4	2	1	1	1	1	1	1	1	1	1	1	1

Course Content

Module 1: Introduction to sensors and transducers 10L

Principles of sensing & transduction, Measurement system, Classification of sensors, Static characteristics, Dynamic characteristics, Brief on Sensors used for measuring displacements, force, temperature, light, etc. Advanced sensors like Medical Sensors, Neural Sensors, Environmental and Chemical Sensors, Radio Frequency Identification, Actuators.

Module 2: Smart sensors and wireless sensor network 8L

IC temperature Sensor, Electrochemical Gas sensors, Fibre optic sensors- Thick film technology, MEMS sensors, Nano sensors, Integrated Sensors, Multifunctional sensors.
Sensors for intelligent systems- Introduction to Smart sensors and Sensor network. Wireless medium access issues, MAC protocol, Routing protocols.

Module 3: Fundamental of IoT and IoT devices 8L

The Internet of Things, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Design challenges, Development challenges, Security challenges, Other challenges. Brief on available IoT devices in the market.

Module 4: IoT Architecture, M2M and security 4L

Main design principles and needed capabilities, IoT architecture outline, standards, M2M and IoT Technology Fundamentals, Devices and gateways, Challenges: Design challenges, Development challenges, Privacy and Security challenges, Data Management and Other challenges.

Module 5: IoT Applications for Value Creations 6L

Application of IoT: Smart Homes: Smart Appliances, Security and Safety. Smart Energy: Smart Meters, Automatic Meter Reading (AMR), Advanced Metering Infrastructure (AMI), Real Time Pricing, Smart grid, Smart Cities: Smart Vehicles, Smart Lighting, Smart Parking etc.

Text Books:

1. John. P, Bentley, “Principles of Measurement Systems”, III Edition, Pearson Education, 2000
2. Patranabis. D, “Sensors and Transducers”, Prentice Hall of India, 1999.
3. Internet of Things By Rajkamal, Tata McGraw Hill publication

Reference Books:

1. John Brignell,”Intelligent Sensor Systems”, CRC Press; 2nd Revised edition edition,1996.
2. Doebelin. E.A, “Measurement Systems – Applications and Design”, Tata McGraw Hill, New York, 2000.
3. Internet of things(A-Hand-on-Approach) By Vijay Madisetti and ArshdeepBahga1st Edition, Universal Press
4. The Internet of Things: Connecting Objects By Hakima Chaouchi Wiley publication
5. The Internet of Things – Key applications and Protocols By Olivier Hersent, David Boswarthick, Omar Elloumi,, Wiley, 2012

Course Name: Electrical Machines – II Laboratory
Course Code: EE591
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Concepts of Electrical Machines - I.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Perform different tests on Three-Phase A.C. Generators, Synchronous Motors and Single-Phase Induction Motor.

CO2. Interpret the observed result using theoretical knowledge and hence calculate unknown parameters.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	3	-	-	-	-	3	2	-	-
CO2	2	-	-	3	-	-	-	-	3	2	-	-

List of Experiments*:

Group A: Three-Phase Induction Machine

1. Separation of losses in three-phase Induction Motor.
2. Load test of a three-phase wound rotor Induction Motor
3. Speed control of three-phase Induction Motor by V/f constant.
4. To study the performance of Three-Phase Induction generator.
5. Circle diagram of a three-phase Induction Motor.

Group B: Synchronous Machine

6. To observe the effect of excitation and speed on induced e.m.f of a three-phase alternator and plot the O.C.C. of the alternator.
7. Determination of regulation of Synchronous machine by Synchronous Impedance method.
8. To determine the direct axis resistance [Xd] and quadrature reactance [Xq] of a 3-phase synchronous machine by slip test.
9. Parallel operation of three-phase Synchronous generators / existing supply system.
10. V-curve of Synchronous motor.

Group C: Low HP Motors

11. Identification of different types of low HP motors.
12. Determination of equivalent circuit parameters of a single-phase Induction motor.
13. Load test on single-phase Induction motor to obtain the performance characteristics.
14. To study the effect of capacitor on the starting and running condition of a Single-Phase Induction motor and to determine the method of reversing the direction of rotation.
15. Load Test on Universal Motor.

N.B. Other than above experiments, one innovative experiment has to be conducted in the laboratory.

* ***Maximum Three experiments to be conducted from each group.***

Course Name: Power System – I Laboratory
Course Code: EE592
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Concepts of Power System.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Demonstrate performance of transmission line and distribution line.
- **CO2.** Construct line support for a particular transmission line.
- **CO3.** Evaluate different methods of active and reactive power control.
- **CO4.** Solve the reliability of different components of transmission line and distribution line.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	-	2	-	-	-	-	2	2
CO2	2	-	3	1	-	-	-	-	-	-	2	3
CO3	2	3	-	3	-	-	-	-	-	-	2	2
CO4	2	3	-	3	-	-	-	-	-	-	2	2

List of Experiments:

1. Draw the schematic diagram of structure of power system and power transmission line and symbol of electrical equipment.
2. Simulation of DC distribution by network analyzer.
3. Measurement of earth resistance by earth-tester.
4. Measurement of dielectric strength of insulating oil.
5. Measurement of dielectric strength of solid insulating material.
6. Different parameter calculation by power circle diagram.
7. Study of different types of insulator.
8. Determination of the generalized constants A, B, C, D of long transmission line.
9. Active and reactive power control of alternator.
10. Study and analysis of an electrical transmission line circuit with the help of software.
11. Dielectric constant tan-delta, resistivity test of transformer oil.
12. Any innovative experiment according to knowledge of Power System – I.

Course Name: Power Electronics Laboratory
Course Code: EE593
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Concept of Basic Electronics, Electrical Circuit Analysis, Analog Electronics.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Analyse the response of any power electronics devices.
- **CO2.** Troubleshoot the operation of a power electronics circuit.
- **CO3.** Choose suitable power electronic devices for any given application.
- **CO4.** Know how to control and convert output signal as per requirements.
- **CO5.** Develop any power electronics circuits as needed in operation.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	1	-	-	-	-	-	-	-	-
CO2	-	1	-	2	-	-	-	-	-	-	-	-
CO3	2	1	-	2	-	-	-	-	1	-	-	-
CO4	2	-	-	2	-	-	-	-	1	-	-	-
CO5	2	1	-	2	-	-	-	-	-	-	-	-

List of Experiment (At least *ten* experiments to be performed):

1. Study of the characteristics of an SCR.
2. Study of the characteristics of a TRIAC
3. Study of different triggering circuits of an SCR.
4. Study of the operation of a single phase full controlled bridge converter with R and R-L load.
5. Study of performance of single phase half controlled symmetrical and asymmetrical bridge converters.
6. Study of performance of three phase six pulse controlled bridge converters.
7. Study the performance of step down chopper.
8. Study the performance of step up chopper.
9. Study the performance of single-phase inverter with 180° conduction mode of operation.
10. Study of performance of single phase controlled converter with and without source inductance (Simulation).
11. Study of performance of step up and step down chopper with MOSFET, IGBT and GTO as switch (simulation).
12. Study of performance of single phase half controlled symmetrical and asymmetrical bridge converter (Simulation).
13. Study of performance of three phase controlled converter with R & R-L load (simulation).
14. Innovative Experiments.

Course Name: Electrical Workshop
Course Code: EE594
Contact: 0L:0T:2P
Credit: 1

Prerequisite: Concepts of Basic Electrical Engineering, Electric circuit, Measurements, Power electronics.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Implement the theoretical and practical knowledge and skills gained through various subjects/courses into an application suitable for a real practical working environment, preferably in an industrial environment.

CO2. Develop software packages or applications and implement these for the actual needs of the community/industry. Identify and contrast gap between the technological knowledge acquired through curriculum and the actual industrial need and to compensate it by acquiring additional knowledge as required.

CO3. Carry out cooperative learning through synchronous guided discussions within the class in key areas, asynchronous document sharing and discussions, as well as prepare collaborative edition of the final project report.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	-	-	-	-	1	-	2	-
CO2	-	-	3	-	2	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	3	-	-	-

List of Experiments*:

1. Design and winding of small power transformers, Induction motor winding (squirrel cage type).
2. Speed control techniques using thyristor.
3. Battery design and its maintenance.
4. Energy management Techniques.
5. Dynamic models of Electrical machine.
6. Solar based cooker, lamp, water heater etc. & Solar operated vehicles.
7. Remote control operated Electrical devices.
8. Advanced energy meter.
9. Design of Illumination techniques using advanced luminaries etc.
10. Dynamic models of Electrical Machine.
11. PLC and Microprocessor based project.
12. Repair of electrical apparatus coil.
13. Wiring of relay circuits;
14. Computer maintenance
15. Any other related area found worth.

* ***Following are the suggestive areas of project work***

Course Name: Database Management System Laboratory
Course Code: CS(EE)591A
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Knowledge about the basics of electronics and basic concepts in logic design, basic knowledge of data structure and programming concept.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Design and implement a database schema for a given problem-domain
- **CO2.** Create and maintain tables using PL/SQL Course Outcome
- **CO3.** Populate and query a database
- **CO4.** Application development using PL/SQL & front end tools

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	3	3	2	-	-	-	-	-	-	-
CO2	-	-	3	3	2	-	-	-	2	-	-	-
CO3	2	-	3	3	2	-	-	-	-	2	-	-
CO4	2	-	3	3	2	-	-	-	-	-	-	2

List of Experiments:

1. Study of Backend Tool – Oracle.
2. Data Definition Language (DDL) commands in RDBMS.
3. Data Manipulation Language (DML) and Data Control Language (DCL) commands in RDBMS.
4. High-level language extension with Cursors.
5. High level language extension with Triggers
6. Procedures and Functions.
7. Embedded SQL.
8. Database design using E-R model and Normalization.
9. Mini project (Application Development using Oracle and Visual Basic)
   i. Inventory Control System.
   ii. Material Requirement Processing
   iii. Hospital Management System
   iv. Railway Reservation System
   v. Personal Information System
   vi. Web Based User Identification System
   vii. Time-table Management System

Text Books:

1. ORACLE PL/SQL by example. Benjamin Rosenzweig, Elena Silvestrova, Pearson Education 3rd Edition.

Reference Books:

1. ORACLE DATA BASE LOG PL/SQL Programming SCOTT URMAN, Tata Mc- Graw Hill.
2. SQL & PL/SQL for Oracle 10g, Black Book, Dr. P. S. Deshpande.

Course Name: Computer Network Laboratory
Course Code: CS(EE)591B
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Basic Computer Architecture and Operating System.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand and apply different network commands.
- **CO2.** Analyze different networking functions and features for implementing optimal solutions.
- **CO3.** Apply different networking concepts for implementing network solution.
- **CO4.** Implement different network protocols.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	3	-	-	-	-	-	-	-
CO2	3	2	2	3	3	-	-	-	-	-	-	-
CO3	3	2	2	3	3	-	-	-	-	-	-	2
CO4	3	2	2	3	3	-	-	-	-	-	-	2

List of Experiments:

1. Familiarization with: Different networking cables, Different connectors, Hubs, Switches, Routers
2. NIC Installation & Configuration (Windows/Linux)
3. Understanding IP address, subnet etc, Connect the computers in Local Area Network.
4. Study of basic Network Configuration commands.
5. Configure a Network topology using packet tracer software
6. Link Layer Error Detection Mechanism (Cyclic Redundancy Check), Data Link Layer Error Control mechanism (Selective Repeat, Go Back N)
7. Implementation of Data Link Layer Flow Control Mechanism (Stop & Wait, Sliding Window), Data
8. Server Setup/Configuration: FTP, TELNET, NFS, DNS, Firewall.
9. TCP/UDP Socket Programming: Simple, TCP based, UDP based Multicast & Broadcast Sockets

Text Books:

1. B. A. Forouzan – "Data Communications and Networking (5th Ed.) " – TMH
2. W. Stallings – "Data and Computer Communications (5th Ed.)" – PHI/ Pearson Education

Reference Books:

1. A. S. Tanenbaum – "Computer Networks (4th Ed.)" – Pearson Education/PHI
2. Black, Data & Computer Communication, PHI
3. Zheng & Akhtar, Network for Computer Scientists & Engineers, OUP

Course Name: Sensors and IoT Laboratory
Course Code: CS(EE)591C
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Operating System, Wireless Sensor Networks, Computer Networks, Cryptography, Communication Technology, Python Programming Language, and Cloud computing.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Understand the basic concept of Sensors, IoT devices.
CO2. Built IoT environment and interface it with smart sensing devices.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	1	-	-	2	1	2	1
CO2	3	3	3	3	3	1	-	-	2	1	2	1
CO3	3	3	3	3	3	1	-	-	2	1	2	1
CO4	3	3	3	3	3	1	-	-	2	1	2	1

List of Experiments:

1. Familiarization with sensors and transducers used to measure displacements, force, temperature, light, etc.
2. Familiarization with advanced/ smart sensors like Medical Sensors, Neural Sensors, Environmental and Chemical Sensors, Radio Frequency Identification, Actuators.
3. Familiarization with IoT enabled embedded boards like Arduino, Node MCU, Raspberry Pi, etc.
4. Familiarization with the IoT environment using IDE and Python.
5. Interacting of embedded boards with smart sensing devices like medical sensors, gas sensors, integrated sensors.
6. Establish the serial communication between smart devices and PC.
7. Perform experiment to measure sensing parameters and store the data in IoT environment.
8. Switch Light On And Off Based On The Input Of User Using Raspberry Pi
9. Extramural Experiments.

3rd Year 6th Semester									
Sl. No.	**Broad Category**	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG	Major	EE601	Electric Drives	3	0	0	3	3
2	ENGG	Major	EE602	Power System – II	3	0	0	3	3
3	ENGG	Major	EE603	PLC and Automation	2	0	0	2	2
4	ENGG	Major	EE604A	Line Commutated and Active Rectifiers	2	0	0	2	2
			EE604B	Energy Conservation and Audit					
			EE604C	Electrical Machine Design					
5	ENGG	Minor	CS(EE)601	Artificial Intelligence and Machine Learning	2	0	0	2	2
			ECS(EE)601	Bio-Medical Instrumentation					
			EC(EE)601	Analog and Digital Communication					
B. Practical									
6	ENGG	Major	EE691	Electric Drives Laboratory	0	0	3	3	1.5
7	ENGG	Major	EE692	Power Systems – II Laboratory	0	0	3	3	1.5
8	ENGG	Major	EE693	PLC and Automation Laboratory	0	0	2	2	1
9	ENGG	Skill Enhancement Courses	EE694	Dissertation on Design and Development - II	0	0	3	3	1.5
10	HUM	Ability Enhancement Courses	HU(EE)691	Soft Skill and Aptitude	0	0	2	2	1
11	PROJ	Internship†	EE681	Seminar on Industrial Training / Internship	0	0	0	0	2
Total for Theory and Practical								**25**	**20.5**

† Students have to complete Internship/Vocational Training at the Industry to earn Credit point subjected to appear in the Seminar and submission of Certificate(s).

Course Name: Electric Drives
Course Code: EE601
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Concept of Electrical Machines, and Power Electronics

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand the concept, characteristics, application fields and development trend of electric motor required for a Power Drives System
- **CO2.** Understand different types of braking and speed-control of electric motors for various applications.
- **CO3.** Analyze the converter fed motor under different torque/speed conditions.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	-	-	-	-	-	-	-	-
CO2	1	3	2	-	1	-	-	-	1	-	-	1
CO3	1	3	2	-	1	-	-	-	1	-	-	1

Course Content

Module 1: Fundamental Concept of Electric Drive **4L**
Definition and concept of electric drive and its block diagram, Concept of Multi-quadrant operation, concept of load torque.

Module 2: Electric Braking (concept only) **4L**
Electric Braking of AC Drive (Induction motor drive and synchronous motor drive)

Module 3: Selection of motor power rating (concept only) **4L**
Thermal model of motor for heating and cooling (equation and problems), classes of motor duty, determination of motor rating for continuous, short time and intermittent duty, Load equalization (concept only)

Module 4: DC Motor Drives **6L**
Ward-Leonard System, Single phase and three phases controlled DC drives (two quadrant operation and steady state analysis), Dual converter control of DC drives. Two and Four quadrant dc motor drive.

Module 5: Induction Motor Drives **7L**
Stator voltage control, V/f controlled induction motors, Slip power recovery, VSI (Full bridge inverter operation, constant slip speed control, constant air gap flux control, torque pulsation, control harmonics, flux weakening operation) and CSI fed induction motor drives, vector controlled induction motor drive

Module 6: Synchronous Motor Drives **7L**
Synchronous machine variable speed drive, Variable frequency control, Sinusoidal SPM machine drives, synchronous reluctance machine drives, wound field synchronous motor drive, Load-commutated Synchronous Motor Drives, Model of PMSM.

Module 7: Stepper Motor and Energy conservation in drives 4L

Solar and battery powered drives, Stepper motor Drive, Energy Efficient operation and power factor improvement of drives.

Text Books:

1. G. K. Dubey, Fundamentals of Electrical Drives, Narosa, 2001.
2. R. Krishnan, Electric Motor Drives: Modeling, Analysis and Control, PHI-India, 2005.
3. N. K. De and P. K. Sen, Electric Drives, Prentice Hall of India Private Limited, 2006.
4. S. K. Pillai, A First Course on Electrical Drives, New Age International.
5. S. B. Dewan, G. R. Slemon and A. Straughen, Power Semiconductor Drives, John Wiley and Sons, New York 1984.

Reference Books:

1. G. K. Dubey, ―Power Semiconductor Controlled Drives‖, Prentice Hall international, New Jersey, 1989.
2. B. K. Bose, ―Modern Power Electronics and AC Drives, Pearson Education Asia, 2003.

Course Name: Power System – II
Course Code: EE602
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisites: Basic Electrical Engineering, Circuit Theory, Electrical Machines – II, Power System – I.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Learn about advance structure of Power System.
- **CO2.** Get depth knowledge of different types of power system protection, fault, stability analysis and load flow method.
- **CO3.** Design and analysis of different types of substation and implement these ideas in industry or real life problem solve.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	3	-	-	-	-	-	-	-	1
CO2	-	3	2	3	-	-	-	-	-	-	-	1
CO3	3	-	2	-	-	2	-	-	-	-	-	1

Course Content

Module 1: Representation of Power System Components **4L**

Single-phase representation of balanced three phase networks, the one-line diagram and the Impedance or reactance diagram, per unit (PU) system.

