Sanjivani College of Engineering, Kopargaon

(An Autonomous Institute affiliated to SPPU, Pune)

DECLARATION

We, the Board of Studies (Electrical Engineering Department), hereby declare that, we have designed the four year structure of Electrical Engineering and curriculum of Semester III of Curriculum Pattern 2020 w.e.f. A.Y 2021-2022 as per the guidelines. So, we are pleased to submit and publish this FINAL copy of the curriculum for the information to all the concerned stakeholders.

Submitted by

BoS Chairman

Head of Dept.
Dept.of Electrical Engg.
Sanjivani College of Engineering
Kopargaon 423603

Approved by

Dean Academics

Director

COURSE STRUCTURE- 2020 PATTERN
SECOND YEAR B. TECH. ELECTRICAL ENGINEERING

SEMESTER-III

Course			Teaching Scheme Hours/week				Evaluation Scheme-Marks						
							Theory						
Cat.	Code	Title	L	T	P	Credits	ISE	ESE	CA	OR	PR	TW	Total
PCC	EE201	Material Science	3	-	-	3	30	50	20	-	-	-	100
BSC	BS202	Mathematics III	3	1	-	4	30	50	20	-	-	-	100
PCC	EE203	Electrical Measurements and Instrumentation	4	-	-	4	30	50	20	-	-	-	100
PCC	EE204	Analog and Digital Electronics	3	-	-	3	30	50	20	-	-	-	100
HSMC	HS205	Universal Human Values & Ethics	3	-	-	3	30	50	20	-	-	-	100
HSMC	EE206	General Proficiency	-	-	2	1	-	-		-	-	50	50
LC	EE207	Material Science Laboratory	-	-	2	1	-	-	-	50	-	-	50
LC	EE208	Electrical Measurements and Instrumentation Laboratory	-	-	2	1	-	-	-	-	50	-	50
LC	EE209	Analog and Digital Electronics Laboratory	-	-	2	1	-	-	-	-	50	-	50
MC	MC210	Mandatory Course-III	2	-	-	No	-	-	-	-	-	-	-
Total			**18**	**1**	**8**	**21**	**150**	**250**	**100**	**50**	**100**	**50**	**700**

MC210	Mandatory Course-III	Constitution of India – Basic features and fundamental principles

List of Abbreviations			
Abbreviation	**Full Form**	**Abbreviation**	**Full Form**
BSC	Basic Science Course	MC	Mandatory Course
ESC	Engineering Science Course	PCC	Professional Core Course
HSMC	Humanities/Social Sciences/Management Course	PEC	Professional Elective Course
IP	Induction Program	OEC	Open Elective Course
L	Lecture	LC	Laboratory Course
T	Tutorial	CA	Continuous Assessment
P	Practical	OR	End Semester Oral Examination
ISE	In-Semester Evaluation	PR	End Semester Practical Examination
ESE	End-Semester Evaluation	TW	Continuous Term Work Evaluation
Cat	Category	PROJ	Project

Sanjivani College of Engineering, Kopargaon

(An Autonomous Institute affiliated to SPPU, Pune)

DECLARATION

We, the Board of Studies (Electrical Engineering Department), hereby declare that, we have designed the four year structure of Electrical Engineering and curriculum of Semester IV of Curriculum Pattern 2020 w.e.f. A.Y 2021-2022 as per the guidelines. So, we are pleased to submit and publish this FINAL copy of the curriculum for the information to all the concerned stakeholders.

Submitted by

BoS Chairman

Head of Dept.
Dept.of Electrical Engg.
Sanjivani College of Engineering
Kopargaon 423603

Approved by

Dean Academics

Director

COURSE STRUCTURE- 2020 PATTERN
SECOND YEAR B. TECH. ELECTRICAL ENGINEERING

SEMESTER-IV

Course			Teaching Scheme Hours/week				Evaluation Scheme-Marks						
							Theory						
Cat.	Code	Title	L	T	P	Credits	ISE	ESE	CA	OR	PR	TW	Total
PCC	EE211	Numerical Computations with Signals and Systems	3	1	-	4	30	50	20	-	-	-	100
PCC	EE212	Network Analysis	3	1	-	4	30	50	20	-	-	-	100
PCC	EE213	Electrical Machines I	4	-	-	4	30	50	20	-	-	-	100
PCC	EE214	Power System I	3	-	-	3	30	50	20	-	-	-	100
LC	EE215	Numerical Computations with Signals and Systems Laboratory	-	-	2	1	-	-	-	-	50	-	50
LC	EE216	Network Analysis Laboratory	-	-	2	1	-	-	-	-	50	-	50
LC	EE217	Electrical Machines I Laboratory	-	-	2	1	-	-	-	-	50	-	50
LC	EE218	Power System I Laboratory	-	-	2	1	-	-	-	50	-	-	50
PROJ	EE219	Seminar / Mini Project	-	-	2	1	-	-	-	-	-	50	50
PROJ	EE220	Professional Development	-	-	2	1	-	-	-	-	-	50	50
MC	MC221	Mandatory Course-IV	2	-	-	No Credits	-	-	-	-	-	-	-
		Total	**15**	**2**	**12**	**21**	**120**	**200**	**80**	**50**	**150**	**100**	**700**

MC221	Mandatory Course-IV	Innovation - Project based – Sc., Tech, Social, Design & Innovation

List of Abbreviations			
Abbreviation	**Full Form**	**Abbreviation**	**Full Form**
BSC	Basic Science Course	MC	Mandatory Course
ESC	Engineering Science Course	PCC	Professional Core Course
HSMC	Humanities/Social Sciences/Management Course	PEC	Professional Elective Course
IP	Induction Program	OEC	Open Elective Course
L	Lecture	LC	Laboratory Course
T	Tutorial	CA	Continuous Assessment
P	Practical	OR	End Semester Oral Examination
ISE	In-Semester Evaluation	PR	End Semester Practical Examination
ESE	End-Semester Evaluation	TW	Continuous Term Work Evaluation
Cat	Category	PROJ	Project

Sanjivani College of Engineering, Kopargaon
(An Autonomous Institute affiliated to SPPU, Pune)

Sanjivani College of Engineering * Dept.of Electrical Engineering * Kopargaon-423603 *

DECLARATION

We, the Board of Studies (Electrical Engineering Department), hereby declare that, we have designed the four year structure of Electrical Engineering and curriculum of Semester V of Curriculum Pattern 2020 w.e.f. A.Y. 2022-2023 as per the guidelines. So, we are pleased to submit and publish this FINAL copy of the curriculum for the information to all the concerned stakeholders.

Submitted by

BoS Chairman

Approved by

29/09/2022

Dean Academics

SANJIVANI COLLEGE OF ENGINEERING KOPARGAON Approved

Director

COURSE STRUCTURE- 2020 PATTERN
THIRD YEAR B. TECH. ELECTRICAL ENGINEERING

SEMESTER- V

Course			Teaching Scheme Hours/week				Evaluation Scheme-Marks						
							Theory						
Cat.	Code	Title	L	T	P	Credits	ISE	ESE	CIA	OR	PR	TW	Total
PCC	EE301	Microcontrollers And Applications	3	-	-	3	30	50	20	-	-	-	100
PCC	EE302	Electrical Machines II	3	-	-	3	30	50	20	-	-	-	100
PCC	EE303	Power System II	3	-	-	3	30	50	20	-	-	-	100
PCC	EE304	Power Electronics	3	-	-	3	30	50	20	-	-	-	100
PEC	EE305	Professional Elective-I	3	-	-	3	30	50	20	-	-	-	100
LC	EE306	Microcontrollers And Applications Laboratory	-	-	2	1	-	-	-	25	-	-	25
LC	EE307	Electrical Machines II Laboratory	-	-	2	1	-	-	-	-	50	-	50
LC	EE308	Power System II Laboratory	-	-	2	1	-	-	-	25	-	-	25
LC	EE309	Power Electronics Laboratory	-	-	2	1	-	-	-	-	50	-	50
PRJ	EE310	Skill based Credit Course	1	-	-	1	-	-	-	-	-	50	50
MLC	MC311	Mandatory Learning Course-V	1	-	-	No Credit	-	-	-	-	-	-	-
		Total	17	-	8	20	150	250	100	50	100	50	700

EE305	Professional Elective-I	EE305A	Renewable Energy Sources
		EE305B	Smart Grid
MC311	Mandatory Learning Course-V	MC311A	Electrical Energy Conservation and Auditing

Approved

Sanjivani College of Engineering, Kopargaon
(An Autonomous Institute affiliated to SPPU, Pune)

Sanjivani College of Engineering Dept of Electrical Engineering Kopargaon-423603

DECLARATION

We, the Board of Studies (Electrical Engineering Department), hereby declare that, we have designed the four year structure of Electrical Engineering and curriculum of Semester VI of Curriculum Pattern 2020 w.e.f. A.Y 2022-2023 as per the guidelines. So, we are pleased to submit and publish this FINAL copy of the curriculum for the information to all the concerned stakeholders.