Distribution substation: Types of substations, location of substations, substation equipments and accessories, Earthling (system and equipment), feeder and distributors, radial and loop systems.

Module 2: Basic Idea of Real and Reactive Power Control **2L**

Introduction to Real and Reactive Power Control (SMIB)Single machine connected to Infinite Bus.

Module 3: Load Flow Studies **7L**

Network model formulation, formation of Ybus, load flow problem, Gauss-Siedel method, Newton-Raphson method, Decoupled load flow studies with flowchart, comparison of load flow methods.

Module 4: Power System Stability **4L**

Steady state stability, transient stability, equal area criteria, swing equation, multi machine Stability concept, Introductory idea of Voltage Stability and Voltage Collapsed.

Module 5: Faults in Electrical Systems **7L**

Transient on a transmission line, short circuit of a synchronous machine under no load and Loaded condition. Symmetrical component transformation, sequence impedance and sequence network of power system, synchronous machine, transmission lines and transformers. Symmetrical component analysis of unsymmetrical faults, L-G fault, L-L fault, L-L-G fault.

Module 6: Power System Protection **12L**

i) Operating Principles and Relay Constructions: ***6L***

Functions of Protective Relaying, different terminologies used in protective relaying, Basic Operation of Relay, Electromagnetic Attraction Relays (Plunger Type, Hinged Armature Type,

Balanced Beam Type, Polarized Moving Iron Type), Advantages and Disadvantages, Applications of Electromagnetic Attraction Relays, Electromagnetic Induction Type Relays, Theory of Induction Relay Torque, Induction Type Over Current Relay (Non-Directional), Induction Type Directional Power Relay, Directional Over Current Relay, Distance Relay (Impedance Relays, Reactance Relay, MHO Relay), Differential Relay (Current Differential Relay, Voltage Balance Differential Relay) Translay Relay, Directional Relay (Single Phase Directional Relays), Negative Sequence Relays, Under Frequency Relays, Over Current Relays, Static Relays (Transductor Relays, Rectifier Bridge Relays, Transistors Relays, Hall Effect Relays, Gauss Effect Relays). Over Current Relays (Static Time Over Current Relays, Directional Static Over Current Relay), Static Differential Relay, Static Distance Relays, Microprocessor Based Relays, Universal Relay Torque Equations, Protection Scheme for Transformer, Generators and Motors, Bus Zone Protection, Protection of Transmission Lines, C.T.s and P.T.s and their applications in the protective schemes. Static Relays and Numerical Protections.

ii) Construction and operating principle of circuit Breaker: 6L

Brief description of Circuit Breakers, Operating principle of Circuit Breaker, Arc Phenomenon, Principles of Arc Extinction, Methods of Arc Extinction, Voltage Breaking Transients, Transient Recovery Voltage, Current Chopping and Resistance Switching, Circuit Breaker Rating, Arc and Arc Extinction, Circuit Breaker Types, Oil Circuit Breaker, Vacuum Circuit Breaker, Air Blast Circuit Breaker, SF_6 Circuit Breaker and Operating Mechanism, Advantages and Disadvantages of Different Types of Circuit Breakers. Testing of Circuit Breakers.

Text Books:

1. Electrical Power System, Subir Roy, Prentice Hall
2. Power System Engineering, Nagrath & Kothary, TMH
3. Elements of power system analysis, C.L. Wodhwa, New Age International.
4. Electrical Power System, Ashfaq Hussain, CBS Publishers & Distributors
5. Principles of Power System, V.K. Mehta and Rohit Mehta, S.Chand.
6. A Course in Power Systems, J.B. Gupta, S.K. Kataria & Sons.

Reference Books:

1. Electric Power transmission & Distribution, S.Sivanagaraju, S.Satyanarayana, Pearson Education.
2. A Text book on Power system Engineering, Soni, Gupta, Bhatnagar & Chakrabarti, Dhanpat Rai & Co.
3. Power System Protection and Switchgear, Badri Ram, TMH
4. Electric Power distribution system Engineering, 2nd Edition, T. Gonen, CRC Press.
5. www.powermin.nic.in/acts_notification/pdf/ier1956.pdf

Course Name: PLC and Automation
Course Code: EE603
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisites: Knowledge of Process Control Course.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Understand the operational functions of PLC, DCS, and SCADA.
CO2. Analyze Industrial Networking, Networking protocols, and topologies.
CO3. Demonstrate competence in maintaining and troubleshooting technology, detecting more serious problems, generating workable solutions to correct deviations, and recognizing when to get additional help.
CO4. Analyse the automation technologies in different types of plants

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1	3	2	1	1	1	1	1	1
CO2	2	2	1	2	2	1	1	1	1	2	1	1
CO3	2	1	1	1	3	2	1	1	1	1	1	1
CO4	2	1	1	1	1	1	1	1	1	1	1	1

Course Content

Module 1: Introduction to Plant Automation 7L

Architecture, Recapitulation Basic Components and Functions of DCS, PLC, HMI (OS and ES); ISO/OSI Reference Model; TCP/IP Basics, Industrial Ethernet, Fieldbus, Network Access Protocols, Network Topology, and Arbitration Methods; Computer Integrated Processing; OPC and OLE Connectivity Network topology, OSI reference model, TCP/IP Basics, UDP, IP, OPC, Data connectivity issues in the pre-OPC period. A client-server software architecture using OPC, OPC protocols, OPC UA.

Module 2: Plant Automation System network Elements of Plant Automation System (PAS) 8L

Smart Sensors, Sensor networks, Intelligent actuators, SCADA systems, I/O Modules (wired and wireless), RTUs, AS-Interface. Safety Interlocks, Sequence Controls PAS network and typical system architecture using the above elements PAS developed into MES (manufacturing execution systems) integrated with high-level software.

Module 3: Automation Solutions 4L

PLC-based systems; HMI and SCADA-based systems PC-based automation systems, Safety in industries. FIELDBUS: Cloud and Edge computing – their difference, Bridging the OT and IT world, Types of IoT networks, Seven-layer IoT architecture, IoT addressing Concept of Fieldbus, Advantages, Types, Topology, HART, Foundation Fieldbus: H1 and HSE, OSI reference model, DLL: MAC, LAS, Redundancy. PROFIBUS: Types, Cyclic & Acyclic communication, Slave to slave communication, Bus access method in PROFIBUS PA. MODBUS: Communication stack, Network architecture Intrinsically Safe Fieldbus Systems: Types Wireless Fieldbuses: WHART and ISA 100.11a.

Module 4: IIOT **5L**

Introduction, What is IoT, What is IIoT, Differences between IoT and IIoT, Evolution of IIoT, Architecture of IIoT, IIoT Characteristics, IIoT Platform, IIoT Protocols, Application Areas of IIoT, Challenges: Adaptability, Scalability, Security; Benefits of IIoT.

Text Books:

1. Process Automation Handbook: A Guide to Theory and Practice. J LOVE, Springer 2007
2. Overview of Industrial Process Automation, KLS Sharma, Elsevier, 2011
3. Automation Made Easy, P. G. Martin & H. Gregory, ISA, 2009

Reference Books:

1. Fieldbus and Networking in process automation, CRC Press, 2nd edition, 2021
2. Industrial Automation, Circuit Design and components, D W Pessen
3. Serial Networked Field Instrumentation, JR Jordan, Wiley Series - Measurement Science and Technology
4. Springer Handbook of Automation

Paper Name: Line Commutated and Active Rectifiers
Paper Code: EE604A
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisites: Concept of Transformers and Power Electronic Converters.

Course Outcomes: After successful completion of the course students will be able to

- **CO1.** Analyse controlled rectifier circuits.
- **CO2.** Understand the operation of line-commutated rectifiers – 6 pulse and multi-pulse configurations.
- **CO3.** Understand the operation of PWM rectifiers – operation in rectification and regeneration modes and lagging, leading and unity power factor model.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	-	-	-	-	-	-	-	3
CO2	3	2	1	2	2	-	-	-	-	-	-	3
CO3	3	2	2	3	-	-	-	-	-	-	-	3

Course Content

Module 1: Diode and Phase-Controlled Rectifiers with passive filtering 7L
single-phase full-wave diode rectifier with L, C and LC filter; 3-phase diode rectifier with L, C and LC filter; continuous and discontinuous conduction, input current waveshape. single-phase thyristor rectifier with L and LC filter; 3-phase thyristor rectifier with L and LC filter; continuous and discontinuous conduction, input current waveshape.

Module 2: Multi-Pulse converter 4L
Review of transformer phase shifting, generation of 6-phase AC voltage from 3-phase AC, 6-pulse converter and 12-pulse converters with inductive loads, steady state analysis, commutation overlap, notches during commutation.

Module 3: Single-phase AC-DC single-switch boost converter 3L
Review of DC-DC boost converter, power circuit of single-switch AC-DC converter, steady state analysis, unity power factor operation, closed-loop control structure.

Module 4: AC-DC bidirectional boost converter 4L
Review of 1-phase inverter and 3-phase inverter, power circuits of 1-phase and 3-phase ac-dc boost converter, steady state analysis, operation at leading, lagging and unity power factors. Rectification and regenerating modes.

Module 5: Isolated single-phase AC-DC flyback converter 6L
DC-DC flyback converter, output voltage as a function of duty ratio and transformer turns ratio. Power circuit of AC-DC flyback converter, steady state analysis, unity power factor operation.

Text Books:

1. G. De, “Principles of Thyristorised Converters”, Oxford & IBH Publishing Co, 1988.
2. J. G. Kassakian, M. F. Schlecht and G. C. Verghese, “Principles of Power Electronics”, Addison-Wesley, 1991.
3. L. Umanand, “Power Electronics: Essentials and Applications”, Wiley India, 2009.

Reference Books:

1. N. Mohan and T. M. Undeland, “Power Electronics: Converters, Applications and Design”, John Wiley & Sons, 2007.
2. R. W. Erickson and D. Maksimovic, “Fundamentals of Power Electronics”, Springer Science & Business Media, 2001.

Paper Name: Energy Conservation and Audit
Paper Code: EE604B
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: Concept of Electrical Machines, Power System and Power Electronics.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Learn about Energy Conservation and its benefits
- **CO2.** Learn Life Cycle costing of Electrical Appliances
- **CO3.** Learn about Energy auditing
- **CO4.** Learn about Supply and Demand Side Management
- **CO5.** Learn about the role of Smart Grid and Energy Control Centers.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	3	-	-	-	-	-	-
CO2	2	2	-	2	3	-	3	2	2	1	-	-
CO3	3	-	-	-	-	2	-	2	3	2	3	-
CO4	3	2	2	3	2	-	-	-	-	-	-	2
CO5	2	-	-	3	3	-	3	-	-	-	-	2

Course Content

Module 1: Energy Conservation and Environment **3L**

Electricity Act 2003, Integrated Energy Policy. Energy and environment, Air pollution, Climate change, United Nations Framework Convention on climate change (UNFCCC), Montreal Protocol, Kyoto Protocol, Clean Development Mechanism (CDM), CDM methodology and Procedures, Sustainable development.

Module 2: **7L**

Electrical Systems (2L): Supply & Demand Side, Economic operation, Input-Output curves, Electricity tariff types; Case Study 1;

Cogeneration (1L): Types and Schemes;

Energy auditing (3L): Load profiling; Case Study 2; Necessity of Energy audit, Types of energy audit, Energy audit instruments; Case Study 3; Energy Conservation Act-2001 and its features, Notification Under the act, Designated agencies, Schemes of Bureau of Energy Efficiency (BEE); Intervals of EA regulation;

Energy Economics (1L): Economic assessment and Economic methods for specific energy analysis; Case study 4

Module 3: **7L**

Electric Motors & Energy Conservation (4L): Energy efficient controls and starting efficiency - Electric Motors; Energy efficient /high efficient Motors; Case study 5; Load Matching and selection of motors; Case Study 6; Variable speed drives; Case study 7; Pumps and Fans-Efficient Control strategies; Case study 8;

Electric loads & Energy conservation measures (3L): Air conditioning & Refrigeration, Cold storage-Types-Optimal operation-case study 9; Electric water heating-Geysers-Solar Water Heaters-Power Consumption in Compressors, Energy conservation measures; Electrolytic Process.

Module 4: Electrical Demand Side Management (DSM) 4L

Reactive Power management-Capacitor Sizing-Degree of Compensation; Case study 10; Peak Demand controls-Methodologies-Types of Industrial loads-Optimal Load scheduling -Case study 11; Lighting- Energy efficient light sources-Energy conservation in Lighting Schemes- Electronic ballast-Power quality issues-Luminaries, case study 12;

Module 5: 3L

Smart Grid Technologies in Energy Conservation (2L): Plug In Hybrid Electric Vehicles (PHEV); Microgrids; Home Energy Management Systems (HEMS); Electrical Energy Storage Technologies; ***Computer Controls (1L):*** Hardware, Software-EMS

Text Books:

1. Leon K. Kirchmayer, "Economic Operation of power system", Wiley India Pvt Ltd, July 2010.
2. Timothy J. E. Miller, "Reactive power control in electric systems", Wiley edition, August 2010
3. Albert Thumann, P.W, Plant Engineers and Managers Guide to Energy Conservation" TWI Press Inc, Terre Haute, 9th edition, 2008
4. Turner, Wayne C., "Energy Management Handbook", Lilburn, The Fairmont Press, 2001
5. Anthony J. Pansini, Kenneth D. Smalling, "Guide to Electric Load Management", Pennwell Pub,1998
6. Albert Thumann, "Handbook of Energy Audits", Fairmont Pr; 5th edition,1998
7. Howard E. Jordan, "Energy-Efficient Electric Motors and Their Applications", Plenum Pub Corp; 2nd edition 1994

Reference Books:

1. Jean-Claude Sabonnadi Are, "Low emission power generation technologies and energy management", John Wiley & Sons, August 2010
2. Ursula Eicker, "Low energy cooling for sustainable buildings", John Wiley & Sons, August 2010
3. Francois, Leveque, "Transport pricing of electricity networks", Springer 2003.
4. Giovanni Petrecca, "Industrial Energy Management: Principles and Applications", The Kluwer international series -207,1999 Springer 2000.
5. Parasiliti F., P. Bertoldi, "Energy Efficiency in motor driven systems", Springer, 2003.
6. Donald R. W., "Energy Efficiency Manual", Energy Institute Press,2000
7. Petrecca, Giovanni, "Industrial Energy Management", Springer 1993
8. IEEE Bronze Book- "Recommended Practice for Energy Conservation and cost effective planning in Industrial facilities", IEEE Inc, USA.,1985
9. NESCAP-Guide Book on Promotion of Sustainable Energy Consumption

Paper Name: Electrical Machine Design
Paper Code: EE604C
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: Concept of Basic Electrical Engineering, Engineering Mathematics and Electrical Machines, Computer Aided Design.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Select appropriate design parameters according to applications and rating of electrical machines.
- **CO2.** Design the AC machines as per the given specifications.
- **CO3.** Evaluate the performance parameters of electrical machines using design parameters.
- **CO4.** Formulate the optimum design problem and solve it with computer aided tools.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	3	-	-	-	-	-	-
CO2	2	2	-	2	3	-	3	2	2	1	-	-
CO3	3	-	-	-	-	2	-	2	3	2	3	-
CO4	3	2	2	3	2	-	-	-	-	-	-	2

Course Content

Module 1: Introduction **6L**

Major considerations in electrical machine design, Materials: Conducting, magnetic and insulating materials, Space factor, Choice of specific electrical and magnetic loadings, Thermal considerations, Heat flow, Temperature rise.

Module 2: Design of Transformers **8L**

Sizing of a transformer, Main dimensions, kVA output for single- and three-phase transformers, Window space factor, Overall dimensions, Operating characteristics, Voltage regulation, No load current, Temperature rise in transformers, Design of cooling tank, Methods for cooling of transformers, Design of Chokes.

Module 3: Design of Three-Phase Induction Motors **8L**

Sizing of an induction motor, Main dimensions, Length of air gap, Rules for selecting rotor slots of squirrel cage machines, Design of rotor bars and slots, Design of end rings, Design of wound rotor, Magnetic leakage calculations, Leakage reactance of poly phase machines, Magnetizing current, Short circuit current, Circle diagram, Operating characteristics.

Module 4: Computer Aided Design of Electrical Machines **2L**

Analysis and synthesis approaches, design algorithms, Introduction to optimization techniques.

Text Books:

1. A. K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, 2010
2. R. K. Agarwal, "Principles of Electrical Machine Design", S. K. Kataria and Sons, 2009

Reference Books:

1. M.G. Say, "Theory & Performance & Design of A.C. Machines", CBS Publishers, 2005
2. Walker, J.H., Large AC Machines: Performance and Operation, BHEL (1997).

3. S. K. Sen, “Principles of Electrical Machine Design with computer programmes”, Oxford and IBH Publishing, 2006.
4. Smith, S.P. and Say, M.G., Electrical Engineering Design Manual, Chapman and Hall (1984).

Paper Name: Artificial Intelligence and Machine Learning
Paper Code: CS(EE)601
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: Trigonometric Fourier series, Exponential Fourier series, Fourier transform and its properties, Energy and power signal, Probability and Statistics.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand the basic concepts of machine learning and some typical applications.
- **CO2.** Understanding how to build and validate models and improve them iteratively.
- **CO3.** Understand the core concepts of artificial intelligence and applications.
- **CO4.** Apply knowledge representation with artificial intelligence using FOL and Predicate logic.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	-	-	-	-	-	3	3
CO2	3	3	3	3	3	-	-	-	-	-	3	3
CO3	3	3	-	-	-	-	-	-	-	-	2	3
CO4	3	3	3	2	-	-	-	-	-	-	3	3

Course Content

Module 1: Introduction to Machine Learning **7L**

Introduction, Machine Learning Process, Supervised Learning, Regression, Linear Regression, Predicting, Polynomial Regression, Classification, Feature Engineering, Logistic Regression, kNN classification, SVM, Naive bayes, Decision tree and Random Forest classifier, Unsupervised Learning, Clustering techniques.