Submitted by

BoS Chairman

Approved by

Dean Academics

SANJIVANI COLLEGE OF ENGINEERING KOPARGAON Approved

Director

COURSE STRUCTURE- 2020 PATTERN
THIRD YEAR B. TECH. ELECTRICAL ENGINEERING

SEMESTER-VI

Course			Teaching Scheme: Hours/week				Evaluation Scheme-Marks						
							Theory			OR	PR	TW	Total
Cat.	Code	Title	L	T	P	Credits	ISE	ESE	CIA				
PCC	EE312	Power System Operation and Control	4	-	-	4	30	50	20	-	-	-	100
PCC	EE313	Feedback Control Systems	3	-	-	3	30	50	20	-	-	-	100
PCC	EE314	Electrical Machine Design	3	-	-	3	30	50	20	-	-	-	100
PEC	EE315	Professional Elective-II A. Electrical Drives B. Utilization of Electrical Energy C. Electromagnetic Fields	3	-	-	3	30	50	20	-	-	-	100
HSMC	HS315	Corporate Readiness	2	-	-	2	-	-	50	-	-	-	50
PROJ	PR316	IPR & EDP	2	-	-	2	-	30	20	-	-	-	50
LC	EE317	Power System Operation and Control Laboratory	-	-	2	1	-	-	-	25	-	-	25
LC	EE318	Feedback Control Systems Laboratory	-	-	2	1	-	-	-	-	50	-	50
LC	EE319	Electrical Machine Design Laboratory	-	-	2	1	-	-	-	25	-	-	25
LC	EE320	Programming Laboratory	-	-	2	1	-	-	-	-	50	-	50
PROJ	EE321	Creational Activity	-	-	2	1	-	-	-	-	-	50	50
MLC	MC322	Mandatory Learning Course-VI A. PCB Design	1	-	-	Non Credit	-	-	-	-	-	-	Pass/Fail
		Total	18	-	10	22	120	230	150	50	100	50	700

Sanjivani College of Engineering, Kopargaon
(An Autonomous Institute affiliated to SPPU, Pune)

Sanjivani College of Engineering * Dept.of Electrical Engineering * Kopargaon-423603 *

DECLARATION

We, the Board of Studies (Electrical Engineering Department), hereby declare that we have designed the four-year structure of Electrical Engineering and curriculum of Semester VII of Curriculum Pattern 2020 w.e.f. A.Y 2023-2024 as per the guidelines. So, we are pleased to submit and publish this FINAL copy of the curriculum for the information to all the concerned stakeholders.

Submitted by

BoS Chairman

Approved by

Dean Academics

SANJIVANI COLLEGE OF ENGINEERING KOPARGAON Approved

Director

COURSE STRUCTURE- 2020 PATTERN
FINAL YEAR B. TECH. ELECTRICAL ENGINEERING

SEMESTER-VII

Course			Teaching Scheme Hours/week				Evaluation Scheme-Marks						
							Theory						
Cat.	Code	Title	L	T	P	Credits	ISE	ESE	CA	OR	PR	TW	Total
PCC	EE401	Switch Gear and Protection	3	-	-	3	30	50	20	-	-	-	100
PCC	EE402	Control System Design	3	-	-	3	30	50	20	-	-	-	100
PCC	EE403	High Voltage Engineering	3	-	-	3	30	50	20	-	-	-	100
PEC	EE404	Professional Elective-III **A.** Electric and Hybrid Vehicle **B.** HVDC Transmission Systems **C.** Digital Signal Processing	4	-	-	4	30	50	20	-	-	-	100
PEC	EE405	Professional Elective-IV **A.** Power Quality **B.** Transmission and Distribution **C.** Intelligent Systems with AI and ML	3	-	-	3	30	50	20	-	-	-	100
LC	EE406	Switch Gear and Protection Laboratory	-	-	2	1	-	-	-	50	-	-	50
LC	EE407	Control System Design Laboratory	-	-	2	1	-	-	-	50	-	-	50
LC	EE408	High Voltage Engineering Laboratory	-	-	2	1	-	-	-	-	50	-	50
PROJ	EE409	Project Stage I	-	-	6	3	-	-	-	50	-	100	150
MLC	MC410	Mandatory Learning Course-VII **A.** Financially Smart	1	-	-	Non Credit	-	-	-	-	-	-	Pass/ Fail
		Total	17	-	12	22	150	250	100	150	50	100	800

Sanjivani College of Engineering, Kopargaon

(An Autonomous Institute affiliated to SPPU, Pune)

Sanjivani College of Engineering # Dept of Electrical Engineering # Kopargaon-423603 #

DECLARATION

We, the Board of Studies (Electrical Engineering Department), hereby declare that, We have designed the four year structure of Electrical Engineering and curriculum of Semester VIII of Curriculum Pattern 2020 w.e.f. A.Y. 2023-2024 as per the guidelines. So, we are pleased to submit and publish this FINAL copy of the curriculum for the information to all the concerned stakeholders.

Submitted by

BoS Chairman
Head of Dept.
Dept.of Electrical Engg.
Sanjivani College of Engineering
Kopargaon 423603

Sanjivani College of Engineering # Dept of Electrical Engineering # Kopargaon-423603 #

Approved by

Dean Academics

SANJIVANI COLLEGE OF ENGINEERING, KOPARGAON Approved

Director

COURSE STRUCTURE- 2020 PATTERN
FINAL YEAR B. TECH. ELECTRICAL ENGINEERING

SEMESTER-VIII

Course			Teaching Scheme Hours/week				Evaluation Scheme-Marks					
Cat.	Code	Title	L	T	P	Credits	Theory ISE	Theory ESE	OR	PR	TW	Total
OEC	EE411	Open Elective I (NPTEL) A. Sensors and Actuators B. Circuit Analysis for Analog Designers C. Industrial Automation and Control D. Problem Solving through programming in C	3	-	-	3	25	75	-	-	-	100
OEC	EE412	Open Elective-II (NPTEL) A. Fundamentals of Semiconductor Devices B. Computer-Aided Design of Electrical Machines C. Introduction To Industry 4.0 And Industrial Internet of Things D. Embedded Sensing, Actuation and Interfacing Systems	3	-	-	3	25	75	-	-	-	100
OEC	EE413	Open Elective III (NPTEL) A. EV - Vehicle Dynamics and Electric Motor Drives B. FACTs Devices C. Power Quality Improvement Technique D. Data Science for Engineers	2	-	-	2	25	75	-	-	-	100
PROJ	EE414	Internship	-	-	12	6	-	-	50	-	100	150
PROJ	EE415	Project Stage-II	-	-	4	2	-	-	50	-	-	50
		Total	9	-	16	16	150	150	100	-	100	500

Head of Dept.
Dept.of Electrical Engg.
Sanjivani College of Engineering
Kopargaon 423603

Dean Academics
Sanjivani College of Engineering
Kopargaon-423603

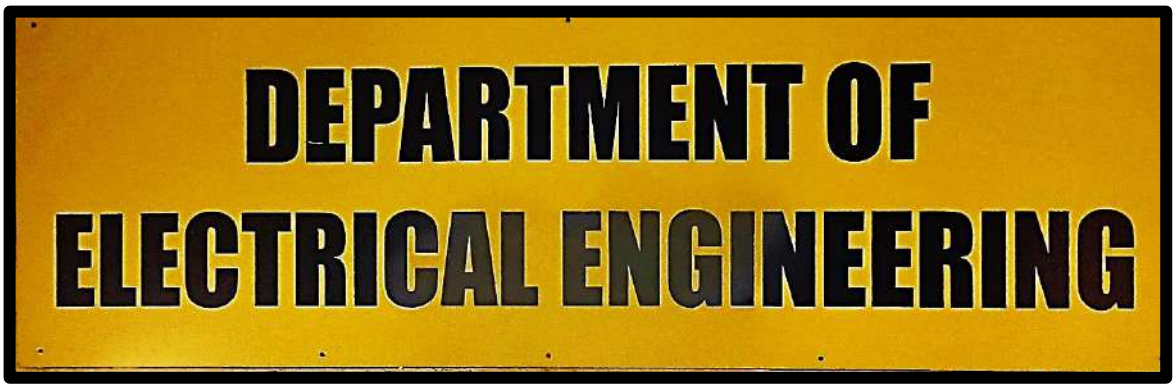
Director
Sanjivani College of Engineering
Kopargaon