Module 2: Analysis of Models **6L**

Model representation, decision boundary, cost function, gradient descent, regularization, evaluating a hypothesis (Model selection), training/validation/testing procedures, bias/variance, learning curves, Accuracy and Error measures, evaluating the accuracy of a classifier or predictor, Confusion metric, precision, recall, ROC curve and AUC score, Parameter Tuning.

Module 3: Artificial Intelligence – Problem Solving **5L**

Introduction to AI, Control strategies, Search strategies, Production system characteristics, Specialized production system, Problem solving methods, Problem graphs, Matching, Indexing and Heuristic functions -Hill Climbing Depth first and Breadth first, Constraint's satisfaction Problem.

Module 4: Knowledge Representation and Reasoning **6L**

Game playing, Knowledge representation, Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, use of predicate calculus, Knowledge representation using other logic, Structured representation of knowledge, First order logic, Syntax and Semantics, Knowledge Engineering in First Order, Logic – Inference in First Order Logic.

Text Books:

1. Alexey Grigorev, 2020, "Machine Learning Bookcamp", MEAP.
2. Shai Shalev-Shwartz, Shai Ben-David, 2014, "Understanding Machine Learning From Theory to Algorithms", Cambridge University Press.

Reference Book:

1. Kevin Night and Elaine Rich, Nair B., 2008, “Artificial Intelligence (SIE)”, McGraw Hill.

Paper Name: Bio-Medical Instrumentation
Paper Code: ECS(EE)601
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: Knowledge of Instrumentation and Measurement.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand the physiology of biomedical system.
- **CO2.** Measure biomedical and physiological information.
- **CO3.** Discuss the application of Electronics in diagnostics and therapeutic area.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	-	-	-	-	-	-	-	-	-	-
CO2	1	-	-	-	-	2	-	-	-	-	2	-
CO3	-	-	-	-	-	2	-	-	-	-	2	-

Course Content

Module 1: Physiology and transducers 6L

Cell and its structure, Resting and Action Potential, Nervous system: Functional organization of the nervous system, Structure of nervous system, neurons, synapse, transmitters and neural communication, Cardiovascular system, respiratory system, Basic components of a biomedical system, Transducers, selection criteria, Piezo-electric, ultrasonic transducers, Temperature, measurements - Fiber optic temperature sensors.

Module 2: Electro – Physiological measurements 6L

Electrodes: Limb electrodes, floating electrodes, pre-gelled disposable electrodes, Micro, needle and surface electrodes, Amplifiers: Preamplifiers, differential amplifiers, chopper amplifiers, Isolation amplifier. ECG, EEG, EMG, ERG, Lead systems and recording methods, typical waveforms. Electrical safety in medical environment: shock hazards, leakage current-Instruments for checking safety parameters of biomedical equipment.

Module 3: Non-electrical parameter measurements 6L

Measurement of blood pressure, Cardiac output, Heart rate, Heart sound Pulmonary function measurements, spirometer, Photo Plethysmography, Body Plethysmography, Blood Gas analyzers: pH of blood, measurement of blood pCO2, pO2, finger-tip oximeter, ESR, GSR, measurements, Standard HL7.

Module 4: Assisting and therapeutic equipments 6L

Pacemakers, Defibrillators, Ventilators, Nerve and muscle stimulators, Diathermy, Heart Lung machine, Audio meters, Dialyzers, Lithotripsy

Text Books:

1. R.S.Khandpur, 'Hand Book of Bio-Medical instrumentation', Tata McGrawHill PublishingCoLtd., 2003.
2. Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer, 'Bio-Medical InstrumentationandMeasurements', II edition, Pearson Education, 2002 / PHI.

Reference Books:

1. J.Webster, ‘Medical Instrumentation’, John Wiley & Sons, 1995.
2. L.A. Geddes and L.E.Baker, ‘Principles of Applied Bio-Medical Instrumentation’, JohnWiley&Sons, 1975.

Paper Name: Analog and Digital Communication
Paper Code: EC(EE)601
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: Trigonometric Fourier series, Exponential Fourier series, Fourier transform and its properties, Energy and power signal, Probability and Statistics.

Course Outcomes: After successful completion of the course, student will be able to

- **CO4.** Explain the importance of Amplitude Digital modulation demodulation schemes
- **CO5.** Analyze Analog communication systems for their Signal to Noise ratio, efficiency and bandwidth.
- **CO6.** Compare the advantages of various pulse modulation techniques and analyse their system performance
- **CO7.** Demonstrate signal representation
- **CO8.** Analyze various digital communication techniques, can compute the bit error performance and compare their advantages and limitations.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	-	1	1	-	2	-	3	3	3
CO2	3	-	-	3	3	-	2	-	1	3	3	3
CO3	3	3	3	3	2	2	-	1	-	3	3	3
CO4	3	-	3	2	3	-	2	-	2	3	3	3
CO5	3	2	-	3	3	2	-	-	-	3	3	3

Course Content

Module 1: Introduction **4L**

Review of signals and systems, Frequency domain representation of signals, Principles of Amplitude Modulation and Demodulation Systems- DSB, SSB and VSB modulations. Angle Modulation and Demodulation Systems - Representation of FM and PM signals, Spectral characteristics of angle modulated signals.

Module 2: Random Processes **4L**

Review of probability and random process. Gaussian and white noise characteristics, Rayleigh's energy theorem, Parseval's theorem, Fourier transform pair Power spectral density vs Autocorrelation likelihood functions, Noise in amplitude modulation systems

Module 3: Pulse modulation **2L**

Sampling theorem. Pulse modulation techniques PAM, PWM, PPM. Pulse code modulation (PCM), Line coding, Regenerative repeater, differential pulse code modulation. Delta modulation, Noise analysis, Time Division multiplexing.

Module 4: Signal Vector Representation **5L**

Analogy between signal and vector, distinguishability of signal, orthogonally and orthonormality, basis function, orthogonal signal space, message point , signal constellation, geometric interpretation of signals, Schwartz inequality, Gram- Schmidt orthogonalization procedure, response of the noisy signal at the receiver, maximum likelihood decision rule, decision boundary, optimum correlation receiver; probability of error, error function, Optimum detection of signals in noise, matched Filter, Inter symbol Interference and Nyquist criterion.

Module 5: Digital Modulation Techniques 9L

Types of Digital Modulation, coherent and non-coherent ASK, FSK and PSK, Coherent Binary Phase Shift Keying (BPSK), geometrical representation of BPSK signal; error probability of BPSK, generation and detection of BPSK Signal, power spectrum of BPSK. Concept of M-ary Communication. M-ary phase shift keying, the average probability of symbol error for coherent M-ary PSK, power spectra of MPSK, Quadrature Phase Shift Keying (QPSK), error probability of QPSK signal, generation and detection of QPSK signals, power spectra of QPSK signals, Offset (OQPSK) vs. Non-offset (NOQPSK) Quadrature Phase shift keying, Coherent Frequency Shift Keying(FSK),Binary FSK, error probability of BFSK signals, generation and detection of Coherent Binary FSK signals, power spectra of BFSK signal, basic concept of OFDM.

Text Books:

1. Haykin S., "Communications Systems", John Wiley and Sons, 2001.
2. Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education, 2002.
3. Taub H. and Schilling D.L., "Principles of Communication Systems", Tata McGraw Hill, 2001.
4. Wozencraft J. M. and Jacobs I. M., "Principles of Communication Engineering", John Wiley, 1965.
5. Barry J. R., Lee E. A. and Messerschmitt D. G., "Digital Communication", Kluwer Academic Publishers, 2004.
6. Proakis J.G., "Digital Communications", 4th Edition, McGraw Hill, 2000.

Reference Books:

1. Carlson — Communication System,4/e , Mc-Graw Hill
2. Communication Systems, A. Bruce Carlson, Paul B. Crilly TMH Education
3. Digital Communication, A. Bhattacharya, TMH Publishing Co.

Paper Name: Electric Drives Laboratory
Paper Code: EE691
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Concept of Electrical Machines and Power Electronics.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Apply power electronic converters for motor speed control.
CO2. Analyze the characteristics of electric motors for different type of loads.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	1	-	3	3	2	-	-	-	-	-	1
CO2	-	1	-	3	3	2	-	-	-	-	-	1

List of Experiments:

1. Study of Thyristor controlled DC Drive using MATLAB/PSIM.
2. Study of Chopper fed DC Drive using MATLAB/PSIM.
3. Study of AC Single phase motor-speed control using TRIAC.
4. Speed Control DC Motor Using BJT H- Bridge Simulation Using MATLAB.
5. Three Phase Permanent Magnet Synchronous Motor Drive Simulation Using MATLAB.
6. PWM Inverter fed three-phase Induction Motor control.
7. Three Phase Voltage Source Converter with Space Vector PWM simulation using MATLAB/PSIM.
8. CSI fed Induction motor Drive analysis MATLAB/PSIM.
9. Study of V/f control operation of three-phase induction motor drive.
10. Study of permanent magnet synchronous motor drive fed by PWM Inverter.
11. Regenerative or Dynamic braking operation for DC Motor and AC Motor.
12. AC and DC Drive Applications using PLC.
13. Introduction to Industrial Automation.

Course Name: Power System – II Laboratory
Course Code: EE692
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Circuit Theory, Electrical Machines – I, Power System – I.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Demonstrate the performance of different types of relays.
- **CO2.** Determine polarity, ratio and magnetization characteristics of CT and PT.
- **CO3.** Demonstrate AC and DC load flow by simulation.
- **CO4.** Design different protection schemes for transformer, generator, motor and feeder by simulation.
- **CO5.** Determine economic load dispatch of a power plant.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	3	-	-	-	-	3	-	-	3
CO2	3	-	-	3	-	-	-	-	3	-	-	3
CO3	3	-	-	3	3	-	-	-	3	-	-	3
CO4	3	-	-	3	3	-	-	-	3	-	-	3
CO5	3	-	-	3	-	-	-	-	3	-	-	3

List of Experiments:

1. Study on (i) on load Time Delay Relay (ii) off load Time Delay Relay
2. Polarity, Ratio and Magnetization Characteristics Test of CT & PT
3. Testing on (i) Under Voltage Relay and (ii) Earth Fault Relay
4. Study on D C Load Flow
5. Study of A C Load Flow Using Gauss – Seidel Method
6. Study of A C Load Flow Using Newton – Raphson Method
7. Study of IEEE 30, 57 bus Load Flow by Software Simulation (ETAP, MAT Lab or others)
8. Study on Economic Load Dispatch by software
9. Study of Transformer Protection by Simulation
10. Study of Generator Protection by Simulation
11. Study of Motor Protection by Micom Relay and Simulation.
12. Study of Different Characteristics of Over Current Relay.

Course Name: PLC and Automation Laboratory
Course Code: EE693
Contact: 0L:0T:2P
Credit: 1

Prerequisite: Knowledge of Process Control Course.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Perform different types of PLC programming schemes.
- **CO2.** Implement ladder diagrams for process control.
- **CO3.** Apply the PLC for different applications.
- **CO4.** Interface PLC with other technologies like SCADA, HMI, etc.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	1	-	-	2	1	2	1
CO2	3	3	3	3	3	1	-	-	2	1	2	1
CO3	3	3	3	3	3	1	-	-	2	1	2	1
CO4	3	3	3	3	3	1	-	-	2	1	2	1

List of Experiments:

1. Study of PLC and associated systems.
2. Familiarization with PLC & SCADA software for top brands like BOSCH & REXROWTH, Siemens, Delta, Omran, ABB, etc.
3. Implementation of Ladder logic, instruction list syntax, Basic logic operations, AND, OR, NOT functions.
4. Familiarization with AUTOCAD Electrical software.
5. To design the Industrial layout (P& ID) in AutoCAD Electrical.
6. To study hardware and software platforms for DCS.
7. Logic implementation for traffic Control Application.
8. Logic implementation for Bottle Filling Application.
9. Logic implementation for speed control of DC Motor.
10. Extramural Experiments.

4th Year 7th Semester									
Sl. No.	**Broad Category**	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG	Major	EE701	Control Systems – II	3	0	0	3	3
2	ENGG	Major	EE702	Electric Vehicles	3	0	0	3	3
3	ENGG	Major	EE703A	Power System – III	2	0	0	2	2
			EE703B	Introduction to Smart Grid					
			EE703C	Power Quality					
4	ENGG	Major	EE704A	Distributed Generation and Microgrids	2	0	0	2	2
			EE704B	Computer Applications in Power System					
			EE704C	HVDC Transmission Systems					
5	ENGG	Minor	CS(EE)701	Object Oriented Programming	3	0	0	3	3
			EC(EE)701A	Microelectronics and VLSI					
			EC(EE)701B	PCB Design and Manufacturing					
B. Practical									
6	ENGG	Major	EE791	Control Systems – II Laboratory	0	0	2	2	1
7	ENGG	Major	EE792	Electric Vehicles Laboratory	0	0	2	2	1
8	ENGG	Minor	CS(EE)791	Object Oriented Programming Laboratory	0	0	2	2	1
			EC(EE)791A	Microelectronics and VLSI Laboratory					
			EC(EE)791B	PCB Design and Manufacturing Laboratory					
9	PROJ	Project	EE781	Major Project – I	0	0	12	12	6
Total for Theory and Practical								**31**	**22**

Course Name: Control Systems – II
Course Code: EE701
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Any introductory course on Matrix Algebra, Calculus, Engineering Mechanics.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Calculate mathematical model of linear-time-invariant systems using state- space representations.
- **CO2.** Analyze the nonlinear systems using appropriate methods.
- **CO3.** Illustrate discrete representation of LTI systems.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	-	2	-	-	-	-	-	-	2
CO2	2	3	2	-	2	-	-	-	-	-	-	2
CO3	2	3	2	-	2	-	-	-	-	-	-	2

Course Content

Module 1: State Variable Analysis **13L**

Introduction, Concepts of state, state variables and state model, Concept of State Equation for Dynamic Systems, state model for linear continuous-time systems, Non Uniqueness of State model, State Diagrams, Conversion of State variable model to transfer function, Conversion of transfer function to canonical state variable model, Diagonalization, Solution of state equations, State transition matrix – Properties and Computation, Eigenvalues and Stability Analysis, Concepts of Controllability and Observability, Pole placement by state feedback.

Module 2: Non-Linear Control Systems **13L**

Introduction to Non-Linear Systems: Introduction, Features of Linear and Non Linear Systems, Types of non-linearity, Common nonlinearities in control systems, Typical Examples, Concept of phase portraits – Singular points – Limit cycles.

Describing Function Analysis: Describing function fundamentals, Describing functions of common nonlinearities, Describing function analysis of nonlinear systems, Limit cycles, Stability of Oscillations

Lyapunov Stability Analysis: Stability Concepts, Equilibrium Points, BIBO and Asymptotic Stability, Lyapunov theory, Lyapunov's Direct method, Simple problem

Phase Plane Analysis: Construction of phase portrait, Concepts of phase plane analysis, Phase plane analysis of simple linear system and nonlinear system.

Module 3: Digital Control Systems **10L**

Basics of Digital Control Systems. Discrete representation of continuous systems. Sample and hold circuit. Mathematical Modelling of sample and hold circuit. Effects of Sampling and Quantization. Choice of sampling frequency. ZOH equivalent. Z-Transform and Inverse Z Transform for analyzing discrete time systems. Pulse Transfer function. Pulse transfer function of closed loop systems. Mapping from s-plane to z plane. Stability analysis by Jury test.

Text Books:

1. Katsuhiko Ogata, "Modern Control Engineering ", PHI Learning Pvt Ltd, 5th Edition, 2010.

2. Hassan K Khalil, "Nonlinear Control ", Pearson Prentice Hall, 1st Edition, 2014.
3. Gopal M : Digital Control and State Variable Methods, 2e, – TMH

Reference Books:

1. Goodwin, Control System Design, Pearson Education
2. Bandyopadhyaya, Control Engg. Theory and Practice, PHI
3. KuoB.C. : Digital Control System, Oxford University Press.
4. Houpis, C.H, Digital Control Systems, McGraw Hill International.
5. Ogata, K., Discrete Time Control Systems, Prentice Hall, 1995.

Course Name: Electric Vehicles
Course Code: EE702
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Power Electronics and Electric Drives.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Identify EV concepts, EV configurations and various EV parameters for better understanding of the EV technology.
- **CO2.** Analyse the EV propulsion system and electric motors for vehicular applications & power electronics converters required for their control.
- **CO3.** Analyse DC motor & induction motor drives and discuss methods for controlling them.
- **CO4.** Elaborate various hybrid electric vehicle configurations and Identify different energy sources used in EV and analyse the various methods used in charging these energy sources.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	-	2	-	-	-	-	-	-	2
CO2	2	3	2	-	2	-	-	-	-	-	-	2
CO3	2	3	2	-	2	-	-	-	-	-	-	2
CO4												

Course Content

Module 1: Introduction 6L

Past, Present & Future of EV, Current Major Issues, Advanced Electric drive vehicle technology, Comparison of EV Vs IC Engine. Components of Hybrid Electric Vehicle, Economic and environmental impacts of Electric hybrid vehicle: Comparative study of vehicles for economic, environmental aspects.
In-wheel drives EV Parameters: Weight, size, force, energy & performance parameters.

Module 2: Dynamics of Electric vehicles 8L

General description of vehicle movement. Choice of electric propulsion system, block diagram of EV propulsion system, Factors affecting vehicle motion- Vehicle resistance, tires ground adhesion, rolling resistance, aerodynamic drag, equation of grading resistance, dynamic equation. Drive train configuration, Automobile power train, classification of vehicle power plant , need of gear box, Concept of EV Motors, classification of EV motors, single motor and multi-motor configurations, fixed & variable geared transmission, In wheel motor configuration.

Module 3: Required Power Electronics & Control 6L

Comparison of EV power devices, introduction to power electronics converter, four quadrant DC chopper, three-phase full bridge voltage-fed inverter, soft-switching EV converters, comparison of hard-switching and soft-switching converter, three-phase voltage-fed resonance dc link inverter.

Module 4: EV Motor Drives 8L

DC Motor: Type of wound-field DC Motor, Torque speed characteristics. DC-DC Converter, Two quadrant DC Chopper, two quadrant zero voltage transition converter-fed dc motor drive, speed control of DC Motor.

Induction Motor Drive: Three Phase Inverter Based Induction Motor Drive, Equal Area PWM, Three Phase Auxiliary resonant snubber (ARS) Inverter Type (ZVC & ZCS), Single Phase ARS Inverter Topology, Speed Control of Induction Motor, Sliding mode Control.

Module 5: Energy Sources & Charging 8L

Different Batteries and Ultra-capacitors, Battery characteristics (Discharging & Charging) Battery Chargers: Conductive (Basic charger circuits.). Arrangement of an off-board conductive charger, Standard power levels of conductive chargers, Charging Infrastructure: Domestic Charging Infrastructure, Public Charging Infrastructure, Normal Charging Station, Fast Charging Station.

Text Books:

1. A.K. Babu, Electric & Hybrid Vehicles, Khanna Publishing House, New Delhi (Ed. 2018).
2. Ehsani, M. Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press.
3. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York, 2001.
4. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.

Reference Books:

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
2. David Andrea, “Battery Management System for Large Lithium -Ion Battery Packs”, Artech house, 2010.

Paper Name: Power System - III
Paper Code: EE703A
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisites: Electrical Machines – II, Power System – I, Power System – II, Control Systems – I, Control Systems – II.

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

CO1. Demonstrate various power system components, models and their operation, optimization of cost criteria.

CO2. Apply fundamentals and concepts to analyze, formulate and solve complex problems of electrical power system and its components and control of frequency and voltages.

CO3. Analyze advanced techniques, skills and modern scientific and engineering tools for professional practice for power system to enhanced power quality, Stability, reliability, security and load ability.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	2	-	-	1	1	-	1	3
CO2	3	2	3	2	-	-	-	-	2	-	-	3
CO3	3	2	3	3	-	-	-	-	2	-	1	3

Course Content

Module 1: Objectives of Power System Operation **3L**

Power System in Restructured Environment; Distributed and Dispersed Generation; Environment Aspects of Electric Power Generation.

Module 2: Economic Operation of Energy Generation Systems **5L**

Generation Cost Curves; Economic Operation of Thermal System; Plant Scheduling; Transmission Loss and Penalty Factor; Hydro-Thermal Scheduling; Concept of Reserves and Constraints; Unit Commitment.

Module 3: Automatic Generation Control **5L**

Concept of AVR and ALFC Loops, Significance of Double Loop in ALFC; Exciter and VAR Control; Single Area Load Frequency Control; Two Area Load Frequency Control; Frequency Response.

Module 4: Compensation in Power System **7L**

Reactive Power Sensitivity and Voltage Control; Load Compensation with Capacitor Banks; Line Compensation with Reactors; Shunt and Series Compensation; Fixed Series Capacitors; Thyristor Controlled Series Capacitors (TCSC); Introduction to SVC and STATCOM, UPFC.

Module 5: Power System Transients **4L**

Types of System Transients; Overvoltage in Transmission Lines; Propagation of Surges and Travelling Waves; Protection against Lightning and Surges.

Text Books:

1. Kothari and Nagrath, “Power System Engineering”, McGraw Hill.
2. John J. Granger and William D. Stevension, “Power System Analysis”, McGraw Hill.

3. Allen J. Wood and Bruce F. Woolenberg, “Electric Power Generation, Operation and Control”, Willey.

Reference Books:

1. Prabha Kundur, “Power System Stability and Control”, McGraw Hill.
2. D. P. Kothari and I. J. Nagrath, “Modern Power System Analysis”, McGraw Hill.
3. T. K. Nagsarkar and M. S. Sukhija, “Power System Analysis”, Pearson.
4. Abhijit Chakrabarti and Sunita Halder, “Power System Analysis, Operation and Control”, PHI.
5. Elgerd, Olle Ingemar, “Electric Energy Systems Theory: An Introduction”, McGraw Hill.

Course Name: Introduction to Smart Grid
Course Code: EE703B
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: Concept of Power System and Power Electronics.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Describe the necessity and evolution of smart grid with policies.
- **CO2.** Apply theoretical concepts for analyzing the performance of the grid.
- **CO3.** Understand Smart Grid design, operation and control.
- **CO4.** Discuss on two-way power flow of distribution system.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	3	-	-	-	-	-	1	-
CO2	3	3	2	2	2	-	-	-	-	-	2	-
CO3	3	3	2	-	2	-	-	-	-	-	-	-
CO4	3	3	2	-	2	-	-	-	-	-	-	-

Course Content

Module 1: Smart Grid Architectural Designs **3L**
Introduction. Evolution of electric Grid, Need for smart grid, difference between Conventional grid and smart grid, General View of the Smart Grid Market Drivers, Functions of Smart Grid Components, present development and international policies in smart grid.

Module 2: Smart Grid Communications and Measurement Technology **3L**
Communication and Measurement, Monitoring, PMU, Smart Meters, and Measurements Technologies, Wide Area Monitoring Systems (WAMS), Phasor Measurement Units (PMU) , Smart Meters , Smart Appliances, Advanced Metering Infrastructure (AMI), Micro grid and Smart Grid Comparison.

Module 3: Performance Analysis Tools for Smart Grid Design **4L**
Challenges to Load Flow in Smart Grid and Weaknesses of the Present Load Flow Methods, types, Load Flow State of the Art: Classical, Extended Formulations, and Algorithms, Congestion Management Effect, Load Flow for Smart Grid Design Contingency Studies for the Smart Grid.

Module 4: Information Security and Communication Technology for Smart Grid **4L**
Data communication, switching techniques, communication channels, HAN, NAN, WAN, Bluetooth, Zigbee, GPS, Wi-Fi based communication, Wireless mesh network, Basic of cloud computing and cyber security for smart grid, Broadband over power line(BPL).

Module 5: Islanding & Smart Grid Protection **3L**
Islanding Detection Techniques, Smart Grid Protection, Digital relays for Smart Grid Protection.

Module 6: Operation and control **3L**
Modelling of Storage Devices, Modelling of DC Smart Grid components, Operation and control of DC Microgrid, Operation and control of AC Microgrid, Operation and control of AC-DC hybrid Microgrid.

Module 7: Smart Grid Case Study **4L**

Simulation and Case study of AC Microgrid, Simulation and Case study of DC Microgrid, Simulation and Case Study of AC-DC Hybrid Microgrid, Demand side management of Smart Grid, Demand response analysis of Smart Grid.

Text Books:

1. James momoh, "Smart grid fundamentals of design and analysis, IEEE Press, a john wiley & sons, inc., publication, 2012.
2. Bernd M. Buchholz, Zbigniew Styczynski, Smart grid fundamentals and Technologies Electricity Networks, Springer, Heidelberg New York Dordrecht London, 2014.

Reference Books:

1. Janaka Ekanayake, Nick Jenkis, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, Smard grid technology and applications, Wiley, 2012.
2. Stuart Borlase Smart grid: Infrastructure, Technology and solutions, CRC Press 2012.

Paper Name: Power Quality
Paper Code: EE703C
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: Power Electronics, Synchronous Machine, Power Systems.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand the basic concepts of power quality.
- **CO2.** Understand the working principles of devices to improve power quality.
- **CO3.** Describe power quality characteristics as per IEEE/IEC standards.
- **CO4.** Understand voltage sag and interruption.
- **CO5.** Describe methods to reduce over voltages.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	2	-	-	3
CO2	3	3	-	-	2	-	-	-	2	-	-	3
CO3	3	3	-	-	-	-	-	-	2	-	-	3
CO4	3	3	-	-	-	-	-	-	2	-	-	3
CO5	3	3	-	-	-	-	-	-	2	-	-	3

Course Content

Module 1: Introduction to Power Quality **5L**

Terms and definitions: Overloading - under voltage - over voltage. Concepts of transients - short duration variations such as interruption - long duration variation such as sustained interruption. Sags and swells - voltage sag - voltage swell - voltage imbalance - voltage fluctuation - power frequency variations. International standards of power quality. Computer Business Equipment Manufacturers Associations (CBEMA) curve.

Module 2: Voltage Sags and Interruptions **3L**

Sources of sags and interruptions - Estimating Voltage Sag Performance -Fundamental Principles of Protection -Solutions at the End-User Level-Motor-Starting Sags, Utility System Fault-Clearing Issues.

Module 3: Overvoltages **4L**

Sources of over voltages - Capacitor switching – lightning - ferro resonance. Mitigation of voltage swells - surge arresters - low pass filters - power conditioners. Lightning protection – shielding - line arresters - protection of transformers and cables.

Module 4: Harmonics **5L**

Harmonic sources from commercial and industrial loads, locating harmonic sources. Power system response characteristics - Harmonics Vs transients. Effect of harmonics - harmonic distortion - voltage and current distortion - harmonic indices.

Module 5: Power Quality Standards and Regulations **3L**

Standards - IEEE, IEC, ANSI, Limits and regulations on power quality in transmission and distribution network.

Module 6: Power Quality Monitoring and Survey **4L**

Monitoring Considerations - Historical Perspective of Power Quality Measuring Instruments-Power Quality Measurement Equipment-Assessment of Power Quality Measurement Data - Application of Intelligent Systems - Power Quality Monitoring Standards.

Text Books:

1. Roger C. Dugan, Mark F. McGranaghan, Surya Santoso “Electrical Power System Quality”, Tata Mcgraw-hill, New Delhi, 2012.
2. R. C. Dugan, “Electrical Power Systems Quality”, McGraw Hill Education, 2012.

Reference Books:

1. Mohammad A. S Masoum, Ewald F.Fuchs, “Power Quality in Power Systems and Electrical Machines”, Academic Press, Elsevier, 2015.
2. Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, “Power Quality: Problems and Mitigation Techniques”, John Wiley & sons Ltd, 2015.
3. T. J. E. Miller, “Reactive Power Control in Electric Systems”, John Wiley and Sons, New York, 1983.
4. G. T. Heydt, Electric Power Quality, Stars in a Circle Publications, 1991.
5. “Electric Power Quality" by Surajit Chattopadhyay, Madhuchhanda Mitra, Samarjit Sengupta, Springer, 2011.

Paper Name: Distributed Generation and Microgrids
Paper Code: EE704A
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: Power System – I & II, Power Electronics, Electrical Machines – I &II, Renewable Energy – I & II.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understanding comparative studies of the conventional and non- conventional power generation.
- **CO2.** Analyse and design of distributed generation, installation and grid integration.
- **CO3.** Design the dc and ac micro-grid.
- **CO4.** Analyse power quality issues and control operation of micro grid.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	2	-	2	-	-	-	-	2
CO2	2	2	3	2	3	-	2	-	-	-	2	2
CO3	3	2	-	3	2	-	-	-	-	2	-	-
CO4	3	2	3	-	2	-	-	-	-	1	2	2

Course Content

Module 1: Architecture of Distributed Generations (DG) Technologies 4L

Introduction, Comparative study between conventional and non-conventional methods of power generation: energy crisis due to scarcity of fossil fuel & economic point of view, distributed generation (DG) overview and technology trend. Working principle, architecture, application of renewable DG technologies: solar PV, bio-energy, wind energy, hydroelectricity, tidal power, wave energy, geothermal energy etc.

Non-conventional technology based DGs: Fuel cells, CHP based micro turbine, IC engines, etc.Storage based DGs: Energy storage elements: Batteries, ultra-capacitors, flywheels. Captive power plants.

Module 2: Interconnection Issues and Standards of DG(s) 3L

Concept of distributed generations, topologies, selection of sources, regulatory standards/ framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547. DG installation classes, security issues in DG implementations.

Module 3: Power Electronics and DG systems 5L

Relevance of power electronics in DG applications, Power quality requirements and source switching using SCR based static switches, Distribution system loading, line drop model, series voltage regulators and on line tap changers, power converter topologies, model and specifications for DG applications, issues filter designs, harmonic reduction, Control of DG inverters, phase locked loops, current control and DC voltage control for stand-alone and grid parallel operations. Protection of converters, power quality implication, acceptable ranges of voltage and frequency, reactive power compensation and active filtering.

Module 4: Impact of Grid Integration 3L

Requirements for grid interconnection, limits on operational parameters: voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues.

Module 5: Operation, Control and Modelling of Micro Grid 5L

Concept and definition of micro grid, review of sources of micro grids, typical structure and configuration of a micro grid, micro grid implementation in Indian and international scenario, AC and DC micro grids, Power Electronics interfaces in DC and AC micro grids, communication infrastructure, modes of operation and control of micro grid: grid connected and islanded mode operation, anti-islanding schemes. Control techniques for voltage, frequency, active and reactive power control of micro grid system, Computer aided Modelling of micro grid. Power quality issues in micro grids, regulatory standards, micro grid economics,

Module 6: Introduction to Reliability and Market Issues of Micro grid 2L

Power quality issue, THD reduction techniques, protection and stability analysis of micro grid, regulatory standards, introduction to micro grid reliability. Features of micro grid economy and market. LVDC Micro grid.

Module 7: Future Micro Grid 2L

Basic introduction of smart & future micro grid. IOT application and Machine learning applications in micro grid for controlling and mitigation problems of Islanding.

Text Books:

1. Renewable Energy- Power for a sustainable future, third edition, Edited by Godfrey Boyle, Oxford University Press, 2013.
2. Amirnaser Yezdani, and Reza Iravani, “Voltage Source Converters in Power Systems: Modeling, Control and Applications”, IEEE John Wiley Publications, 2009.
3. Dorin Neacsu, “Power Switching Converters: Medium and High Power”, CRC Press, Taylor & Francis, 2006. New Delhi.
4. Microgrids: Architectures and Control, Nikos Hatziargyriou (Editor), ISBN: 978-1-118-72068-4, 340 pages, December 2013, Wiley-IEEE Press
5. Microgrids and Active Distribution Networks, S. Chowdhury, S.P. Chowdhury and P. Crossley, The Institution of Engineering and Technology, London, U.K, 2009.
6. Technical literatures- research papers published in power system and power electronics.

Reference Books:

1. Amirnaser Yezdani, and Reza Iravani, “Voltage Source Converters in Power Systems: Modeling, Control and Applications”, IEEE John Wiley Publications, 2009.
2. DorinNeacsu, “Power Switching Converters: Medium and High Power”, CRC Press, Taylor & Francis, 2006.
3. Chetan Singh Solanki, “Solar Photo Voltaics”, PHI learning Pvt. Ltd., New Delhi, 2009.
4. J.F. Manwell, J.G “Wind Energy Explained, Theory Design and Applications,”. McGowan Wiley publication, 2nd Edition, 2009.
5. D. D. Hall and R. P. Grover, “Biomass Regenerable Energy”, John Wiley, New York, 1987. 6. John Twidell and Tony Weir, “Renewable Energy Resources”, Taylor and Francis Publications, Second Edition, 2006.

Paper Name: Computer Applications in Power System
Paper Code: EE704B
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: Numerical Methods, Power System – I and Power System – II.

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

- **CO1.** Develop proper mathematical models for analysis of a selected problem like load flow study or fault analysis.
- **CO2.** Prepare the practical input data required for load flow or fault calculations.
- **CO3.** Select and identify the most appropriate algorithm for load–flow and short circuit studies.
- **CO4.** Develop power system software for static power system studies.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	-	2	-	-	-	-	-	2
CO2	3	3	3	3	-	1	-	-	-	-	-	3
CO3	3	3	3	3	-	1	-	-	-	-	-	3
CO4	3	3	3	2	3	2	-	-	-			2

Course Content

Module 1: Network Formulation and Graph Theory **3L**

Introduction, Network Equations, Graph Theory, Development of Network Matrices from Graph Theoretic Approach, Augment Cut-set Incidence Matrix Cut-set and Circuit Equations, Building Algorithm for the Bus Impedance Matrix Modification of Z_{BUS} matrix due to changes in the primitive network

Module 2: Load Flow Studies **4L**

Introduction, Different techniques such as Gauss Saidal method, Newton Raphson method, De-Coupled method, Fast Decoupled method, Modified Fast Decoupled, Concept of Optimal Power Flow, Solution of Optimal power flow by Gradient method, Solution of Optimal power flow by Newton's method Linear Programming Methods, DC load flow, Continuation Power flow

Module 3: Sensitivity Analysis **4L**

Sensitivity analysis- General sensitivity relations, generation shift distribution factors, line outage distribution factors, compensated shift factors, sensitivity associated with voltage-VAR, sensitivities relating load bus voltage changes in terms of PV bus voltage changes, sensitivity relating changes in reactive power generation for changes in PV Bus Voltage.

Module 4: Power System Security **4L**

Introduction, Factors Affecting Power System Security, Short Circuit Studies of a Large Power System Networks, Symmetrical Fault Analysis Using Bus Impedance Matrix, Algorithm for Formation of Bus Impedance Matrix, Contingency Analysis: Detection of Network Problems, Overview of security analysis, Linear Sensitivity Factors, Contingency Selection, Concentric Relaxation, Bounding

Module 5: Introduction to State Estimation in Power Systems **5L**

Introduction, Power system state estimation, Maximum Likelihood Concept, Weighted Least Squares Estimation, Introduction, Matrix Formulation, State Estimation of an AC network, Development of Method, State Estimation by Orthogonal Decomposition, An Introduction to Advanced topics in state estimation, Detection and Identification of Bad measurements, Estimation of quantities not being measured, Network Observability and Pseudo measurements, Application of Power Systems State Estimation

Module 6: Numerical Integration Techniques 4L

Numerical integration techniques: One step methods, Taylor series based methods, Forward - Euler's method, Runge-Kutta methods, Trapezoidal method, backward-Euler's method, Accuracy and error analysis, Numerical stability analysis, Stiff systems, Step-size selection, Differential algebraic systems, triangular factorization, Power system applications: Transient stability analysis.

Text Books:

1. Computer Methods in Power System Analysis, Glenn Stagg and El-abiad, McGraw-Hill.
2. Power System Analysis, Stevenson and Grainger, TATA McgrawHill.
3. Computational Methods for Electric Power Systems, Mariesa Crow, CRC press.
4. Computer-Aided Power Systems Analysis, George Kusic, CRC Press – Indian Edition.