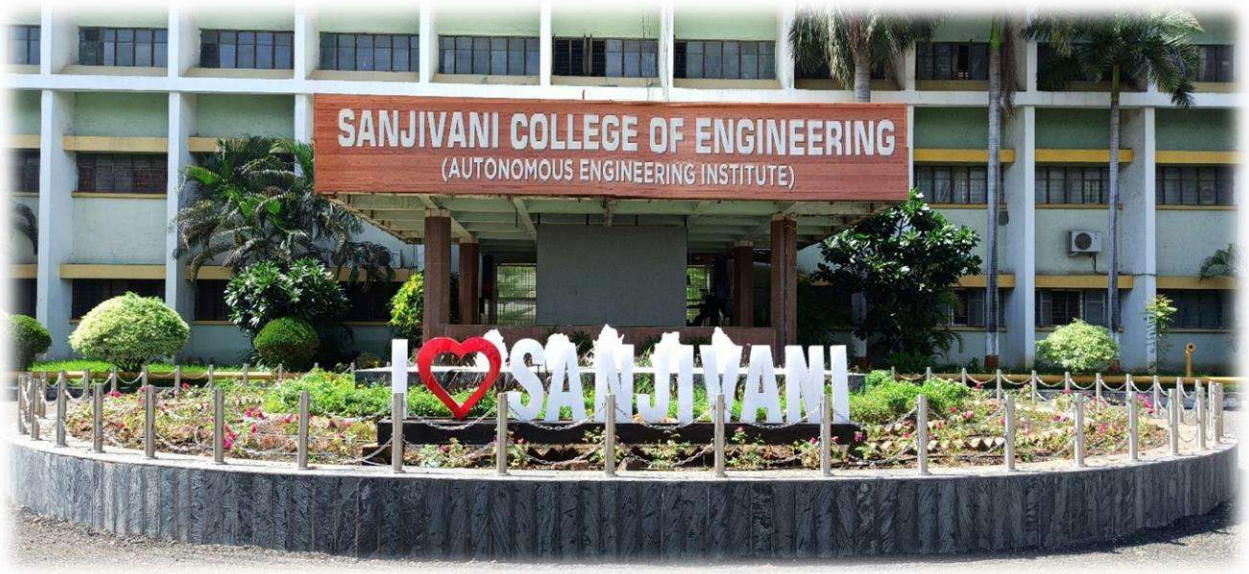
Approved

SANJIVANI RURAL EDUCATION SOCIETY'S

SANJIVANI COLLEGE OF ENGINEERING KOPARGAON

(An Autonomous Institute Affiliated to Savitridbai Phule Pune University, Pune)





DEPARTMENT OF ELECTRICAL ENGINEERING

COURSE STRUCTURE - 2020 PATTERN

SECOND YEAR B. TECH

Academic Year 2021-22

SANJIVANI RURAL EDUCATION SOCIETY'S

SANJIVANI COLLEGE OF ENGINEERING KOPARGAON

(An Autonomous Institute Affiliated to Savitribai Phule Pune University, Pune)

DEPARTMENT OF ELECTRICAL ENGINEERING

Profile: The Electrical Engineering degree program offer the graduates to enter a dynamic and rapidly changing field with career opportunities in Electric Power System, Power Electronics, Robotics and Control, Microprocessors and Controllers, Integrated Circuits, Computer Software. The demand for electrical power and electronic systems is increasing rapidly and electrical engineers are in great demand to meet the requirements of the growing industry. Electrical Engineers are mainly employed in industries using Electrical Power, Manufacturing Electrical Equipment, Accessories, Electronic Systems, Research and Development departments which work on energy saving devices and Software Development.

Many of these disciplines overlap with other engineering branches, spanning a huge number of specializations including hardware engineering, electromagnetic and waves, microwave engineering, nanotechnology, electrochemistry, renewable energies, Artificial Intelligence, mechatronics, and electrical materials science. Identifying these areas today's Electrical Engineer needs to have the capacity of adaptability and creativity in these new technical eras, to meet the industry 4.0.

Electrical Engineering Department of Sanjivani College of Engineering offers the B. Tech. course in Electrical Engineering with an intake of 60 students. The department has well qualified and dedicated faculty and is known for its high academic standards, well-maintained discipline, and complete infrastructure facilities.

Vision of Department

Our vision is to create an environment of academic excellence in the subject areas of Electrical Engineering & allied discipline through classroom teaching, practical demonstration & research activities.
We are looking towards expansion of problem-solving horizons in the emerging areas of Switchgear & Protection, Power Systems, Electrical Machines & Drives, Control Systems etc.

Mission of Department

Our mission is to make use of the Technology of Electrical Engineering as a principal instrument for deriving optimal solutions in multidisciplinary Engineering problems having social relevance. We are committed to the development of Technical human resources exhibiting professional and ethical attitudes and interdisciplinary approach.

Program Outcomes (POs):

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, society, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning in formed by the contextual knowledge to assess social, health, safety, legal and cultural issues, and the consequent responsibilities relevant to the professional engineering practice

7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply the set of one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Educational Objectives (PEOs)

The PEOs of undergraduate programme in Electrical Engineering are broadly classified as follows

1. **PEO 1:** Graduates will have the mathematical & scientific knowledge to analyze & solve emerging real-world problems related to power systems, electrical machines, control systems, electrical measurements, switchgear & protection.

2. **PEO 2:** Graduates will be able to pursue higher education in Electrical Engineering or other fields of their interest in reputed organizations.

3. **PEO 3:** Graduates will be employable in the diversified sectors of industry, government organizations, public sector, and multinational corporations.

4. **PEO 4:** Graduates will be able to communicate effectively, adopt lifelong learning, act with integrity, and have interpersonal skills with commitment to their ethical and social responsibilities.

Program Specific Objectives (PSOs)

1. **PSO 1:** Apply the knowledge of mathematics, science & Electrical Engineering fundamentals to complex problems in Electrical Machines, Control Systems, Power Systems, Power Electronics, switchgear & Protection.

2. **PSO 2:** Ability to critically understand the generation, transmission and distribution concepts in Electrical Power Systems, Control systems and renewable energy sector.

3. **PSO 3:** Capability to understand various computational methods for design & analysis of Electrical Systems.

4. **PSO 4:** An understanding of professional, ethical, legal, security issues, social responsibilities and indulge in lifelong learning.

COURSE STRUCTURE- 2020 PATTERN

SECOND YEAR B. TECH. ELECTRICAL ENGINEERING

SEMESTER-III

Course			Teaching Scheme Hours/week				Evaluation Scheme-Marks						
							Theory						
Cat.	Code	Title	L	T	P	Credits	ISE	ESE	CA	OR	PR	TW	Total
PCC	EE201	Material Science	3	-	-	3	30	50	20	-	-	-	100
BSC	BS202	Engineering Mathematics III	3	1	-	4	30	50	20	-	-	-	100
PCC	EE203	Electrical Measurements and Instrumentation	4	-	-	4	30	50	20	-	-	-	100
PCC	EE204	Analog and Digital Electronics	3	-	-	3	30	50	20	-	-	-	100
HSMC	HS205	Universal Human Values & Professional Ethics	3	-	-	3	30	50	20	-	-	-	100
HSMC	EE206	General Proficiency	-	-	2	1	-	-	-	-	-	50	50
LC	EE207	Material Science Laboratory	-	-	2	1	-	-	-	50	-	-	50
LC	EE208	Electrical Measurements and Instrumentation Laboratory	-	-	2	1	-	-	-	-	50	-	50
LC	EE209	Analog and Digital Electronics Laboratory	-	-	2	1	-	-	-	-	50	-	50
MC	MC210	Mandatory Course-III	2	-	-	No	-	-	-	-	-	-	-
Total			**18**	**1**	**8**	**21**	**150**	**250**	**100**	**50**	**100**	**50**	**700**

MC210	Mandatory Course-III	Constitution of India – Basic features and fundamental principles

List of Abbreviations			
Abbreviation	**Full Form**	**Abbreviation**	**Full Form**
BSC	Basic Science Course	MC	Mandatory Course
ESC	Engineering Science Course	PCC	Professional Core Course
HSMC	Humanities/Social Sciences/Management Course	PEC	Professional Elective Course
IP	Induction Program	OEC	Open Elective Course
L	Lecture	LC	Laboratory Course
T	Tutorial	CA	Continuous Assessment
P	Practical	OR	End Semester Oral Examination
ISE	In-Semester Evaluation	PR	End Semester Practical Examination
ESE	End-Semester Evaluation	TW	Continuous Term Work Evaluation
Cat	Category	PROJ	Project