Reference Books:

1. Computer Modelling of Electrical Power System, J. Arrilaga and N. R. Wattson, Wiley 2001.
2. Computational Methods for Large Sparse Power System Analysis – An Object Oriented Approach, S. A. Soman, S. A. Khaparde, Kluwer Academic Publishers.
3. Power System Analysis, Hadi Saadat, Tata Mcgraw Hill, New Delhi.
4. Large Networks by Matrix Methods, H. E. Brown, John Wiley.
5. Power Generation Operation & Control, A. J. Wood and B. F. Wollenberg, John Wiley & Sons, Inc.
6. AC-DC Power System Analysis, Jos Arrillaga and Bruce Smith, IEE London UK.

Paper Name: HVDC Transmission Systems
Paper Code: EE704C
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisites: Concept of Power System and Power Electronics.

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

- **CO1.** Describe HVDC converters and HVDC transmission.
- **CO2.** Formulate and solve mathematical problems related to rectifier and inverter control methods and learn about different control schemes as well as starting and stopping of DC links.
- **CO3.** Analyze the different harmonics generated by the converters and their variation with the change in firing angles.
- **CO4.** Distinguish the nature of faults on the converters and their protection schemes.
- **CO5.** Demonstrate the existing HVDC systems along with MTDC systems and modern transmission system.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	2	-	-	-	-	-	-	-	-	-	-
CO3	2	3	1	-	-	-	-	-	-	-	-	-
CO4	-	-	2	-	1	-	-	-	-	-	-	-
CO5	-	-	1	2	-	-	-	-	-	-	-	-

Course Content

Module 1: Introduction **4L**

Introduction of DC power transmission technology, comparison of AC and DC transmission, limitation of HVDC transmission, reliability of HVDC systems, application of DC transmission, description of DC transmission system, planning for HVDC transmission, modern trends in DC transmission.

Module 2: Analysis of HDVC Converters **3L**

Choice of converter configuration, simplified analysis of Graetz circuit, converter bridge characteristics, Characteristics of a twelve pulse converter, detailed analysis of converters.

Module 3: Control of HVDC Converter and Systems **5L**

Necessity of control of a DC link, rectifier control, compounding of rectifiers, power reversal of DC link, voltage dependent current order limit(VDCOL) characteristics of the converter, inverter extinction angle control, pulse phase control, starting and stopping of DC link, constant power control, control scheme of HVDC converters.

Module 4: Harmonics and Filters **6L**

Generation of harmonics by converters, characteristics of harmonics on DC side, characteristics of current harmonics, characteristic variation of harmonic currents with variation of firing angle and overlap angle, effect of control mode on harmonics, non-characteristic harmonic. Harmonic model and equivalent circuit, use of filter, filter configuration, design of band-pass and high pass filter, protection of filters, DC filters, power line communication and RI noise, filters with voltage source converter HDVC schemes.

Module 5: Fault and Protection Schemes in HVDC Systems 3L

Nature and types of faults, faults on AC side of the converter stations, converter faults, fault on DC side of the systems, protection against over currents and over voltages, protection of filter units.

Module 6: Multiterminal HVDC Systems 3L

Types of multiterminal (MTDC) systems, parallel operation aspect of MTDC Series and shunt devices and principle of operation and control, UPFC and IPFC, modelling of FACTS devices for power system studies.

Text Books:

1. S. Kamakshaiah and V. Kamaraju, "HVDC Transmission", Tata McGraw Hill Education.
2. K. R. Padiyar, "HVDC Power Transmission System", Wiley Eastern Limited.
3. J. Arrillaga, "High Voltage Direct Current Transmission", The Institution of Electrical Engineers.

Reference Books:

1. Prabha Kundur, "Power System Stability and Control", McGraw Hill.
2. Abhijit Chakrabarti and Sunita Halder, "Power System Analysis: Operation and Control", PHI Learning Pvt. Ltd.

Paper Name: Object Oriented Programming
Paper Code: CS(EE)701
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite:

1. Computer Fundamentals.
2. Basic understanding of Computer Programming and related Programming Paradigms.
3. Problem Solving Techniques with proper logic Implementation.

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

- **CO1.** Design the process of interaction between Objects, classes & methods w.r.t. Object Oriented Programming.
- **CO2.** Acquire a basic knowledge of Object Orientation with different properties as well as different features of Java.
- **CO3.** Analyze various activities of different string handling functions with various I/O operations.
- **CO4.** Discuss basic code reusability feature w.r.t. Inheritance, Package and Interface.
- **CO5.** Implement Exception handling, Multithreading and Applet (Web program in java) programming concept in Java.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	-	-	-	1	-	-	1
CO2	3	2	2	-	1	-	-	-	1	-	-	2
CO3	2	3	2	3	-	-	-	-	2	-	-	-
CO4	1	-	-	-	-	-	-	-	1	2	-	2
CO5	2	1	1	-	1	-	-	-	2	-	-	2

Course Content

Module 1: Introduction **5L**

Object Oriented Analysis and Design-Concepts of object oriented programming language, Object, Class; Relationships among objects and classes-Generalization, Specialization, Aggregation, Association, Composition, links, Meta-class; Object Oriented Programming concepts - Difference between OOP and other conventional programming – advantages and disadvantages. Class, object, Method; Properties of OOP- message passing, inheritance, encapsulation, polymorphism, Data abstraction; Difference between different OOPs Languages.

Module 2: Java Basics **9L**

Basic concepts of java programming - Advantages of java, Byte-code and JVM, Data types, Different types of Variables; Access specifiers, Operators, Control statements and loops; Array; Creation of class, object, method; Constructor - Definition, Usage of Constructor, Different types of Constructor; finalize method and garbage collection, Method and Constructor overloading; this keyword, use of objects as parameter & methods returning objects; Call by value & call by reference; Static variables & methods. Nested & inner classes.

Module 3: Basic String handling & I/O **4L**

Basic string handling concepts- Concept of mutable and immutable string, Methods of String class- charAt(), compareTo(), equals(), equalsIgnoreCase(), indexOf(), length(), substring(); toCharArray(), toLowerCase(), toString(), toUpperCase() , trim() , valueOf() methods, Methods

of String buffer class- append(), capacity(), charAt(), delete(), deleteCharAt(); ensureCapacity(), getChars(), indexOf(), insert(), length(), setCharAt(), setLength(), substring(), toString(); Command line arguments, basics of I/O operations – keyboard input using BufferedReader& Scanner classes.

Module 4: Inheritance and Java Packages 8L

Inheritance - Definition, Advantages, Different types of inheritance and their implementation; Super and final keywords, super() method; Method overriding, Dynamic method dispatch; Abstract classes and methods; Interface - Definition, Use of Interface; Multiple inheritance by using Interface; Java Packages - Definition, Creation of packages; Importing packages, member access for packages.

Module 5: Exception handling, Multithreading and Applet Programming 10L

Exception handling - Basics, different types of exception classes. Difference between Checked & Unchecked Exception; Try & catch related case studies; Throw, throws & finally; Creation of user defined exception; Multithreading - Basics, main thread, thread life cycle; Creation of multiple threads-yield(), suspend(), sleep(n), resume(), wait(), notify(), join(), isAlive(); Thread priorities, thread synchronization; Interthread communication, deadlocks for threads; Applet Programming - Basics, applet life cycle, difference between application & applet programming; Parameter passing in applets.

Text Books:

1. Herbert Schildt – "Java: The Complete Reference " – 9th Ed. – TMH
2. E. Balagurusamy – " Programming With Java: A Primer " – 3rd Ed. – TMH.

Reference Books:

1. R. K. Das – " Core Java for Beginners " – VIKAS PUBLISHING.
2. Rambaugh, James Michael, Blaha – " Object Oriented Modelling and Design " – Prentice Hall, India.

Paper Name: Microelectronics and VLSI
Paper Code: EC(EE)701A
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Basic concept of Electronic Devices, Analog & Digital Electronic Circuits.

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

- **CO1.** Illustrate scale of integration – SSI, MSI, LSI, VLSI, Moor's Law, scaling, short channel effect, VLSI design flow, FPGA architecture, classify Standard IC & ASIC, and construct gate level circuit with the help of PAL & PL A architecture.
- **CO2.** Analyze CMOS inverter voltage transfer characteristics with the parameters – VIL, VIH, VOL, VOH, Vth and based on the knowledge of digital circuit design methodology like–CMOS, Pass transistor, TG, DCVSL, dynamic logic, NORA, able to construct schematic of simple and complex combinational circuit, sequential circuit (SR flip-flop, JK flip-flop, D flip flop), 6T- SRAM Cell, 3T-DRAMcell using MOSFET.
- **CO3.** Estimate the value of resistance of current source/sink, MOS diode, current of current mirror circuit, voltage of reference circuits (voltage divider, threshold voltage references and band gap reference), value of parameters to design CMOS differential amplifier, resistance of switch capacitor circuit, gain of switch capacitor integrator and 1st order switch capacitor filter based on the concept of small signal model & switching characteristics of MOSFET.
- **CO4.** Describe the fabrication steps of ICs and construct the stick diagram & layout of CMOS inverter & basic gates based on lambda and micron design rules.
- **CO5.** Estimate the gate delay, dynamic power, short circuit power and leakage power and total power consumption across CMOS inverter circuit with the help of switching activity, saturation & linear region current equations of MOSFETs and principle of charging & discharging of capacitor.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1	3	-	-	1	1	1	1	1
CO2	2	2	1	2	2	-	-	1	1	2	1	1
CO3	2	1	1	1	3	-	-	1	1	1	1	1
CO4	2	1	1	1	1	-	-	1	1	1	1	1
CO5	2	1	1	-	1	-	-	-	2	-	-	2

Course Content

Module 1: Introduction to IC **5L**

Integrated Circuits – Advantages, disadvantages, limitations; Scale of Integration – SSI, MSI, LSI, VLSI, ULSI; Moor's Law; Scaling of MOSFET-Constant field scaling and constant voltage scaling, Short Channel Effects; VLSI design flow, Y- Chart, IC Classification –Standard IC and ASIC, PAL, PLA, FPGA Architecture.

Module 2: Digital VLSI Circuit Design **11L**

Inverter Characteristics: (2L)

Resistive load inverter – Voltage transfer characteristics (VTC, significance of parameters (only expression, no derivation) –VIL, VIH, VOL, VOH, Vth; CMOS inverter - VTC, Noise margin and aspect ratio of symmetric CMOS inverter.

Combinational Logic Circuit Design: (6L)
Circuit design using Static CMOS style–basic gates, design of circuit for product of sum (POS) and sum of product (SOP) expression, Complex logic circuit, full adder; Circuit design using pseudo NMOS logic, DCVSL Logic, TG Logic, Pass Transistor Logic, Complementary pass transistor logic, Dynamic logic, domino logic, NORA logic.
Sequential Circuit and Semiconductor Memory Design: (3L)
Bistable Circuit – Design of CMOS, S-R & J-K Latch, CMOS Clocked SR & JK Latch/Master – slave JK Flip-flop, CMOS D Flip flop; 6T SRAM cell and 3T DRAM cell design.

Module 3: Analog VLSI Circuit Design 9L
Small Signal model of MOSFET; Analog sub-circuits -MOS Switch, Active resistors/MOS Diode, Current source and Sink, Current Mirror; Current and voltage references-voltage divider, MOS equivalent of P-N junction Voltage reference, Threshold voltage reference, Band gap reference (Basic Principle); Switch- Capacitor Circuit – resistance emulation of series, parallel and series-parallel circuit, Switch capacitor integrator and filter (1st order only); CMOS differential amplifier–design parameters; Output amplifier (basic circuit); Block diagram of two-stage CMOS OP-AMP (description only).

Module 4: Layout Design Rules and Fabrication Steps of ICs 6L
Micron and lambda design rules; Stick diagram and Layout - CMOS Inverter, NAND and NOR gate; Fabrications steps of IC – Wafer preparation, Oxidation, photolithography, etching, diffusion, ion-implantation, metallization, and packaging. CMOS N-Well Process, overview of P-well and twin-tub process.

Module 5: Introduction to Low Power and High-Speed VLSI Circuit Design 5L
Dynamic power, short circuit power and leakage power in CMOS Inverter; Switching activity & Logical effort of basic gates; Timing parameters (concept only) – Critical path, arrival time, slack, skew, set-up time, hold time, gate delay and path delay, delay time expression of CMOS inverter (expression only), Adiabatic logic (basic concept)

Text Books:
1. Digital Integrated Circuit, J.M.Rabaey, Chandrakasan, Nicolic, Pearson Education.
2. CMOS Digital Integrated Circuits Analysis and Design, S.M.Kang & Y.Leblebici, TMH.
3. CMOS Analog Circuit Design, Allen & Holberg, Oxford
4. Design of Analog CMOS Integrated Circuits, Behzad Razavi, TMH.

Reference Books:
1. Microelectronic Circuits, Sedra & Smith, Oxford
2. Introduction to VLSI Circuits and System, Uyemura , Wiley
3. VLSI Design, Debaprasad Das, Oxford
4. VLSI Design and EDA Tools, Angsuman Sarkar, Swapnadip De, C.K. Sarkar, Scitech
5. VLSI Design Techniques for Analog and Digital Circuits, Geiger, Allen, Strader, TMH

Paper Name: PCB Design and Manufacturing
Paper Code: EC(EE)701B
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Knowledge of analog and digital circuits..

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

- **CO1.** Appreciate the necessity and evolution of PCB, types and classes of PCB.
- **CO2.** Understand the steps involved in schematic, layout, fabrication and assembly process of PCB design..
- **CO3.** Understand basic concepts of transmission line, crosstalk and thermal issues.
- **CO4.** Design (schematic and layout) PCB for analog circuits, digital circuits and mixed circuits.
- **CO5.** Design (schematic and layout) and fabricate PCB for simple circuits.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	-	-	-	-	-	-	2	2	3
CO2	2	3	2	3	-	-	-	-	-	2	2	3
CO3	3	2	1	2	3	-	-	-	-	2	3	2
CO4	1	2	1	2	1	-	-	-	-	2	1	2
CO5	3	2	2	1	3	-	-	-	-	2	3	2

Course Content

Module 1: Tutorials **12L**

(i) Introduction to PCB:

Definition and Need/Relevance of PCB, Background and History of PCB, Types of PCB Classes of PCB Design, Terminology in PCB Design, Different Electronic design automation (EDA) tools and comparison.

(ii) PCB Design Process:

PCB Design Flow, Placement and routing, Steps involved in layout design, Artwork generation Methods - manual and CAD, General design factor for digital and analog circuits, Layout and Artwork making for Single-side, double-side and Multi- layer Boards. Design for manufacturability, Design-specification standards.

(iii) Introduction to PCB Fabrication & Assembly:

Steps involved in fabrication of PCB, PCB Fabrication techniques-single, double sided and multilayer, Etching: chemical principles and mechanisms, Post operations- stripping, black oxide coating and solder masking, PCB component assembly processes.

(iv) Transmission lines and crosstalk:

a) Transmission Line:

Transmission lines and its effects, Significance of Transmission line in Board design,Types of Transmission lines.

b) Crosstalk:

The crosstalk in transmission lines, Crosstalk control in PCB design parts, planes, tracks, connectors, terminations, Minimization of crosstalk.

c) Thermal issues:

Thermal mapping of design

Module 2: Practice Exercises **9L**

Using any Electronic design automation (EDA) software, Practice following PCB Design steps (Open source EDA Tool KiCad Preferable)

Example circuit: Basic RC Circuit, Schematic Design: Familiarization of the Schematic Editor, Schematic creation, Annotation, Netlist generation, Layout Design: Familiarization of Footprint Editor, Mapping of components, Creation of PCB layout Schematic, Create new schematic components, Create new component footprints.

Module 3: Exercises **15L**

Regulator circuit using 7805, Inverting Amplifier or Summing Amplifier using op-amp, Full-wave Rectifier, Astable or Monostable multivibrator using IC555, RC Phase-shift or Wein-bridge Oscillator using transistor.

References:

1. Printed Circuit Board by RS Khandpur, Tata McGraw Hill Education Pvt Ltd., New Delhi
2. Electronic Product Design Volume-I by S D Mehta, S Chand Publications
3. Open source EDA Tool KiCad Tutorial: http://kicad-pcb.org/help/tutorials/
4. PCB Fabrication user guide page: http://www.wikihow.com/Create-Printed-Circuit-Boards,http://www.siongboon.com/projects/2005-09-07_home_pcb_fabrication/, http://reprap.org/wiki/MakePCBInstructions#Making_PCBs_yourself

Course Name: Control Systems – II Laboratory
Course Code: EE791
Contact: 0L:0T:2P
Credit: 1

Prerequisite: Knowledge of MATLAB.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Examine the Position Control with proper tuning of P, PI and PID controller.
- **CO2.** Demonstrate Lead-Lag Compensators.
- **CO3.** Investigate the response of a Real Time System using State Variable Analysis.
- **CO4.** Analyze Performance of Discrete-Time System and Non-Linear System.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	2	3	2	-	-	-	3	-	-	2
CO2	2	-	2	3	2	-	-	-	3	-	-	2
CO3	2	-	3	3	3	-	-	-	3	-	-	2
CO4	2	-	2	3	3	-	-	-	3	-	-	2

List of Experiments*:

1. **Study of a Practical Position Control System:**
   Obtaining closed step responses for gain setting corresponding to over-damped and under-damped responses. Determination of rise time and peak time using individualized components in SIMULINK. Determination of un-damped natural frequency and damping ratio from the experimental data.

2. **Tuning of P, PI and PID Controller for First Order Plant with Dead Time using Z-N Method:**
   Process parameters (time constant and delay/lag) will be provided, the students would compute controller gains by using Z-N method. Steady state and transient performance of the closed loop plant with and without steady disturbances will have to be noted. Theoretical phase and gain margins will have to be manually computed for each gain settings.

3. **Design of Lead and Lag Compensation Using CACSAD Tools:**
   Plant transfer function will be provided. Step response is to be obtained. (PSPICE, MATLAB, SciLab may be used).

4. **State Variable Analysis using CACSAD Command Tool:**
   Familiarization and use of CACSAD command for state variable analysis. Obtaining transfer function from SV model and vice versa. Obtaining step response for a SISO system given in SV form. (PSPICE, MATLAB, SciLab may be used).

5. **State Variable Analysis using CACSAD Block Diagram Tool:**
   Familiarization and use of CACSAD block diagram tool for state variable analysis. Obtaining step response and initial condition response for a single input, two output system given in SV form. (PSPICE, MATLAB, SciLab may be used).

6. **Performance Analysis of a Discrete Time System using CACSAD Tool:**

** **From the list of experiments a minimum of 7 (seven) experiments shall have to be performed by each student.***

Familiarization and use of CACSAD block diagram tool for Digital Control System. Study of closed response of a continuous system with a digital controller with sample and hold. (PSPICE, MATLAB, SciLab may be used).

7. **Studying the Effects of Nonlinearity in a Feedback Controlled System using Time Response:**
   Determination of step response with a limiter nonlinearity introduced into the forward path of 2nd order unity feedback control systems. The open loop plant will have one pole at the origin and the other pole will be in LHP or RHP. To verify that (i) with open loop stable pole, the response is slowed down for larger amplitude input and (ii) for unstable plant; the closed loop system may become oscillatory with large input amplitude. (PSPICE, MATLAB, SciLab may be used).

8. **Studying the Effects of Nonlinearity in a Feedback Controlled System using Phase Plane Plots:**
   Determination of phase plane trajectory and possibility of limit cycle of common nonlinearities. CACSAD block diagram tool will be used (PSPICE, MATLAB, SciLab may be used).

Reference Books:

1. Herniter, Programming in MATLAB, Vikas
2. Ogata K : Modern Control Engg. 4e, Pearson/PHI

Course Name: Electric Vehicles Laboratory
Course Code: EE792
Contact: 0L:0T:2P
Credit: 1

Prerequisite: Power Electronics and Electric Drives.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Demonstrate various electric motors drives used in Electric Vehicles.
- **CO2.** Identify various components of electric and hybrid electric vehicle and analyse its performance.
- **CO3.** Demonstrate use of solar based EV charging station.
- **CO4.** Demonstrate the use of BMS in managing energy storage devices of EVs.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	3	3	1	-	-	2	-	2	-	-	-
CO4	-	-	2	-	-	-	-	-	-	-	-	-

List of Experiment:

1. Electric Rickshaw Motor kit
2. BLDC motor-based EV
3. PMSM based Electric vehicle
4. Induction motor based electric vehicle.
5. Study of off-grid solar Inverter
6. Study of 4 Leg Semikron Stack
7. Solar based EV Charging station.
8. Study of electric vehicle system.
9. Study of hybrid electric vehicle system.
10. Demonstration of battery management System

Course Name: Object Oriented Programming Laboratory
Course Code: CS(EE)791
Contact: 0L:0T:2P
Credit: 1

Prerequisites:
1. Computer Fundamentals.
2. Basic understanding of Computer Programming and related Programming Paradigms.
3. Problem Solving Techniques with proper logic Implementation.

Course Outcomes: After successful completion of the course, student will be able to
- **CO1.** Create the procedure of communication between Objects, classes & methods.
- **CO2.** Understand the elementary facts of Object Orientation with various characteristics as well as several aspects of Java.
- **CO3.** Analyze distinct features of different string handling functions with various I/O operations.
- **CO4.** Discuss simple Code Reusability notion w.r.t. Inheritance, Package and Interface.
- **CO5.** Apply Exception handling, Multithreading and Applet (Web program in java) programming concept in Java.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	3	3	1	-	-	2	-	2	-	-	-
CO4	-	-	2	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	2	-	-	-	2	2	2	-

List of Experiment:

Module 1: Java Basics
1. Simple Java programming using operators, control statements & loops, array.
2. Programming on class, object, and method, access specifier.
3. Programming on constructor, method/constructor overloading.
4. Programming on this keyword, call by value & call by reference, static variables & methods, inner classes.

Module 2: Basic String handling & I/O
1. Programming to show the use of String class methods - charAt(), compareTo(), equals(), equalsIgnoreCase(), indexOf(), length() , substring(), toCharArray(), toLowerCase(), toString(), toUpperCase(), trim(), valueOf() methods.
2. Programming to show the use of StringBuffer class methods - append(), capacity(), charAt(), delete(), deleteCharAt(),ensureCapacity(), getChars(), indexOf(), insert(), length(), setCharAt(), setLength(), substring(), toString() methods.
3. Programming on Command line arguments.
4. Programming using keyboard input by implementing BufferedReader& Scanner classes.

Module 3: Inheritance, Interface and Java Packages
1. Programming on Simple Inheritance, super and final keywords, super() method.
2. Programming on method overriding, dynamic method dispatch,abstract classes & methods, multiple inheritance by using interface.

3. Programming on importing system package, creating user-defined package, importing user- defined package, using protected access specifier, subclassing an imported class of a package, using same names for classes of different packages, adding multiple public classes to a package.

Module 4: Exception handling, Multithreading and Applet Programming

1. Programming on exception handling using try-catch block, implementing throw and throws keywords, using finally block, creating user-defined exception.
2. Programming on creating child threads i) by extending thread class ii) by implementing runnable interface, creating child threads by assigning thread priorities.
3. Programming on creating simple applet to display some message, creating applet two add 2 integers, creating applet to do GUI based programming.

Text Books:

1. Herbert Schildt – "Java: The Complete Reference " – 9th Ed. – TMH
2. E. Balagurusamy – " Programming With Java: A Primer " – 3rd Ed. – TMH.

Reference Books:

1. R.K Das – " Core Java for Beginners " – VIKAS PUBLISHING.
2. Rambaugh, James Michael, Blaha – " Object Oriented Modelling and Design " – Prentice Hall, India.

Course Name: Microelectronics and VLSI Laboratory
Course Code: EC(EE)791A
Contact: 0L:0T:2P
Credit: 1

Prerequisite: Basic concept of Electronic Devices, Analog & Digital Electronic Circuits

Course Outcomes: After successful completion of the course, student will be able to

CO1. Measure & analyze VIL, VIH, VOL, VOH, noise margin, gate delay and average power consumption of CMOS inverter for VDD in between 0.5V - 1.2 V using nano dimensional channel length of MOS transistor following DC &transient analysis with the help of SPICE tools.

CO2. Design & explain the working of basic gates-AND/NAND, OR/NOR, XOR/XNOR gate; full adder circuit; sequential circuit -SR latch, clocked SR latch & D flip-flop using CMOS design method at schematic level for the VDD range 0.5 V to 1.2 V at nano dimensional channel length with the help of SPICE tools.

CO3. Construct the layout & examine the functionality of CMOS inverter, CMOS NAND, CMOS NOR gate using SPICE layout design tools based on design rules for VDD 0.5V to 1.2V.

CO4. Design combinational circuits - logic gates, half adder, full adder, 4:1 MUX using 2:1 MUX ; sequential circuits-S-R flip-flop, 8-bit synchronous counter, 8-bit bi-directional register with help of behavioural , dataflow , structural & mixed modelling style through VHDL code and able to demonstrate system design using FPGA at prototype level.

CO5. Design CMOS differential amplifier with active load and biased with current mirror using nano dimensional channel length of MOS transistors with the help of SPICE tools at schematic level.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	-	-	1	2	3	2	3
CO2	3	3	3	3	3	-	-	1	2	3	2	3
CO3	3	3	3	3	3	-	-	1	2	3	2	3
CO4	3	3	3	3	3	-	-	1	2	3	2	3
CO5	3	3	3	3	3	-	-	1	2	3	2	3

List of Experiment:

1. Simulation of CMOS inverter to plot voltage transfer characteristics (VTC) for different values of kn/kp ratio for VDD=1 V and nano dimensional channel length using SPICE.
   a. Measurement of critical voltages VIL, VIH, VOL , VOH from VTC.
   b. Calculation of noise margin from critical voltages.
2. Functional verification, measurement of gate delay and average power consumption of CMOS inverter circuit for VDD range 0.5V to 1.2V and with then dimensional channel length of MOS transistor using SPICE tools.
3. Design and testing of functionality of the following gate and combinational circuit with the help of SPICE tools at schematic level.
   a. CMOS AND/NAND, OR/NOR, XOR/XNOR gate
   b. CMOS full adder circuit.
4. Layout design and functional verification of CMOS inverter, CMOS NAND, CMOS NOR gate using layout design tools of SPICE based on design rules.
5. Design and examination of functionality of the sequential circuits - CMOS SR latch,

clocked SR latch & D flip-flop at schematic level using SPICE tools.

6. Design and simulation of a) Logic gates b) Full adder using half adder c) 4:1 MUX using 2:1 MUX with the help of VHDL following suitable modelling style (structural, behavioral, dataflow, mixed).
7. Design of the following Sequential circuits using VHDL a) S-R Flip-Flop b) 8 bit synchronous counter c) 8 Bit bi-directional register with tri-stated input output.
8. Familiarity with FPGA based system design. Design and realization of 4:1Mux using FPGA.
9. Design of CMOS differential amplifier at schematic level with active load and current mirror bias circuit for given specifications using SPICE tools.
10. Innovative experiment.

Paper Name: PCB Design and Manufacturing Laboratory
Paper Code: EC(EE)791B
Contact: 0L:0T:2P
Credit: 1

Prerequisite: Knowledge of analog and digital circuits..

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

- **CO1.** Appreciate the necessity and evolution of PCB, types and classes of PCB.
- **CO2.** Understand the steps involved in schematic, layout, fabrication and assembly process of PCB design..
- **CO3.** Understand basic concepts of transmission line, crosstalk and thermal issues.
- **CO4.** Design (schematic and layout) PCB for analog circuits, digital circuits and mixed circuits.
- **CO5.** Design (schematic and layout) and fabricate PCB for simple circuits.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	-	-	-	-	-	-	2	2	3
CO2	2	3	2	3	-	-	-	-	-	2	2	3
CO3	3	2	1	2	3	-	-	-	-	2	3	2
CO4	1	2	1	2	1	-	-	-	-	2	1	2
CO5	3	2	2	1	3	-	-	-	-	2	3	2

List of Experiment:

1. Introduction to circuit creation and simulation software
2. Introduction to Layout Tool, and creating Layout board
3. Design a half wave rectifier.
4. Design a full wave centre tapped rectifier.
5. Design a clipper circuits.
6. Design a clamper circuits.
7. Design a RLC resonance circuit & verify the transient response for different values of R, L & C
8. Design a 8051 Development board having
   a) Power section consisting of IC7805, capacitor, resistor, headers, LED
   b) Serial communication section consisting of MAX 232, Capacitors, DB9 connector, Jumper, LEDs
   c) Reset & Input/ output sections consisting of89C51 Microcontroller, Electrolytic Capacitor, Resistor, Jumper, Crystal Oscillator, Capacitors

Tools and materials required for PCB fabrication:

a) Open source EDA Tool KiCad.
b) Single-sided copper clad sheet.
c) Diluted Acidic solution for copper etching purpose with plastic tray.
d) Tapes and pads for layout design of different dimensions.
e) Hand drilling/Power drilling machine.
f) Tool kit (tong, hand gloves etc.)

4th Year 8th Semester									
l. No.	**Broad Category**	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. Theory									
1	ENGG	Major	EE801A	Renewable Energy – II	2	0	0	2	2
			EE801B	Restructured Power Systems					
			EE801C	Power System Operation and Control					
2	ENGG	Major	EE802A	Flexible AC Transmission Systems	2	0	0	2	2
			EE802B	Remote Sensing and GIS					
			EE802C	Robotics Engineering					
3	ENGG	Major	EE803A	Advanced Electric Drives	2	0	0	2	2
			EE803B	Illumination Engineering					
			EE803C	High Voltage Engineering					
4	ENGG	Minor	EC(EE)801	Digital Image Processing	3	0	0	3	3
			ME(EE)801	Power Plant Engineering					
			ECS(EE)801	Process Control					
B. Practical									
5	ENGG	Minor	EC(EE)891	Digital Image Processing Laboratory	0	0	2	2	1
			ME(EE)891	Power Plant Engineering Laboratory					
			ECS(EE)891	Process Control Laboratory					
6	ENGG	Major	EE881	Grand Viva	0	0	0	0	2
7	PROJ	Project	EE882	Major Project – II	0	0	12	12	6
Total for Theory and Practical								**23**	**18**

Course Name: Renewable Energy – II
Course Code: EE801A
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: Concept of energy conversion, Power system, Machine.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Obtain the basic knowledge of biomass energy conversion techniques and its types with waste into useful energy conversion.
- **CO2.** Obtain the knowledge of basic operating principles of tidal and wave energy to design an Ocean Thermal Energy Conversion (OTEC) plant.
- **CO3.** Understand the working principles of geothermal energy and fuel cell and its application along with estimation.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	3	-	-	-	-	3
CO2	3	-	3	-	2	2	2	-	2	-	2	-
CO3	2	2	3	-	-	3	2	-	-	-	2	-

Course Content

Module 1: Introduction to Renewable Energy Sources 3L

World energy resources - Indian energy scenario – Environmental aspects of energy utilization; review of conventional energy resources- Different form of nonconventional energy; Renewable energy resources and their importance – role of energy in economic development and social transformation.

Module 2: Biomass Energy 7L

Origin of biomass from different sources; Biomass resource assessment - Estimation of woody biomass, non woody biomass and wastes, ASTM standards. Bulk chemical properties - Moisture content, proximate and ultimate analyses, calorific value, and waste water analysis for solids; Anaerobic digestion, biogas production mechanism and technology, types of digesters, design of biogas plants, installation, operation and maintenance of biogas plants, biogas slurry utilization and management, biogas applications, cost benefit analysis of biogas for cooking, lighting, power generation applications, Feedstock for biogas, Microbial and biochemical aspects, operating parameters for biogas production. Kinetics and mechanism, Bio hydrogen production: hydrolysis, fermentation. Biodiesel production, different types of raw materials, non-edible oil-seeds, Pyrolysis, mechanism of trans esterification, fuel characteristics of biodiesel.

Module 3: Ocean and Tidal Energy 6L

Ocean energy resources, ocean energy routes; principles of ocean thermal energy conversion systems; principles of ocean wave energy conversion and tidal energy conversion; Ocean power generation: tidal energy estimation, components of tidal power plant, wave area of determining energy, mathematical analysis of wave energy, Wave energy conversion machine, Working principle – OTEC, Anderson closed cycle OTEC system, thermoelectric OTEC.

Module 4: Geothermal Energy 5L

Geothermal energy: Geothermal energy sources – types and potential principle of working and operation of different types of geothermal power generation- Direct and indirect uses of geothermal

energy resources; geothermal energy conversion technologies; High temperature geothermal power plants; Environment impacts; Estimation of geothermal power –Future of geothermal energy.

Module 5: Fuel Cell **3L**

Fuel cells – Principle of operation, classification and types of fuel cells – comparison on battery vs. fuel cell- Applications- Limitations and future prospect.

Text Books:

1. Kothari ,Renewable Energy Sources and Emerging Technologies, PHI, Eastern Economy
2. R.K.Rajpoot, Non-Conventional Energy Sources and Utilization, S. Chand Publication, New Delhi.
3. John Twidell and Tony Weir, Renewable Energy Resources, Second edition, Taylor & Francis, 2006.
4. Ronald Shaw, Wave Energy: A Design Challenge, Eills Horwood Ltd. Publishers, First Edition 1982.

Reference Books:

1. K.C. Khandelwal and S.S. Mahdi, Biogas Technology– A Practical Handbook, Tata McGrawHill, 1986.
2. Rai, G.D, Non-Conventional Energy Sources, Khanna Publishers, New Delhi
3. N. K. Bansal and M.K. Kleema, Renewable Sources of Energy and Conversion Systems
4. J. Twidell & T. Weir, Renewable Energy Resources, Taylor and Francis; 2006 (2nd ed)

Paper Name: Restructured Power Systems
Paper Code: EE801B
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisites: Engineering Mathematics, Fundamentals of Power System Operation.

Course Outcome: After successful completion of the course students will be able to

CO1. Understand the need for restructuring of Power Systems, discuss different market models, different stakeholders and market power.

CO2. Understand and generalize the functioning and planning activities of Independent System Operator (ISO) and to define ancillary services and understand reactive power as ancillary service.

CO3. Understand transmission open access pricing issues and congestion management, define transfer capability and estimate the transfer capability.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	1	1	-	-	1	1	1
CO2	2	2	1	1	-	1	1	-	-	1	1	1
CO3	2	2	1	1	-	1	1	-	-	1	2	1

Course Content

Module 1: Introduction to restructuring of power industry 3L

Introduction, Reasons for restructuring / deregulation of power industry, Understanding the restructuring process, Introduction to issues involved in deregulation, Reasons and objectives of deregulation of various power systems across the world.

Module 2: Power System Operation 8L

Introduction, need for operational reliability, value of reliability, cost of reliability, procuring reliability resources, operational issues, balancing resources, effect of generation from stochastic renewable sources, limits on power transfer, voltage control and reactive support, stability services, system restoration, market models, obtaining reliability resources, market for reliability resources, buying reliability resources, co-optimization of energy and reserve in a centralized electricity market, allocation of transmission capacity between energy and reserve, allocating the costs, who should pay for reserve, selling reliability resources.

Module 3: Transmission Congestion Management 5L

Introduction, Classification of congestion management methods, Calculation of ATC, Non-market methods, Market based methods, Nodal pricing, Price area congestion management, Capacity alleviation method.

Module 4: Pricing of transmission network usage and loss allocation 4L

Introduction to transmission pricing, Principles of transmission pricing, Classification of transmission pricing methods. Attributes of a perfectly competitive market, The firm's supply decision under perfect competition, Imperfect competition, Market power.

Module 5: Investing in Transmission 4L

Nature of transmission business, cost based transmission expansion, allocating the cost of

transmission, optimal transmission capacity, effect of load fluctuation, load duration curve, the transmission demand function.

Text Books:

1. 1.Daniel Kirschen and Goran Strbac, "Fundamentals of Power System Economics", John Wiley & Sons Ltd, 2004.
2. Jin Zhong, Power System Economics and Market Operations, CRC Press
3. Jeremy Lin Fernando H. Magnago, Electricity Markets Theories and Applications, IEEE Press, Wiley.