COURSE STRUCTURE- 2020 PATTERN
SECOND YEAR B. TECH. ELECTRICAL ENGINEERING

SEMESTER-IV

Course			Teaching Scheme Hours/week				Evaluation Scheme-Marks						
							Theory						
Cat.	Code	Title	L	T	P	Credits	ISE	ESE	CA	OR	PR	TW	Total
PCC	EE211	Numerical Computations with Signals and Systems	3	1	-	4	30	50	20	-	-	-	100
PCC	EE212	Network Analysis	3	1	-	4	30	50	20	-	-	-	100
PCC	EE213	Electrical Machines I	4	-	-	4	30	50	20	-	-	-	100
PCC	EE214	Power System I	3	-	-	3	30	50	20	-	-	-	100
LC	EE215	Numerical Computations with Signals and Systems Laboratory	-	-	2	1	-	-	-	-	50	-	50
LC	EE216	Network Analysis Laboratory	-	-	2	1	-	-	-	-	50	-	50
LC	EE217	Electrical Machines I Laboratory	-	-	2	1	-	-	-	-	50	-	50
LC	EE218	Power System I Laboratory	-	-	2	1	-	-	-	50	-	-	50
PROJ	EE219	Seminar / Mini Project	-	-	2	1	-	-	-	-	-	50	50
PROJ	EE220	Professional Development	-	-	2	1	-	-	-	-	-	50	50
MC	MC221	Mandatory Course-IV	2	-	-	No Credits	-	-	-	-	-	-	-
		Total	**15**	**2**	**12**	**21**	**120**	**200**	**80**	**50**	**150**	**100**	**700**

MC221	Mandatory Course-IV	Innovation - Project based – Sc., Tech, Social, Design & Innovation

List of Abbreviations			
Abbreviation	**Full Form**	**Abbreviation**	**Full Form**
BSC	Basic Science Course	MC	Mandatory Course
ESC	Engineering Science Course	PCC	Professional Core Course
HSMC	Humanities/Social Sciences/Management Course	PEC	Professional Elective Course
IP	Induction Program	OEC	Open Elective Course
L	Lecture	LC	Laboratory Course
T	Tutorial	CA	Continuous Assessment
P	Practical	OR	End Semester Oral Examination
ISE	In-Semester Evaluation	PR	End Semester Practical Examination
ESE	End-Semester Evaluation	TW	Continuous Term Work Evaluation
Cat	Category	PROJ	Project

SEMESTER III

EE201: MATERIAL SCIENCE

Teaching Scheme	**Examination Scheme**	
Lectures: 03 Hrs./Week	**Continuous Assessment:**	**20 Marks**
Tutorial: -- Hrs./Week	**In-Sem Exam:**	**30 Marks**
	End-Sem Exam:	**50 Marks**
Credits: 3	**Total:**	**100 Marks**

Prerequisite Course: Students should have knowledge of various classes of materials like solid, liquid, gaseous, conducting, insulating and resistive along with their basic characteristics.

Course Objectives

1. To classify different materials from Electrical Engineering application point of view.
2. To understand various properties and characteristics of different classes of materials.
3. To select materials for applications in various electrical equipment.
4. To impart knowledge of Nano-technology, battery and solar cell materials.
5. To develop ability to test different classes of materials as per IS.

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Categorize and classify different materials from Electrical Engineering applications point of view.	3	Applying
CO2	Explain and summarize various properties and characteristics of different classes of materials.	2	Understanding
CO3	Choose materials for application in various electrical equipment	3	Applying
CO4	Explain and describe knowledge of nanotechnology, batteries, and solar cell materials.	2	Understanding
CO5	Test different classes of materials as per IS.	4	Analysing
CO6	Use of theoretical knowledge in practical field application.	3	Applying

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	2	3	1	1	--	1	--	2	3	2
CO2	3	1	1	2	2	2	2	1	1	1	1	2	2	2
CO3	3	2	2	1	2	1	1	1	1	--	1	1	1	1
CO4	3	1	2	2	1	2	1	1	1	1	1	2	1	1
CO5	3	2	1	3	1	1	--	1	--	2	1	1	1	2
CO6	3	2	1	1	2	1	1	--	1	1	1	2	1	1

Course Contents			
UNIT-I	**DIELECTRIC & OPTICAL PROPERTIES OF INSULATING MATERIALS**	**Hrs.**	**COs**
	Static Field, Parameters of Dielectric material [Dielectric constant, Dipole moment, Polarization, Polarizability], Introduction to Polar and Non- Polar dielectric materials. Mechanisms of Polarizations- Electronic, Ionic and Orientation Polarization (descriptive treatment only), Clausius Mossotti Equation, Piezo-Electric, Pyro-Electric & Ferro-Electric Materials, Dielectric loss and loss tangent, Concept of negative tan delta (δ). Introduction to fiber optics, materials used and its applications.	06	CO1
UNIT-II	**INSULATING MATERIALS & DIELECTRIC BREAKDOWN**	**Hrs.**	**CO**
	Introduction, Characteristics of Good Insulating Material, Classification, Solid Insulating Materials-Paper, Press Board, Fibrous Materials, Ceramics, Mica, Asbestos, Resins, Amorphous materials Polymers, Ceramics, Enamels, and its applications. Liquid Insulating Materials such as Transformer Oil, Varnish, Askarel. Insulating Gases like Air, SF_6 and its applications. Introduction, Concept of Primary and Secondary Ionization of Gases (descriptive treatment only), Breakdown Voltage, Breakdown Strength, Factors affecting Breakdown Strengths of Solid, Liquid and Gaseous dielectric materials.	06	CO2
UNIT-III	**MAGNETIC MATERIALS**	**Hrs.**	**CO**
	Introduction, Parameters of Magnetic material [Permeability, Magnetic Susceptibility, Magnetization], Classification of Magnetic Materials, Diamagnetism, Para magnetism, Ferromagnetism, Ferri-magnetism, Ferro-magnetic behavior below Critical Temperature, Spontaneous Magnetization, Curie-Weiss law, Anti-ferromagnetism, Ferrites, Applications of Ferro-magnetic Materials, Magnetic materials for Electric Devices such as Transformer Core , Core of Rotating Machines, Soft Magnetic Materials, Hard Magnetic Materials, Magnetic Recording Materials, Compact Discs. Introduction to laser and magnetic strip technology.	06	CO3
UNIT-IV	**CONDUCTING MATERIALS**	**Hrs.**	**CO**
	General Properties of Conductor, Electrical Conducting Materials - Copper, Aluminum and its applications, Materials of High & Low Resistivity-Constantan, Nickel-Chromium Alloy, Tungsten, Canthal, Silver & Silver alloys, Characteristics of Copper Alloys (Brass & Bronze), Materials used for Lamp Filaments, Transmission Lines, Electrical Carbon Materials, Materials for Super-capacitors. Material used for Solders, Metals & Alloys for different types of Fuses, Thermal Bimetal & Thermocouple. Introduction to Superconductivity and Super Conductors.	06	CO4
UNIT-V	**NANOTECHNOLOGY AND BATTERIES**	**Hrs.**	**CO**
	Introduction, Concepts of Energy bands & various Conducting Mechanism in Nano-structures, Carbon Nano-structures, Carbon Molecules, Carbon Clusters, Carbon Nano-tubes and applications.	06	CO5

	Special Topics in Nano Technology such as Single Electron Transistor, Molecular Machines, BN Nanotubes, Nano wires. Materials used for Batteries: Lead Acid, Lithium-ion, Sodium-Sulphur, Nickel-Cadmium, Zero Emission Battery Research Activity (ZEBRA) Batteries. Batteries used in Electric Vehicle (EV) and Electric Hybrid Vehicle (EHV).		
UNIT-VI	**TESTING OF MATERIALS**	**Hrs.**	**CO**
	Explanation of following with objectives, equipment required, circuit diagrams and observations to be taken. 1. Measurement of Dielectric Loss Tangent (tan δ) by Schering Bridge-IS 13585-1994. 2. Measurement of Dielectric Strength of Solid Insulating Material-IS 2584. 3. Measurement of Dielectric Strength of Liquid Insulating Material – IS 6798. 4. Measurement of Dielectric Strength of Gaseous Insulating Material as per IS. Measurement of Flux Density by Gauss-meter.	06	CO6

Text Books:

[T1] Charles P. Poole, Jr. Frank & J. Ownes, "Introduction to Nanotechnology", Wiley Student Edition.
[T2] Electrical Engineering Materials", T.T.T.I, Madras.
[T3] K. B. Raina & S. K. Bhattacharya, "Electrical Engineering Materials", S. K. Kataria & Sons.
[T4] P.K. Palanisamy, "Material Science for Electrical Engineering", SciTech Pub. (India) Pvt. Ltd., Chennai.
[T5] S.P. Seth, "A Course in Electrical Engineering Materials", Dhanpat Rai and Sons publication.
[T6] RonaldM.DellandDavidA. J. Rand, "Understanding Batteries", Royal Society of Chemistry, 2001Publication.
[T7] JamesF.Shackelford & M.K. Muralidhara, "Introduction to Material Science for Engineering", Sixth Edition by Pearson Education.

References:

[R1] D. M. Tagare, "Electrical Power Capacitors-Design & Manufacture", Tata McGraw Hill Publication.
[R2] S. P. Chalara & B. K. Bhatt, "Electrical Engineering Materials", Khanna Publishers, Nath Market.
[R3] C.S. Indulkar & S. Thiruvengadam, "Electrical Engineering Materials", S. Chand & Com. Ltd.
[R4] Kamraju & Naidu, "High Voltage Engineering", Tata McGraw Hill Publication.
[R5] "Insulation Technology Course Material of IEEMA Ratner", Pearson Education.
[R6] Rakosh Das Begamudre, "Energy Conversion Systems", New Age International Publishers.
[R7] Traugott Fischer, "Materials Science for Engineering Students", Elsevier publications.

BS202: ENGINEERING MATHEMATICS III

Teaching Scheme	**Examination Scheme**	
Lectures: 03 Hrs./Week	**Continuous Assessment:**	**20 Marks**
Tutorial: 01 Hrs./Week	**In-Sem Exam:**	**30 Marks**
	End-Sem Exam:	**50 Marks**
Credits: 4	**Total:**	**100 Marks**

Prerequisite Course:

1. Linear Algebra and Partial Differentiation (LA101)
2. Multivariate Calculus (MC109)

Course Objectives

1 To make students familiarize with concepts and techniques of vector calculus, probability, and differential calculus.

2 The intent is to furnish them with the techniques to understand engineering mathematics and its applications that would develop logical thinking power, useful in their disciplines.

Course Outcomes (COs):

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

	Course Outcome (s)	**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	**Describe** and **recall** the basics of vector algebra, **apply** it to **calculate** directional derivative, divergence, and curl of vector function	**1,2,3**	**Remember/ Understand/ Apply**
CO2	**Understand** the concept vector integration, **analyze,** and **apply** it solve engineering problems **using** Green's theorem, Stoke's theorem, Gauss's theorem	**2,3,4**	**Understand/ Apply/ Analyze**
CO3	**Solve** ordinary differential equations **using** iterative, interpolation methods	**1,2**	**Remember/ Understand**
CO4	**Apply** integral transform technique to **solve** equations involved in engineering applications**.**	**1,3**	**Apply**
CO5	**Analyze** data, **find** mean, correlation, regression of a statistical data, **calculate** probability using different distributions.	**1,4**	**Analyze**
CO6	**Analyze** and **apply** partial differential equation and **solve** practical problems in engineering	**3,4**	**Apply/ Analyze**

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	1	-	-	2	2	1	-	1	-	-
CO2	3	2	-	-	1	-	-	2	2	1	-	1	-	-
CO3	3	2	-	-	1	-	-	2	2	1	-	1	-	-
CO4	3	2	-	-	1	-	-	2	2	1	-	1	-	-
CO5	3	2	-	-	1	-	-	2	2	1	-	1	-	-
CO6	3	2	-	-	1	-	-	2	2	1	-	1	-	-

Course Contents			
UNIT-I	**VECTOR DIFFERENTIATION**	**Hrs.**	**COs**
	Scalar and vector point function, Derivative of a vector point function, Gradient of scalar function ∅, Directional derivative, Divergence and Curl of vector point function, Solenoidal and irrotational vector field and scalar potential, vector identities.	08	1
UNIT-II	**VECTOR INTEGRATION**	**Hrs.**	**COs**
	Line integral, Green's theorem, Work done, Conservative field, surface integral, Stokes theorem, volume integral, Gauss Divergence theorem, Equation of Stream line.	08	2
UNIT-III	**NUMERICAL METHODS**	**Hrs.**	**COs**
	Interpolation with unequal intervals: Lagrange's formulae, Interpolation using Newton's forward and backward difference formulae. Numerical integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules. Numerical Differentiation: Euler and modified Euler's methods, Runge-Kutta method of fourth order for solving first order equations.	08	3
UNIT-IV	**FOURIER TRANSFORM**	**Hrs.**	**Cos**
	Dirichlet's Condition, Definition of Fourier transform, Properties of Fourier transform, Fourier Cosine transform, Fourier sine transform, Inverse Fourier transform.	8	4
UNIT-V	**BASIC STATISTICS AND PROBABILITY**	**Hrs.**	**Cos**
	Measures of Central tendency, Moments, Skewness and Kurtosis, Correlation and regression, Definitions of probability, Bay's theorem, Distribution function, Binomial, Poisson, and normal distributions	8	5
UNIT-VI	**APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS**	**Hrs.**	**COs**
	Separation of variables; solutions of one-dimensional diffusion equation; first and second order one-dimensional wave equation and two-dimensional Laplace equations.	08	6

Text Books:

[T1] B. S. Grewal, Higher Engineering Mathematics, 42/e, Khanna Publishers, 2012, ISBN-13: 978-8174091154.
[T2] Scott Miller, Donald Childers, Probability and Random Processes, 2 Ed, Elsevier, 2012.
[T3] R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House, 2014. ISBN-13: 978-1842653418.

References:

[R1] K.A. Stroud & D. S. Booth, Advanced Engineering Mathematics, Industrial Press, 5/e, 2011, ISBN-9780831134495
[R2] P. C. Matthews, Vector Calculus, Springer, 2/e, 2012, ISBN-9783540761808
[R3] T. Veerarajan, Probability Statistics and random processes, Tata McGraw Hill, 3/e, 2008. ISBN 13: 9780070669253
[R4] Erwin Kreyszig, Advanced Engineering Mathematics, Wiley, 9/e, 2013, ISBN-13: 978-0471488859.

EE203: ELECTRICAL MEASUREMENTS AND INSTRUMENTATION

Teaching Scheme	**Examination Scheme**	
Lectures: 04 Hrs./Week	**Continuous Assessment:**	**20 Marks**
Tutorial: -- Hrs./Week	**In-Sem Exam:**	**30 Marks**
	End-Sem Exam:	**50 Marks**
Credits: 4	**Total:**	**100 Marks**

Prerequisite Course:

Course Objectives

1. To provide the knowledge of system of units, classification, and essentials of measuring instruments.
2. To get the knowledge about the construction & operation of various electrical & non electrical measuring instruments.
3. To apply the knowledge to identify the measuring instruments & make use of it for quantifying measurements of electrical parameters.

Course Outcomes (COs):

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

	Course Outcome (s)	**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Understand various characteristics of measuring instruments, their classification and range extension technique.	2	Understanding
CO2	Classify resistance, apply measurement techniques for measurement of resistance, inductance.	3	Applying
CO3	Explain construction, working principle and use of dynamometer type wattmeter for measurement of power under balance and unbalance condition.	2	Understanding
CO4	Explain Construction, working principle of 1-phase and 3-phase induction, static energy meter and calibration procedures	2	Understanding
CO5	Use of CRO for measurement of various electrical parameters, importance of transducers, their classification, selection criterion and various applications.	3	Applying
CO6	Measurement of various physical parameters using transducers.	4	Analysing

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	1	1	1	1	-	-	2	1	2
CO2	3	2	2	2	2	1	2	1	1	-	-	1	1	2
CO3	3	2	2	2	2	1	1	1	1	-	-	1	1	2
CO4	3	2	1	2	2	1	1	1	1	1	-	2	1	2
CO5	3	2	2	2	1	1	2	1	1	1	-	2	1	2
CO6	3	2	2	2	1	1	2	1	1	1	-	2	1	2

Course Contents			
UNIT I:	**MEASURING INSTRUMENTS**	**Hrs.**	**CO**
	A. Classification of Measuring Instruments - Characteristics of measuring instruments: static and dynamic, accuracy, linearity, speed of response, dead zone, repeatability, resolution, span, reproducibility, drifts. Necessity of calibration, standards and their classification, absolute and secondary instruments, types of secondary instruments: indicating, integrating, and recording, analog / digital. **Ammeter and Voltmeter Theory:** Essentials of indicating instruments deflecting, controlling, and damping systems. Construction, working principle, torque equation, advantages, and disadvantages of Moving Iron (MI) (attraction and repulsion), and Permanent Magnet Moving Coil (PMMC), block diagram and operation of digital ammeter & voltmeter. **B. Range Extension:** PMMC ammeters and voltmeters using shunts, multipliers. Universal shunt, universal multiplier. Instrument Transformers: Construction, connection of CT & PT in the circuit, advantages of CT / PT over shunt and multipliers for range extension of MI Instruments, transformation ratio, turns ratio, nominal ratio, burden, ratio, and phase angle error. (descriptive treatment only)	9	**CO1**
UNIT II:	**MEASUREMENT OF RESISTANCE & INDUCTANCE**	**Hrs.**	**CO**
	A. Measurement of Resistance: Measurement of low, medium, and high resistance. Wheatstone bridge, Kelvin's double bridge, ammeter-voltmeter method, megger, loss of charge method. Earth tester for earth resistance measurement. **B. Measurement of Inductance**: Introduction, sources, and detectors for A.C. bridge, general equation for bridge at balance. Measurement of inductance: Maxwell's inductance & Maxwell's inductance – Capacitance Bridge, Anderson's bridge.	8	**CO2**
UNIT III:	**MEASUREMENT OF POWER**	**Hrs.**	**CO**
	Construction, working principle, torque equation, errors and their compensation, advantages and disadvantages of dynamometer type wattmeter, low power factor wattmeter, poly-phase wattmeter. Active & reactive power measurement in three phase system for balanced and unbalanced load using three wattmeter method, two wattmeter method & one wattmeter method. Power analyser, Multi meter.	8	**CO3**
UNIT IV:	**MEASUREMENT OF ENERGY**	**Hrs.**	**CO**
	Construction, working principle, torque equation, errors, and adjustments of single phase conventional (induction type) energy meter. Calibration of energy meter. Block diagram and operation of electronic energy meter. Three phase energy meter, TOD meter.	7	**CO4**
UNIT V:	**MEASURING INSTRUMENTS-I**	**Hrs.**	**CO**
	A. Oscilloscope: Introduction, various parts, front panel controls,	8	**CO5**