Reference Books:

1. Sally Hunt, "Making competition work in electricity", John Wiley & Sons, Inc., 2002.
2. Kankar Bhattacharya, Jaap E. Daadler, Math H. J. Bollen, "Operation of Restructured Power Systems", Kluwer Academic Pub., 2001.

Paper Name: Power System Operation and Control
Paper Code: EE801C
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisites: Engineering Mathematics, Basic Electrical Engineering, Power System.

Course Outcome: After successful completion of the course students will be able to

- **CO1.** To get an overview of system operation and control.
- **CO2.** To understand and model power-frequency dynamics and to design power-frequency controller.
- **CO3.** To acquire knowledge on the reactive power-voltage and different methods of control for maintaining voltage profile against varying system load.
- **CO4.** To Design SCADA and its application for real time operation.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	-
CO2	1	3	2	-	2	1	-	-	-	-	-	2
CO3	1	3	2	-	2	1	-	-	-	-	-	2
CO4	-	3	3	2	2	-	-	-	-	-	-	3

Course Content

Module 1: Introduction **4L**

Power scenario in Indian grid – National and Regional load dispatching centers –necessity of voltage and frequency regulation - real power vs frequency and reactive power vs voltage control loops - system load variation, basic concepts of load dispatching, Basics of speed governing mechanisms and modeling - speed load characteristics - regulation of two generators in parallel

Module 2: Real Power - Frequency Control **4L**

Load Frequency Control (LFC) of single area system-static and dynamic analysis of uncontrolled and controlled cases - LFC of two area system - tie line modeling - block diagram representation of two area system - static and dynamic analysis - tie line with frequency bias control

Module 3: Control of Voltage and Reactive Power **6L**

Generation and absorption of reactive power - basics of reactive power control – Automatic Voltage Regulator (AVR) – brushless AC excitation system – block diagram representation of AVR loop - static and dynamic analysis, voltage drop in transmission line - methods of reactive power injection - tap changing transformer, SVC (TCR + TSC) and STATCOM for voltage control.

Module 4: Economic Operation of Power System **5L**

Statement of economic dispatch problem - input and output characteristics of thermal plant - incremental cost curve - optimal operation of thermal units without and with transmission losses Unit Commitment (UC)- constraints on UC problem, solution of UC problem using priority list.

Module 5: Computer Control of Power Systems **5L**

Need of computer control of power systems-concept of energy control centers and functions – PMU - system monitoring, data acquisition and controls - System hardware configurations - SCADA and EMS functions - state estimation problem – measurements and errors.

Text Books:

1. S. Sivinagaraju and G. Sreenivasan “Power System Operation and Control” Pearson Publications.
2. Abhijit Chakrabarti and Sunita Halder, “Power System Analysis Operation and Control”, PHI learning Pvt. Ltd., New Delhi, Third Edition, 2010.
3. Allen. J. Wood and Bruce F. Wollen Berg, ‘Power Generation, Operation and Control’, John Wiley & Sons, Inc., 2016

Reference Books:

1. Dr. K, Uma Rao “Power System Operation and Control”. Wiley Publications.
2. Olle. I. Elgerd, Patrick D.van der Puije “Electric Power Engineering”, McGraw Hill Education Pvt. Ltd., New Delhi, 34th reprint, 2010.
3. Yao-nan Yu “Electric Power System Dynamics”, Academic Press.

Paper Name: Flexible AC Transmission Systems
Paper Code: EE802A
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisites: Power System and Power Electronics.

Course Outcomes: After the completion of the course, the student will be able to

- **CO1.** Acquire knowledge about the fundamental principles of Passive and Active Reactive Power Compensation Schemes at Transmission and Distribution level in Power Systems.
- **CO2.** Learn various Static VAR Compensation Schemes like Thyristor/GTO Controlled.
- **CO3.** Reactive Power Systems, PWM Inverter based Reactive Power Systems and their controls.
- **CO4.** To develop analytical modeling skills needed for modeling and analysis of such Static VAr Systems.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	2	3	-	-	-	-	2	3
CO2	3	3	2	3	3	1	2	-	-	-	2	3
CO3	3	2	3	3	1	3	-	-	-	-	2	3
CO4	3	3	3	3	2	3	3	-	-	-	2	3

Course Content

Module 1: Introduction **3L**

FACTS – a toolkit, basic concepts of static VAr compensator, Resonance Damper, thyristor-controlled series capacitor, static condenser, phase angle regulator and other controllers.

Module 2: Series compensation schemes **5L**

Sub-synchronous resonance, torsional interaction, torsional torque, compensation of conventional, ASC, NGH damping schemes, modeling and control of thyristor-controlled series compensators.

Module 3: Unified power flow control **6L**

Introduction, Implementation of power flow control using conventional thyristors, Unified power flow concept, Implementation of unified power flow controller. Phasor Monitoring Units; Power System Control using Synchro phasors.

Module 4: Design of facts controllers **5L**

Approximate multi-model decomposition, variable structure FACTS controllers for power system transient stability, non-linear variable-structure control, variable structure series capacitor control and variable structure resistor control.

Module 5: Static var compensation **5L**

Basic concepts, thyristor-controlled reactor (TCR), Thyristor Switched Reactor (TSR), Thyristor Switched capacitor (TSC), saturated reactor (SR), fixed capacitor (FC).

Text Books:

1. Narin G. Hingorani, Flexible AC transmission, IEEE Spectrum, April 1993, pp 40-45.
2. Narin G. Hingorani, High Power Electronics and flexible AC Transmission systems, IEEE

High Power Engineering Review, 1998.
3. Narin G. Hingorani, Power Electronics in Electric Utilities: Role of Power Electronics in future power systems, Proc. of IEEE, IEEE, Vol.-76, No.-4, April 1988.

Reference Books:

1. Einar V Larsen, Juan J. Sanchez-Gasca, Joe H. Chow, Concepts for design of FACTS Controllers to damp Power Swings, IEEE Trans on Power Systems, Vol.-10, No.-2, May 1995.
2. Gyugyi L., Unified Power Flow Control Concept for Flexible Ac Transmission, IEEE Proc-C Vol.-139, No.-4 July 1992.

Paper Name: Remote Sensing and GIS
Paper Code: EE802B
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisites: Knowledge of Remote Sensing, GIS & GNSS.

Course Outcomes: After the completion of the course, the student will be able to

- **CO1.** Understand about the principles of Remote Sensing and its advantages and limitations.
- **CO2.** Retrieve the information content of remotely sensed data.
- **CO3.** Apply problem specific remote sensing data for engineering applications.
- **CO4.** Analyze spatial and attribute data for solving spatial problems.
- **CO5.** Create GIS and cartographic outputs for presentation.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	-	-	-	-	-	-	-	2	3
CO2	2	3	2	3	-	-	-	-	-	-	2	3
CO3	3	2	1	2	3	-	-	-	-	-	2	3
CO4	1	2	1	2	1	-	-	-	-	-	2	3
CO5	3	2	2	1	3	-	-	-	-	-	2	3

Course Content

Module 1: **6L**

Basic component of remote sensing (RS), advantages and limitations of RS, possible use of RS techniques in assessment and monitoring of land and water resources; electromagnetic spectrum, energy interactions in the atmosphere and with the Earth's surface; major atmospheric windows; principal applications of different wavelength regions; typical spectral reflectance curve for vegetation, soil and water, spectral signatures.

Module 2: **4L**

Different types of sensors and platforms; contrast ratio and possible causes of low contrast; aerial photography; types of aerial photographs, scale of aerial photographs, planning aerial photography- end lap and side lap; stereoscopic vision, requirements of stereoscopic photographs; air-photo interpretation- interpretation elements.

Module 3: **6L**

Photogrammetry- measurements on a single vertical aerial photograph, measurements on a stereo-pair- vertical measurements by the parallax method; ground control for aerial photography; satellite remote sensing, multispectral scanner- whiskbroom and push-broom scanner; different types of resolutions; analysis of digital data- image restoration; image enhancement; information extraction, image classification, unsupervised classification, supervised classification, important consideration in the identification of training areas, vegetation indices.

Module 4: **4L**

Microwave remote sensing. GI Sand basic components, different sources of spatial data, basic spatial entities, major components of spatial data, Basic classes of map projections and their properties.

Module 5: **4L**

Methods of data input into GIS, Data editing, spatial data models and structures, Attribute data management, integrating data (map overlay) in GIS, Application of remote sensing and GIS for the management of land and water resources.

Text Books:

1. Reddy Anji, M. 2006. Textbook of Remote Sensing and Geographical Information Systems. BS Publications, Hyderabad.
2. Elangovan, K. 2006. GIS Fundamentals Applications and Implementations. New India Publication Agency, New Delhi.
3. George Joseph. 2005. Fundamentals of Remote Sensing. 2nd Edition. Universities Press (India) Private Limited, Hyderabad.

Reference Books:

1. Jensen, J.R. 2013. Remote Sensing of the Environment: An Earth Resource Perspective. Pearson Education Limited, UK.
2. Lillesand, T., R.W. Kiefer and J. Chipman. 2015. Remote Sensing and Image Interpretation. 7th Edition, John Wiley and Sons Singapore Pvt. Ltd., Singapore.
3. Sabins, F.F. 2007. Remote Sensing: Principles and Interpretation. Third Edition, Waveland Press Inc., Illinois, USA.

Paper Name: Robotics Engineering
Paper Code: EE802C
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisites: Knowledge of control system, signal system & different types of sensors.

Course Outcomes: After the completion of the course, the student will be able to

- **CO1.** Explain the basic elements of industrial robots.
- **CO2.** Analyse robot kinematics and its control methods.
- **CO3.** Classify the various sensors used in robots for better performance.
- **CO4.** Summarize various industrial and non-industrial applications of robots.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	2	-	-	-	-	-	-	-	2	3
CO2	1	3	1	-	-	-	-	-	-	-	2	3
CO3	3	2	3	2	-	-	-	-	-	-	2	3
CO4	2	2	3	2	-	-	-	-	-	-	2	3

Course Content

Module 1: Robot Basics and Robot Elements 8L

Robot - Basic concepts, Need, Law, History, Anatomy, specifications. Robot configurations- cartesian, cylinder, polar and articulate. Robot wrist mechanism, Precision and accuracy of robot.
End effectors - Classification, Types of Mechanical actuation, Gripper design, Robot drive system Types, Position and velocity feedback devices-Robot joints and links-Types, Motion interpolation.

Module 2: Robot Kinematics and Control 7L

Robot kinematics – Basics of direct and inverse kinematics, Robot trajectories, 2D and 3D Transformation-Scaling, Rotation, Translation Homogeneous transformation.
Control of robot manipulators – Point to point, Continuous Path Control, Robot programming

Module 3: Robot Sensors 4L

Sensors in robot – Touch sensors-Tactile sensor – Proximity and range sensors. Force sensor-Light sensors, Pressure sensors, Introduction to Machine Vision and Artificial Intelligence.

Module 4: Robot Applications 5L

Industrial applications of robots, Medical, Household, Entertainment, Space, Underwater, Defense, Disaster management. Applications, Micro and Nanorobots, Future Applications.

Text Books:

1. Mikell P. Groover, Mitchell Weiss, Roger N Nagel, Nicholas G Odrey, “Industrial Robotics Technology, Programming and Applications”, Tata – McGraw Hill Pub. Co., 2008.
2. Deb. S. R and Sankha Deb, "Robotics Technology and Flexible Automation", Tata McGraw Hill Publishing Company Limited, 2010.
3. Klafter. R. D, Chmielewski. T. A, and Noggin’s., “Robot Engineering: An Integrated Approach”, Prentice Hall of India Pvt. Ltd., 1994.

Reference Books:

1. Fu.K.S, Gonzalez.R.C&Lee.C.S.G, “Robotics control, sensing, vision and intelligence”, Tata- McGraw Hill Pub. Co., 2008
2. Yu. “Industrial Robotics”, MIR Publishers Moscow, 1985.

Paper Name: Advanced Electric Drives
Paper Code: EE803A
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisites: Concept of Electrical Machines and Power Electronics.

Course Outcome: After successful completion of the course students will be able to

- **CO1.** Analyze the operation of power electronic converters and their control strategies.
- **CO2.** construct the modelling of AC motors in different reference frames.
- **CO3.** Understand the vector control strategies for ac motor drives.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	-	-	-	-	-	-	-	-
CO2	1	3	2	-	1	-	-	-	1	-	-	1
CO3	1	3	2	-	1	-	-	-	1	-	-	1

Course Content

Module 1: Power Electronic Converters for AC Drives 8L
Review of Three-Phase Inverter with square-wave switching, Pulse Width Modulation Techniques – SPWM, SHEPWM, SVM, current control of VSI with PWM, three-level inverter and its different topologies, SVM for three-level inverter, H-bridge as a four-quadrant drive.

Module 2: Modelling and Control of DC Machines 4L
Electromechanical modelling, state-space modelling, Block diagram and transfer function, Control of separately excited dc motor drives for Inner current loop and speed control design.

Module 3: Induction Motor Drives 5L
Different transformations and reference frame theory, modelling of induction machines, voltage fed inverter control, open loop Volt/Hz control, vector control, direct torque and flux control, Introduction to three-phase traction drives with parallel machines.

Module 5: Permanent Magnet Motor Drives 4L
Introduction to various PM motors, BLDC and PMSM drive configuration, comparison, block diagrams, Speed and torque control in BLDC and PMSM.

Module 6: Switched Reluctance Motor Drives 3L
Evolution of switched reluctance motors, various topologies for SRM drives, comparison, closed loop speed and torque control of SRM.

Text Books:

1. B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, Asia, 2003.
2. R. Krishnan, "Permanent Magnet Synchronous and Brushless DC motor Drives", CRC Press, 2009.

Reference Books:

1. P. C. Krause, O. Wasynczuk and S. D. Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley & Sons, 2013.
2. Bin-Wu, "High-power Converters and AC Drives", IEEE Press, John Wiley & Sons, 2006.

Paper Name: Illumination Engineering
Paper Code: EE803B
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisites: Concept of Physics, Basic Electrical Engineering.

Course Outcome: After successful completion of the course students will be able to

- **CO1.** Understand the fundamental concept of illumination and its measurements with different apparatus.
- **CO2.** Understand the characteristics of various types of lamp with their accessories and their control circuits.
- **CO3.** Apply the concept of different lighting scheme for interior and exterior lighting design.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	-	2	-	-	-	-	-	3
CO2	3	2	2	-	2	2	2	-	-	-	2	3
CO3	3	1	2	2	3	3	2	-	-	-	2	3

Course Content

Module 1: Fundamentals of Light **4L**

Types of illumination, Theory of gas discharge and production of light, Perception of light and colour, Radiation of energy, Electromagnetic radiation and Electromagnetic spectrum, Human eye as an optical system, Spectral sensitivity of human eye, Visual characteristics and Visual performance.

Module 2: Measurement of Light **5L**

Definition of luminous flux, Luminous intensity, Lumen, Candle power, Illumination, M.H.C.P, M.S.C.P, M.H.S.C.P, Lamp efficiency, Brightness or luminance, Photometry – Fundamentals of detector, Application of Polar Photometer and Goniophotometer, Calculation of luminance and illumination, Luxmeter, CIE standard source of illuminant, Colorimetry –Source colour and Object colour. Colorimetric instrument, Colour rendering index.

Module 3: Lamp, Accessories and Luminaries **4L**

Lamp materials – glass, filament, phosphor coating, ceramics, electrodes, gases, capping cement etc., Theory and basic properties of low and high pressure gas discharge. Theory of operation, Life, Characteristics and Application of - High and Low pressure sodium vapour, High and Low pressure mercury vapour, Metal halide, Fluorescent lamp, LED, LASER, Luminaire – Types of luminaire, Design consideration, Indian standard recommendation.

Module 4: Illumination Control and Control circuits **4L**

Purpose of lighting control in view of energy conservation, Operation of Electromagnetic and Electronic ballast and their comparison in light control, Function of Ignitor in lamps, Control circuits and operation of Fluorescent lamp circuit, Low pressure sodium vapour lamp circuit, High pressure sodium vapour lamp circuit.

Module 5: Interior Lighting **4L**

National standards of interior lighting calculation, Design considerations for interior lighting of

Residential complex, Commercial complex, Industrial premises, Day lighting – Sky luminance pattern, Daylight factor, estimation of average daylight factor, window design considerations for maximum day lighting, Application of daylight in interior lighting, Use of photocell, occupancy sensor in lighting controls, Concept of Isolux contour in lighting design.

Module 6: Exterior Lighting 3L

Lighting calculations of exterior lighting, Calculation of lighting and design considerations for exterior lighting of Road lighting, Flood lighting, Industrial complex, Commercial complex, Sports complex, National and CIE standards of exterior lighting calculation.

Text Books:

1. Generation, Distribution and Utilization of Electrical Energy, C.L. Wadha, New Age International Ltd.
2. Applied Illumination Engineering, Jack L. Lindsey, The Fairmont Press Inc.
3. Art and Science of Utilization of Electrical Energy, H. Partab, Dhanpat Rai & Sons.
4. Standard Hand Book for Electrical Engineers, Fink & Beaty, McGraw Hill International.

Reference Books:

1. Utilization of Electric Power, C.L. Wadha, New Age International Ltd.
2. Handbook of Applied Photometry, Casimer M Decusatis, Springer.
3. Light Engineering: Applied calculations, R.H. Simons, Robert Bean, Architectural Press.

Paper Name: High Voltage Engineering
Paper Code: EE803C
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisites: Concept of Basic Physics, Measurement and Instrumentation, Fundamentals of Power System, Switchgear, Travelling waves.

Course Objective: To introduce the concepts of breakdown in gases, solids, generation and measurement of high voltage and their tests.