	use of CRO for measurement of voltage, current, period, frequency. Phase angle & frequency by Lissajous pattern & numerical. Introduction to DSO. **B. Transducers:** Introduction, classification, types: resistive, inductive, capacitive, basic requirements for transducers. **C. Pressure Measurement:** Introduction, classification of pressure as low, medium & high, absolute, gauge, vacuum, static, dynamic & head pressure. High pressure measurement using electric methods, low pressure measurement by McLeod gauge and Pirani gauge, capacitive pressure transducer.		
UNIT VI:	**MEASURING INSTRUMENTS-II**	**Hrs.**	**CO**
	A. Level Measurement: Introduction and importance of level measurement, level measurement methods: mechanical, hydraulic, pneumatic, electrical, nucleonic, and ultrasonic. **B. Displacement Measurement:** LVDT & RVDT – construction, working, application, null voltage, specifications, advantages & disadvantages, effect of frequency on performance. **C. Strain Gauge**: Introduction, definition of strain, types of strain gauge: Wire strain gauge, foil strain gauge, semiconductor strain gauge etc.; their construction, working, advantages and disadvantages.	8	**CO6**

Text Books:

[T1] A. K. Sawhney, "A Course in Electrical and Electronic Measurements & Instrumentation" Dhanpat Rai & Co.

[T2] J. B. Gupta, "A Course in Electronics and Electrical Measurements and Instrumentation" S. K. Kataria & Sons,

[T3] R. K. Jain, "Mechanical and Industrial Measurements" Khanna Publishers.

[T4] B. C. Nakra & K. K. Chaudhari, "Instrumentation Measurement and Analysis" Tata McGraw Hill.

Reference Books:

[R1] E. W. Golding & F. C. Widdies, "Electrical Measurements & Measuring Instruments", Reem Publications.

[R2] Dr. Rajendra Prasad, "Electronic Measurements & Instrumentation", Khanna Publishers

[R3] Arun K. Ghosh, "Introduction to Measurements and Instrumentation", PHI Publication

[R4] M. M. S. Anand, "Electronics Instruments and Instrumentation Technology", PHI Publication.

[R5] DAVID A BELL, "Electronic Instrumentation and Measurements", Oxford publication.

[R7] John turner and Martyn Hill, "Instrumentation for Engineers & Scientist", Oxford publication

EE204: ANALOG AND DIGITAL ELECTRONICS

Teaching Scheme	**Examination Scheme**	
Lectures: 03 Hrs./Week	**Continuous Assessment:**	**20 Marks**
Tutorial: -- Hrs./Week	**In-Sem Exam:**	**30 Marks**
	End-Sem Exam:	**50 Marks**
Credits: 3	**Total:**	**100 Marks**

Prerequisite Course: Basic Electronics Engineering

Course Objectives

1. To Introduce students to the basic features of operational amplifier.
2. To provide knowledge and experience for implementing simple electronic circuits to meet or exceed design specifications.
3. To enable students for implementing combinational logic circuits for various applications.
4. To impart knowledge for implementing sequential circuits using flip-flops.
5. To analysis conventional rectifier and precision rectifier
6. To design desire voltage regulator

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Analysis of number system, perform binary arithmetic and reduce expressions by K-Map	3	Analyzing
CO2	Design of rectifier	3	Analyzing
CO3	Analyze various parameters of Op-amp and applications	3	Analyzing
CO4	Apply the knowledge of Op-amp as filter and waveform generator	4	Applying
CO5	Analyze BJT as amplifier with various configuration	3	Analyzing
CO6	Explain basics of various types of flipflops, counter and register	4	Applying

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	2	2	1	1	2	1	-	2	2	2
CO2	3	2	1	1	2	2	1	1	2	1	-	2	2	2
CO3	3	2	1	2	2	1	1	1	1	1	-	2	2	2
CO4	3	2	1	1	2	2	1	1	2	1	-	2	2	2
CO5	3	2	1	1	2	1	1	1	1	1	-	2	2	2
CO6	3	2	1	1	2	1	1	1	1	1	-	2	2	2

Course Contents			
UNIT-I	**NUMBER SYSTEM & BOOLEAN'S ALGEBRA**	**Hrs.**	**COs**
	Numbering systems-binary, octal, decimal, and hexadecimal and their conversion, codesBCD, Grey and excess3, Binary arithmetic: - addition and subtraction by 1's and 2's compliment. Boolean's algebra, De-Morgan's theory etc. K-map: - structure for two, three and four Variables, SOP and POS form reduction of Boolean expressions by K-map.	08	CO1
UNIT-II	**DIODE & PRECISION RECTIFIERS:**	**Hrs.**	**COs**
	Diode rectifier: Introduction, Single phase half wave rectifier with R, RL loads. Single phase full wave rectifier-Center tap and bridge rectifier. Three phase full wave bridge rectifier with R load. Comparison of single-phase half wave and full wave rectifiers, Precision rectifiers: Half wave and Full wave. Comparison of diode and precision rectifier.	08	CO2
UNIT-III	**OPERATIONAL AMPLIFIER & APPLICATIONS:**	**Hrs.**	**COs**
	Op-Amp: Block diagrams of 741, ideal and practical parameters, open loop, and close loop configuration of Op-Amp. Applications of Op- Amp- Comparator, Schmitt trigger, zero crossing detectors, V-I and I-V converters, Instrumentation amplifier, peak detector.	08	CO3
UNIT-IV	**FILTERS & REGULATORS & WAVEFORM GENERATOR:**	**Hrs.**	**COs**
	Active filters-Its configuration with frequency response, Analysis of first order low pass and high pass filters, IC 555 –construction, working and modes of operation- astable and monostable multi vibrators, Sequence generator, voltage regulators using ICs 78xx, 79xx, LM 317. Waveform generation using Op-amp - sine, square, saw tooth and triangular generator	08	CO4
UNIT-V	**BJT & FET APPLICATIONS:**	**Hrs.**	**COs**
	BJT amplifier, Introduction, Class A amplifier, single stage and multi stage BJT amplifier, direct coupled, RC coupled and transformer coupled, Darlington pair, push-pull amplifier, and differential amplifier, FET construction and characteristic	08	CO5
UNIT-VI	**COMBINATIONAL & SEQUENTIAL CIRCUITS**	**Hrs.**	**COs**
	Concept of Combinational & Sequential circuits, Flip flops – R-S, Clocked S-R, D latches, Edge Triggered D flip-flops, Edge triggered JK flip flops, JK Master - slave flip flop, Register- Buffer registers, shift registers, controlled shift registers, ring counter, Counters – asynchronous Counters, synchronous counter, up - down counter, twisted ring counters, N –module Counters.	08	CO6

Text Books:

1. Sergio Franco, 'Design with Op-Amps and analog Integrated Circuits', TMH.
2. Allen Mottershed, 'Electronic Devices & Circuits', PHI.
3. A Anand Kumar, 'Fundamentals of Digital Circuits, PHI.
4. R.P. Jain "Digital Electronics "Tata McGraw Hill, New Delhi

Reference Books:

1. R.A. Gayakwad, 'Op-Amps & Linear Integrated Circuits', PHI, Fourth Edition, 2012.
2. Boylestad R. L. and Nashelsky Louis, 'Electronic Devices & Circuit Theory', Pearson, Tenth Edition, 2009.
3. M. Moris Mano and Michael Ciletti, 'Digital Design', Pearson Publications.
4. Tokheim, "Digital Electronics- Principles and application", 6th edition, Tata McGraw Hill, New Delhi

HS205: UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS

Teaching Scheme	**Examination Scheme**	
Lectures: 03 Hrs./Week	**Continuous Assessment:**	**20 Marks**
	In-Sem Exam:	**30 Marks**
	End-Sem Exam:	**50 Marks**
Credits: 3	**Total:**	**100 Marks**

Prerequisite Course:

Course Objectives

1. To help the students appreciate the essential complementarity between values and skills to ensure mutual happiness and prosperity.
2. To elaborate on 'Self exploration' as the process for Value Education
3. To facilitate the understanding of harmony at various levels starting from self and going towards family and society.
4. To elaborate on the salient aspects of harmony in nature and the entire existence
5. To explain how the Right understanding forms the basis of Universal human values and definitiveness of Ethical human conduct.
6. To provide the vision for a holistic way of living and facilitate transition from chaotic life to an orderly life

Course Outcomes (COs):

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

	Course Outcome (s)	**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Recognize the concept of self-exploration as the process of value education.	1	Remember
CO2	Interpret the human being as the coexistence of self and body.	2	Understand
CO3	Explain relationship between one Self and the other Self as the essential part of relationship and harmony in the family	2	Understand
CO4	Explain the goal of human being living in the society, the system required to achieve the human goal and the scope of this system.	2	Understand
CO5	Interpret the interconnectedness, harmony, and mutual fulfilment inherent in the nature and the entire existence.	2	Understand
CO6	Draw ethical conclusions in the light of Right understanding facilitating the development of holistic technologies, production systems and management models.	3	Apply

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	2	-	3	2	1	-	3	-	-
CO2	-	-	-	-	-	2	-	3	2	1	-	3	-	-
CO3	-	-	-	-	-	3	2	3	3	1	-	3	-	-
CO4	-	-	-	-	-	3	2	3	3	1	-	3	-	-
CO5	-	-	-	-	-	3	2	3	3	1	-	3	-	-
CO6	-	-	-	-	-	2	2	3	3	1	-	3	-	-

Course Contents			
UNIT-I	**INTRODUCTION TO VALUE EDUCATION**	**Hrs.**	**COs**
	Values, Morals and Ethics; Concept and need of value education; Self-exploration as the process for value education; Guidelines for value education; Basic human aspirations and their fulfilment	06	CO1
UNIT-II	**HARMONY IN HUMAN BEING**	**Hrs.**	**COs**
	Human being as the coexistence of self and the body; Discrimination between the needs of the self and the body; The body as an instrument; Harmony in the self; Harmony of the self with the body	06	CO2
UNIT-III	**HARMONY IN THE FAMILY, SOCIETY AND NATURE**	**Hrs.**	**COs**
	Harmony in the family- The basic unit of human interaction; Values in the human-to-human relationship; Harmony in the society; Vision for the universal human order; Harmony in the nature; Realizing existence as coexistence at all levels	06	CO3
UNIT-IV	**PROFESSIONAL ETHICS**	**Hrs.**	**COs**
	Natural acceptance of human values; Definitiveness of ethical human conduct; Humanistic education and universal human order; Competence in professional ethics; Transition towards value-based life and profession	06	CO4
UNIT-V	**ENGINEERING ETHICS AND SOCIAL EXPERIMENTATION**	**Hrs.**	**COs**
	Need of engineering ethics; Senses of engineering ethics; Variety of moral issues; Moral autonomy; Utilitarianism; Engineering as experimentation; Engineers as responsible experimenters; Codes of ethics	06	CO5
UNIT-VI	**GLOBAL ISSUES**	**Hrs.**	**COs**
	Globalization and multi-national corporations; Cross-cultural issues; Business ethics; Environmental ethics; Computer ethics; Bio-ethics; Ethics in research; Intellectual property rights and plagiarism	06	CO6

Text Books:

1. R. R. Gaur, R. Sangal, G. P. Bagaria, "A Foundation Course in Human Values and Professional Ethics", Excel Books Pvt. Ltd.
2. R. S. Naagarazan, "A Textbook on Professional Ethics and Human Values", New Age International (P) Ltd. Publishers

Reference Books:

3. B. P. Banerjee, "Foundations of Ethics and Management", Excel Books Pvt. Ltd.
4. P. L. Dhar, R. R. Gaur, "Science and Humanism", Commonwealth Publishers
5. M. K. Gandhi, "The Story of my Experiments with Truth", Discovery Publisher

http://uhv.org.in/

Considering the specific nature of this course, the methodology is explorational and thus universally adaptable. In order to connect the content of this course with practice, minimum 6 group activities should be conducted with active involvement of the students. The teacher's assessment should be strictly based on the participation of the students in these activities.

EE206: GENERAL PROFICIENCY

Teaching Scheme	**Examination Scheme**	
Practical: 02 Hrs./Week	**Term-Work:**	**50 Marks**
Credits: 1	**Total:**	**50 Marks**

Prerequisite Course:

Course Objectives

1. Development of students Soft Skills
2. Expose the students' to right attitudinal and behavioral aspects
3. Enhancement of Students' personality
4. Enhancement of Students' interpersonal skills
5. Enhancement of English Communication

Course Outcomes (COs):

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

Course Outcome (s)		Bloom's Taxonomy	
		Level	**Descriptor**
CO1	Identify the behavioural traits	3	Applying
CO2	Communicate effectively	4	Analysing
CO3	Present themselves confidently in curricular and extra-curricular activities	5	Evaluating
CO4	Function effectively in multidisciplinary and hetero generous teams	5	Evaluating

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	-	-	-	-	-	2	-	2	2	1	-	2	-	-
CO2	-	-	-	-	-	2	-	2	2	1	-	2	-	-
CO3	-	-	-	-	-	2	-	2	2	1	-	2	-	-
CO4	-	-	-	-	-	2	-	2	2	1	-	2	-	-

Course Contents

GUIDELINES FOR GENERAL PROFICIENCY

The course aims to cause a basic awareness about the significance of soft skills in professional and inter-personal communications and facilitate an all-round development of personality. Hard or technical skills help securing a basic position in one's life and career. But only soft skills can ensure a person retain it, climb further, reach a pinnacle, achieve excellence, and derive fulfilment and supreme joy. Soft skills comprise pleasant and appealing personality traits as self-confidence, positive attitude, emotional intelligence, social grace, flexibility, friendliness, and effective communication skills.

Recommended online NPTEL/SWAYAM courses for students are as following

1. **Course Name:** Developing Soft Skills and Personality, By Prof. T. Ravichandran | IIT Kanpur
2. **Course Name:** Body language: Key to professional Success, By Prof. Rashmi Gaur | IIT Roorkee
3. **Course Name:** German – I, By Prof. Milind Brahme | IIT Madras
4. **Course Name:** Fundamental Concepts in Sociolinguistics, By Prof. Om Prakash | IIT Madras
5. **Course Name:** Soft skills, By Prof. Binod Mishra | IIT Roorkee
6. **Course Name:** Science, Technology and Society, By Prof. Sambit Mallick | IIT Guwahati
7. **Course Name:** Business English Communication, By Prof Aysha Iqbal Viswamohan | IIT Madras

And other relevant courses

NOTE: The students should take approval before registering the course from the department.

- ✓ Students are suggested to follow the deadlines of the courses, and submit all the assignments due.
- ✓ Continuous Assessment is based on your Assignment Scores, Final Presentation and Report Submission.
- ✓ Students are motivated to appear for exam and earn Course Completion Certificate.

EE207: MATERIAL SCIENCE LABORATORY

Teaching Scheme	Examination Scheme	
Lectures: -- Hrs./Week	**Oral:**	**50 Marks**
Tutorial: -- Hrs./Week	**Practical:**	**-- Marks**
Practical: 02 Hrs./Week	**Term Work:**	**-- Marks**
Credits: 1	**Total:**	**50 Marks**

Prerequisite Course: Students should have knowledge of various classes of materials like solid, liquid, gaseous, conducting, insulating and resistive along with their basic characteristics.

Course Objectives

1. To classify different materials from Electrical Engineering application point of view.
2. To understand various properties and characteristics of different classes of materials.
3. To select materials for applications in various electrical equipment.
4. To impart knowledge of Nano-technology, battery and solar cell materials.
5. To develop ability to test different classes of materials as per IS.

Course Outcomes (COs):

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

Course Outcome (s)		Bloom's Taxonomy	
		Level	**Descriptor**
CO1	Categorize and classify different materials from Electrical Engineering applications point of view.	3	Applying
CO2	Explain and summarize various properties and characteristics of different classes of materials.	2	Understanding
CO3	Choose materials for application in various electrical equipment	3	Applying
CO4	Explain and describe knowledge of nanotechnology, batteries, and solar cell materials.	2	Understanding
CO5	Test different classes of materials as per IS.	4	Analysing
CO6	Use of theoretical knowledge in practical field application.	3	Applying

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	2	3	1	1	--	1	--	2	3	2
CO2	3	1	1	2	2	2	2	1	1	1	1	2	2	2
CO3	3	2	2	1	2	1	1	1	1	--	1	1	1	1
CO4	3	1	2	2	1	2	1	1	1	1	1	2	1	1
CO5	3	2	1	3	1	1	--	1	--	2	1	1	1	2
CO6	3	2	1	1	2	1	1	--	1	1	1	2	1	1