Course Outcomes: On completion of the course students will be able to

- **CO1.** Understand the basic physics associated with various breakdown processes in different insulating materials.
- **CO2.** Knowledge of generation and measurement of A.C., D.C. Impulse voltages and currents.
- **CO3.** Knowledge of tests on H.V. equipment and on insulating materials, as per the standards.
- **CO4.** Knowledge of the causes of Overvoltages in power system and Insulation Coordination in a substation.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	-	-	-	-	-	-	-	2	3
CO2	3	3	1	-	-	-	-	-	-	-	2	3
CO3	3	2	2	-	-	-	-	-	-	-	2	3
CO4	3	3	2	-	-	-	-	-	-	-	2	3

Course Content

Module 1: Breakdown Occurrences **6L**

i) Breakdown of Gases:

Ionization processes and de-ionization processes, Types of Discharge, Charge multiplication, Secondary emission, Townsend's Theory, Streamer Mechanism, Paschen's Law, Gases as insulating materials, Determination of Minimum breakdown voltage, Breakdown in uniform and non-uniform gaps, Corona discharge.

ii) Breakdown of Liquid:

Breakdown in pure and commercial liquids, Cavitation Theory, Suspended Particle Theory.

iii) Break Down of Solids:

Intrinsic Breakdown, Electromechanical Breakdown, Thermal Breakdown, Streamer Breakdown.

iv) Partial Discharge:

Definition and development in solid dielectrics and composite dielectrics.

v) Breakdown in Vacuum:

Non-metallic electron emission mechanism, Clump mechanism, Effect of pressure on breakdown voltage.

Module 2: Generation of High Voltages and Currents **4L**

i) Generation of High Alternating Voltages and Currents:

Testing transformer, Cascaded transformer, Series resonant circuit, single stage and multi stage. Advantages of Series Resonant Circuit in testing of cables.

ii) Generation of High D.C. Voltages and Currents.:

Cockcroft Walton doubler and multistage circuit, Electrostatic generator.
Definition of Impulse Voltage and current as per Indian Standard Specification, Wave front and wave tail time, Generation of Impulse Voltage, Multistage Impulse generator, tripping and control of impulse generators.

Module 3: Measurement of High Voltages and Currents 5L

Peak voltage, impulse voltage and high direct current measurement method as per Indian Standard Specifications, cathode ray oscillographs for impulse voltage and current measurement, Sphere gap voltmeter, Resistance and Capacitance Potential dividers, Peak voltmeters for measurement of high A.C. voltage in conjunction with capacitance dividers. Capacitance Voltage Transformer, Rotating Voltmeter for the measurement of D.C. high voltage, partial discharge measurements, Electrostatic Voltmeter.

Module 4: Lightning and Switching Over-voltages 5L

Lightning Phenomena, Charge formation in the Clouds, Development of Lightning Stroke, lightning induced over voltage, direct stroke, indirect stroke. Protection of Electrical Apparatus against over voltage, Lightning Arrestors, Valve Type, Metal Oxide arresters, Expulsion type. Effect of location of lightning arresters on protection of transformer. Protection of substation, Ground wires, Surge diverters, Surge absorbers, Insulation Coordination, Basic Insulation level. Basic Impulse level, Switching Impulse level. Volt time characteristics of protective devices, Determination of Basic Impulse level of substation equipment.

Module 5: High Voltage Testing of Electrical Apparatus and High Voltage Laboratories 4L

Various standards for HV Testing of electrical apparatus, IS, IEC standards, Testing of insulators and bushings, testing of isolators and circuit breakers, testing of cables, power transformers and some high voltage equipment, induced over voltage and impulse test on transformers, Power frequency dry and wet withstand test of insulators, Impulse test on insulators, High voltage laboratory layout, indoor and outdoor laboratories, testing facility requirements, safety precautions in H.V. Laboratories.

Text Books:

1. High Voltage Engineering, C.L. Wadhwa, New Age International Publishers.
2. High Voltage Engineering, M.S. Naidu & V. Kamaraju, Tata McGraw Hill publication.
3. Extra High Voltage AC Transmission Engineering, R.D. Bgamudre, New Age Internal Publishers.
4. D. V. Razevig (Translated by Dr. M. P. Chourasia), “High Voltage Engineering Fundamentals”, Khanna Publishers.

Reference Books:

1. High Voltage Engineering, M.A. Salem, H. Anis, A. E. Morahedy, R. Radwan, Marcel Dekker, Inc.
2. E. Kuffel, W. S. Zaengl and J. Kuffel, “High Voltage Engineering Fundamentals”, Newnes Publication.
3. R. Arora and W. Mosch “High Voltage and Electrical Insulation Engineering”, John Wiley & Sons.
4. Various IS standards for HV Laboratory Techniques and Testing.

Paper Name: Digital Image Processing
Paper Code: EC(EE)801
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Digital Signal Processing.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Familiarize with Digital Image characteristics, its representation in different domain.
- **CO2.** Analyze digital image enhancement techniques in spatial and frequency domain.
- **CO3.** Analyze the performance of image compression, segmentation and security.
- **CO4.** Apply image processing algorithms in different applications and solve problems.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	-	-	-	-	-	-	1	1	-
CO2	3	-	2	2	-	-	-	-	2	-	2	1
CO3	3	1	3	1	-	-	-	-	-	-	1	1
CO4	2	3	2	2	-	-	-	-	-	2	-	2

Course Content

Module 1: Digital Imaging Fundamentals and Transform of Digital Images 10L

Digital Imaging Fundamentals: Basic idea of Digital image, Pixel, Mathematical operation of Digital Image, Sampling, Quantization, application of digital Image Processing.

Transform of Digital Images: Importance of Digital Image Transform, Fourier Transform of Digital Image (DFT), Inverse Fourier Transform (IDFT), Application of Digital Image Transform in different area

Module 2: Digital Image Enhancement 9L

Importance of Digital Image enhancement, enhancement in spatial and frequency domain, Bit plane slicing, Histogram, Histogram Equalization, Mean and Median filtering in Digital Images, Frequency domain filtering in Digital Images – LPF, HPF and BPF.

Module 3: Digital Image Compression 10L

Importance of Digital Image Compression, Types of Image Compression, example of lossless and lossy compression, Image compression standards, Compression in spatial domain, compression using Huffman coding, Filter Bank analysis Segmentation of Digital Images: Importance and applications of Image Segmentation, Thresholding, Segmentation based on Region Growing, Watershed algorithm. Edge detection in Digital Image Processing: Importance of Edge detection in Digital Image Processing, Types of Edge Detection, Mathematical Equation of each operator.

Module 4: Security in Digital Image Processing 7L

Importance of Digital Image Security, Watermarking, Image encryption in spatial and frequency domain, Steganography. Application of Artificial Intelligence/ Machine Learning in Image and Video Processing

Text Books:

1. Rafael C. Gonzales, Richard E. Woods, “Digital Image Processing”, Third Edition, Pearson Education, 2010.

2. S. Annadurai, R. Shanmugalakshmi, “Fundamentals of Digital Image Processing”, Pearson Education, 2006
3. Digital Video processing, A Murat Tekalp, Prentice Hall

Reference Books:

1. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, “Digital Image Processing Using MATLAB”, Third Edition Tata Mc Graw Hill Pvt. Ltd., 2011.
2. Anil Jain K. “Fundamentals of Digital Image Processing”, PHI Learning Pvt. Ltd., 2011.
3. Willliam K Pratt, “Digital Image Processing”, John Willey, 2002.
4. Malay K. Pakhira, “Digital Image Processing and Pattern Recognition”, First Edition, PHI Learning Pvt. Ltd., 2011.

Course Name: Power Plant Engineering
Course Code: ME(EE)801
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Concept of Energy Conversion.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand the principles of operation for different power plants.
- **CO2.** Understand the economics of operation for different power plants.
- **CO3.** Analyse the interconnection between different power plants.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	3
CO2	3	-	3	-	-	-	-	-	-	-	2	-
CO3	2	-	3	-	-	-	2	-	-	-	2	-

Course Content

Module 1: Basics of Power Generation **2L**

Importance of electrical power in daily life, Different forms of energy, Comparison of different energy sources, Power crisis in India and Future Trend, Overview of method of electrical power generation.

Module 2: Coal Based Thermal Power Plants **8L**

List of thermal power stations in the state with their capacities, basic Rankine cycle and its modifications, Selection of site for thermal power stations, Layout of modern coal power plant, Quality of fuel and its effect on quality of power generation, Operation of different components Super critical boilers, FBC boilers, Economizer, Air pre heater, Super-heaters and re-heaters, Steam turbines, Condensers, Spray ponds and cooling towers, subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, binary cycles and cogeneration systems, Merits and demerits of Thermal Power Plants.

Module 3: Nuclear Power Stations **6L**

Basics of nuclear energy conversion, Selection of site for Nuclear Power plants, Block diagram and working of Nuclear Power station, Fuels used in Nuclear Power Station, subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants, Merits and demerits of Nuclear Power Plants, List of Nuclear power stations in state and county with their capacities.

Module 4: Hydro Power Stations **5L**

Selection of site and classification of Hydroelectric Power Plants, Layout and working of Hydro Power Station, Types of Turbines and generators used, Pumped storage Power Plant, Merits and demerits of Hydro Power Station, List of Hydro Power stations with their capacities and number of units in the state.

Module 5: Gas Turbine Power Plants **3L**

Selection of site for Gas Turbine Power Station, Fuels for gas turbine, Brayton cycle analysis and optimization, elements of gas turbine power plants, combined cycle power plants, Integrated

Gasifier based Combined Cycle (IGCC) systems, Merits, demerits and application Gas turbine power plants.

Module 6: Diesel Electric Power Stations 3L

Selection of site for Diesel Electric Power Station, Elements of diesel Electric power plants and their working, Operation, maintenance & trouble shooting, chart of diesel Electric plant, Merits, demerits and applications of diesel electric power stations, Performance and thermal efficiency of Diesel Electric Power Plant.

Module 7: Non-Conventional Energy Sources 3L

Types of non-conventional energy sources, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems.

Module 8: Economics of Power Generation 3L

Energy, economic and environmental issues, power tariffs, load distribution parameters, load curve, firm power, cold reserve, hot reserve, spinning reserve, capital and operating cost of different power plants, Factors affecting the cost of Generation, pollution control technologies including waste disposal options for coal and nuclear plants.

Module 9: Interconnected Power Systems 3L

Advantages of Interconnection, Base load and peak loads, load allocation among various types of power stations, Load sharing and transfer of load between power stations, Inter connection of power stations at state and national level.

Text Books:

1. P. K. Nag Power plant Engineering, Tata McGraw Hill.
2. T. C. Elliot, K. Chen and R. C. Swanekamp, Power Plant Engineering, 2nd ed., McGraw Hill, 1998.
3. M. M. El Wakil, Power Plant Technology, Tata McGraw Hill, 2010.
4. Arora and Domkundwar A course in Power Plant Engineering, Dhanpat Rai & Sons.

Reference Books:

1. Godfrey Boyle, Renewable Energy, Oxford University Press.
2. Soni, Gupta and Bhatnagar, A course in Electrical Power, Dhanpatrai & Sons.
3. Dr. S. L. Uppal, Electrical Power, Khanna Publishers.
4. Umesh Rathore, Energy Management, S.K.Katharia & Sons
5. K. K. Ramalingam, Power Plant Engineering, Scitech Publication (India) Pvt. Ltd.
6. S. P. Sukhatme, Solar Energy, Tata McGraw Hill Publishing Co. Ltd.
7. A. K. Raja, M. Dwibedi and A.P.Srivastava, Introduction to Non-conventional Energy sources, Scitech Publication (India) Pvt. Ltd.

Course Name: Process Control
Course Code: ECS(EE)801
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Knowledge of Control Theory.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Design a controller by applying the knowledge of different control action.
- **CO2.** Calculate controller parameters by applying different tuning methods.
- **CO3.** Describe different advanced control strategy.
- **CO4.** State the operation and use of the final control element.
- **CO5.** Develop ladder logic programs and understand the basics of DCS.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	2	1	1	2	1	2	2	2
CO2	3	2	1	2	1	2	1	2	1	1	1	2
CO3	2	1	1	2	1	2	1	1	1	2	2	3
CO4	1	1	1	3	3	2	3	3	2	2	1	2
CO5	3	2	3	2	1	3	2	3	1	1	2	2

Course Content

Module 1: **10L**

General Review of Process, Process Control, and Automation. Servo and Regulatory Control, Basic process. Control loop block diagram. Characteristic parameters of a process – Process Quantity, Process Potential, Process Resistance, Process Capacitance, Process Lag, Self-Regulation Characteristics and functions of different modes of control actions: Schemes and analysis of On-Off, Multistep, Floating, Time Proportional, Proportional, Integral, Derivative, PI, PD & PID control Electronic PID controller design, Pneumatic Controllers - a brief analysis.

Module 2: **5L**

Process Reaction Curves, Controllability - using (i) deviation reduction factors (ii) gain-bandwidth product, State Controllability, Tuning of Controllers: both Closed and Open-loop methods (Ziegler – Nichols, Cohen – Coon, PRC method and 3-C method of parameter adjustment).

Module 3: **12L**

Different control strategies - schemes, brief analysis, and uses (i) Ratio control (ii) Cascade control (iii) Feedforward control (iv)Multivariable control Final Control Element: Actuators (Pneumatic Actuators, Electrical Actuators) and Control Valves (Globe, Ball, Butterfly, Gate, Pinch), Different Parts, Fail Position, Valve characteristics, Cv, Single & Double Seated Valves, Valve sizing, Valve selection, Cavitation, Flashing, Noise Control Valve Accessories – Air Filter Regulator, I/P Converter. A brief study of Safety Valves and Solenoid valves.

Module 4: **9L**

Introduction to Programmable Logic Controllers (PLCs) – Basic Architecture and Functions; Input-Output Modules and Interfacing; CPU and Memory; Relays, Timers, Counters and their uses; PLC Programming and Applications. Introduction to DCS: overview, block diagram

Text Books:

1. D. Patranabis, Principles of Process Control, TMH, New Delhi, 2nd Ed.
2. D. P. Eckman, Automatic Process control, John Wiley, New York.

Reference Books:

1. D. R. Coughanowr, Process Systems Analysis and Control, McGraw Hill
2. G. Stephanopoulos, Chemical process Control, PHI
3. C. D. Johnson, Process Control Instrumentation Technology, PHI
4. B. G. Liptak, Instrument Engineers Handbook, Chilton Book Co., Philadelphia

Course Name: Digital Image Processing Laboratory
Course Code: EC(EE)891
Contact: 0L:0T:2P
Credit: 1

Prerequisite: Digital Signal Processing.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Build knowledge on Digital Imaging fundamentals and Digital Image Transform.
CO2. Understanding Digital Image enhancement techniques in spatial and frequency domain.
CO3. Explain the requiements and types of Image Compression and its standards.
CO4. Demonstrate the Segmentation and Edge detection techniques of Digital Images.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	1	-	-	2	-	2	-	-	-	3
CO2	-	3	-	2	-	1	-	-	2	-	-	3
CO3	2	-	1	-	1	-	3	-	-	2	-	3
CO4	3	-	1	-	-	-	2	1	-	-	-	3

List of Experiment:

1. Convert RGB Digital Images into Grayscale Images and show result.
2. Transform a grayscale image into frequency domain and show its magnitude and phase angle.
3. Display histogram of a digital image and equalized the image.
4. Apply LPF and HPF in a Grayscale Digital Image and display result.
5. Apply Mean and Median filtering in a Grayscale Digital Image and display result.
6. Compress and reconstruct a Grayscale Digital Images in spatial domain.
7. Compress and reconstruct a Grayscale Digital Image in frequency domain.
8. Apply segmentation technique (anyone) in a Digital Image and display result.
9. Apply Edge detection technique in a Digital Image and display result.
10. Apply any cryptography or watermarking technique for image encryption and display result.
11. Innovative experiment.

Course Name: Power Plant Engineering Laboratory
Course Code: ME(EE)891
Contact: 0L:0T:2P
Credit: 1

Prerequisite: Concept of Energy Conversion.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Describe sources of energy and types of power plants.
- **CO2.** Analyze the performance of different power plants.
- **CO3.** Describe basic working principles of gas turbine.
- **CO4.** Estimate different efficiencies associated with power plant systems.
- **CO5.** Analyze economics of power generation.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	3	2	-	-	-	2	3	2
CO2	3	2	2	3	2	2	-	-	-	-	3	2
CO3	2	3	3	3	2	2	-	-	-	-	2	2
CO4	3	3	3	3	2	2	-	-	-	3	-	2
CO5	3	2	3	2	2	2	-	3	-	2	2	2

List of Experiment:

1. To study of modern steam power plant.
2. To Study about the Various Types of Fuel & Ash Handling Systems.
3. To study about different types of dust collectors and pulverized fuel burners.
4. To study about nuclear power plant.
5. To study of different types of steam turbines.
6. To study about different types of condensers and cooling towers.
7. To study about economics of power generation systems.
8. To study of gas power plant.
9. To study of combined steam & gas turbine power plant.
10. Testing of diesel fired water tube boiler based steam power plant.

Course Name: Process Control Laboratory
Course Code: ECS(EE)891
Contact: 0L:0T:2P
Credit: 1

Prerequisite: Knowledge of Control Theory.

Course Outcomes: After successful completion of the course, student will be able to

- **CO6.** Recognize & explain basic process control loop elements via hands on experiment.
- **CO7.** Control different process variable (flow, pressure, level & temperature) using different controller mode.
- **CO8.** Use various PLC functions and develop PLC programs to control a real time system.
- **CO9.** Control & monitor different process variable through DCS.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	3	3	2	3	3	1	3	2	3
CO2	2	2	1	1	2	3	1	3	2	3	3	3
CO3	2	3	3	3	3	1	3	1	1	3	2	3
CO4	1	2	2	3	3	2	3	3	1	3	2	3

List of Experiment:

1. Study of Flow, Level, Pressure, Temperature processes and construction of the P&I diagrams in accordance with ISA guidelines/standards.
2. Study of a Temperature Control Loop having Furnace, suitable final control element, Temperature transmitter, conventional PID controller/Control System, and data logger/recorder.
3. Study of a Pressure Control Loop having Pressure source, Pressure Transmitter, Motorized/Pneumatic control valve, and conventional PID controller/Control System.
4. Study of a Flow Control Loop having suitable Flow meter, Motorized/ Pneumatic control valve, and conventional PID controller/Control System.
5. Study of a Level Control Loop having Level Transmitter, Motorized/ Pneumatic control valve, and conventional PID controller/Control System
6. Study of a typical Air Duct Flow Monitoring and Control.
7. PLC Programming.
8. Study of a PC based Automation Software / Simulation Software.
9. Configuring the DCS for Temp./Flow/Pressure processes.
10. Innovative Experiment.