Course Contents			
Ex. No	**Name of Experiment**	**Hrs.**	**COs**
1	To measure dielectric strength of solid insulating materials.	2	6,3
2	To measure dielectric strength of liquid insulating materials.	**2**	**6,3**
3	To measure dielectric strength of gaseous insulating materials using Sphere Gap-Unit.	2	6,3
4	To obtain Hysteresis Loop of the Ferro-Magnetic Material.	**2**	**4**
5	To understand the principle of thermocouple & to obtain characteristics of different thermocouples.	2	3,4
6	To measure Insulation Resistance & KVAr capacity of power capacitor.	**2**	**2,3**
7	To measure Resistivity of High Resistive Alloys.	2	3
8	To observe development of tracks due to ageing on different insulating materials e.g., Bakelite, Perspex, polyesters, Mica, Fibre glass etc.	**2**	**4,2**
9	Testing of resins and polymers.	2	3
10	Measurement of Tangent of Dielectric Loss Angle (tan δ) of solid/liquid dielectric materials.	**2**	**3,4**
11	Measurement of Flux Density by Gauss-meter.	2	6

Text Books:

[T1] Charles P. Poole, Jr. Frank & J. Ownes, "Introduction to Nanotechnology", Wiley Student Edition.
[T2] Electrical Engineering Materials", T.T.T.I, Madras.
[T3] K. B. Raina & S. K. Bhattacharya, "Electrical Engineering Materials", S. K. Kataria & Sons.
[T4] P.K. Palanisamy, "Material Science for Electrical Engineering", SciTech Pub. (India) Pvt. Ltd., Chennai.
[T5] S.P. Seth, "ACourseinElectricalEngineeringMaterials", DhanpatRaiandSons publication.
[T6] RonaldM.DellandDavidA. J. Rand, "Understanding Batteries", Royal Society of Chemistry, 2001Publication.
[T7] JamesF.Shackelford&M.K. Muralidhara, "IntroductiontoMaterialSciencefor Engineering", Sixth Edition by Pearson Education.

References:

[R1] D. M. Tagare, "Electrical Power Capacitors-Design & Manufacture", Tata McGraw Hill Publication.
[R2] S. P. Chalotra & B. K. Bhatt, "Electrical Engineering Materials", Khanna Publishers, Nath Market.
[R3] C.S. Indulkar&S. Thiruvengadam, "ElectricalEngineeringMaterials", S. Chand & Com. Ltd.
[R4] Kamraju & Naidu, "High Voltage Engineering", Tata McGraw Hill Publication.
[R5] "Insulation Technology Course Material of IEEMA Ratner", Pearson Education.
[R6] Traugott Fischer, "Materials Science for Engineering Students", Elsevier publications.
[R7] Rakosh Das Begamudre, "Energy Conversion Systems", New Age International Publishers.

EE208: ELECTRICAL MEASUREMENTS AND INSTRUMENTATION LABORATORY

Teaching Scheme	**Examination Scheme**	
Lectures: -- Hrs./Week	**Oral:**	**-- Marks**
Tutorial: -- Hrs./Week	**Practical:**	**50 Marks**
Practical: 02 Hrs./Week	**Term Work:**	**-- Marks**
Credits: 1	**Total:**	**50 Marks**

Prerequisite Course:

Course Objectives

1. To provide the knowledge of system of units, classification, and essentials of measuring instruments.
2. To get the knowledge about the construction & operation of various electrical & non electrical measuring instruments.
3. To apply the knowledge to identify the measuring instruments & make use of it for quantifying measurements of electrical parameters.

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Understand various characteristics of measuring instruments, their classification and range extension technique.	2	Understanding
CO2	Classify resistance, apply measurement techniques for measurement of resistance, inductance.	3	Applying
CO3	Explain construction, working principle and use of dynamometer type wattmeter for measurement of power under balance and unbalance condition.	2	Understanding
CO4	Explain Construction, working principle of 1-phase and 3-phase induction, static energy meter and calibration procedures	2	Understanding
CO5	Use of CRO for measurement of various electrical parameters, importance of transducers, their classification, selection criterion and various applications.	3	Applying
CO6	Measurement of various physical parameters using transducers.	4	Analysing

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	1	1	1	1	-	-	2	1	2
CO2	3	2	2	2	2	1	2	1	1	-	-	1	1	2
CO3	3	2	2	2	2	1	1	1	1	-	-	1	1	2
CO4	3	2	1	2	2	1	1	1	1	1	-	2	1	2
CO5	3	2	2	2	1	1	2	1	1	1	-	2	1	2
CO6	3	2	2	2	1	1	2	1	1	1	-	2	1	2

Course Contents			
Ex. No	**Name of Experiment**	**Hrs.**	**COs**
Compulsory Experiments (06):			
1	Demonstration of working parts of various types of meters by opening the instrument & explanation of symbols & notations used on instruments.	2	1
2	Extension of instrument range: ammeter, voltmeter, watt meter using CT & PT.	2	1
3	Measurement of active & reactive power in three phase circuit using two wattmeter methods (balanced & unbalanced loads).	2	3
4	Measurement of active & reactive power in three phase balanced circuit using one wattmeter method with two-way switch.	2	3
5	Calibration of single-phase static energy meter at different power factors.	2	4
6	Measurement of voltage, current, time period, frequency & phase angle using CRO.	2	5
Any four experiments are to be conducted of following experiments:			
1	Measurement of reactive power by one wattmeter with all possible connections of current coil and pressure coil.	2	3
2	Measurement of power in three phase, four wire system using three CTs & two wattmeter.	2	3
3	Calibration of single-phase wattmeter at different power factors.	2	4
4	i) Measurement of resistance by ammeter voltmeter method. ii) Measurement of low resistance using Kelvin's double bridge.	2	2
5	Measurement of inductance using Anderson's bridge/ Maxwell's bridge.	2	2

Text Books:

[T1] A. K. Sawhney, "A Course in Electrical and Electronic Measurements & Instrumentation" Dhanpat Rai & Co.
[T2] J. B. Gupta, "A Course in Electronics and Electrical Measurements and Instrumentation" S. K. Kataria & Sons,
[T3] R. K. Jain, "Mechanical and Industrial Measurements" Khanna Publishers.
[T4] B. C. Nakra & K. K. Chaudhari, "Instrumentation Measurement and Analysis" Tata McGraw Hill.

Reference Books:

[R1] E. W. Golding & F. C. Widdies, "Electrical Measurements & Measuring Instruments", Reem Publications.
[R2] Dr. Rajendra Prasad, "Electronic Measurements & Instrumentation", Khanna Publishers
[R3] Arun K. Ghosh, "Introduction to Measurements and Instrumentation", PHI Publication
[R4] M. M. S. Anand, "Electronics Instruments and Instrumentation Technology", PHI Publication.
[R5] DAVID A BELL, "Electronic Instrumentation and Measurements", Oxford publication.
[R6] Johnturner and Martyn Hill, "Instrumentation for Engineers & Scientist", Oxford publication

EE209: ANALOG AND DIGITAL ELECTRONICS LABORATORY

Teaching Scheme	**Examination Scheme**	
Lectures: -- Hrs./Week	**Oral:**	**-- Marks**
Tutorial: -- Hrs./Week	**Practical:**	**50 Marks**
Practical: 02 Hrs./Week	**Term Work:**	**-- Marks**
Credits: 1	**Total:**	**50 Marks**

Prerequisite Course:
Basic Electronics Engineering

Course Objectives

1. To Introduce students to the basic features of operational amplifier.
2. To provide knowledge and experience for implementing simple electronic circuits to meet or exceed design specifications.
3. To enable students for implementing combinational logic circuits for various applications.
4. To impart knowledge for implementing sequential circuits using flip-flops.
5. To analysis conventional rectifier and precision rectifier
6. To design desire voltage regulator

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Analysis of number system, perform binary arithmetic and reduce expressions by K-Map	3	Analyzing
CO2	Design of rectifier	3	Analyzing
CO3	Analyze various parameters of Op-amp and applications	3	Analyzing
CO4	Apply the knowledge of Op-amp as filter and waveform generator	4	Applying
CO5	Analyze BJT as amplifier with various configuration	3	Analyzing
CO6	Explain basics of various types of flipflops, counter and register	4	Applying

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	2	2	1	1	2	1	-	2	2	2
CO2	3	2	1	1	2	2	1	1	2	1	-	2	2	2
CO3	3	2	1	2	2	1	1	1	1	1	-	2	2	2
CO4	3	2	1	1	2	2	1	1	2	1	-	2	2	2
CO5	3	2	1	1	2	1	1	1	1	1	-	2	2	2
CO6	3	2	1	1	2	1	1	1	1	1	-	2	2	2

Course Contents			
Ex. No	**Name of Experiment**	**Hrs.**	**COs**
1	Design and implementation of half wave rectifier.	2	2
2	Design and implementation of full wave rectifier.	2	2
3	Study of shift register operation IC7495	2	6
4	Study of flip-flops and verification of truth table	2	6
5	Study of opamp comparator and ZCD	2	3,4
6	Study of active filter low pass and high pass	2	2
7	Study of decoders and multiplexers. & decade counters.	2	3
8	Study of op-amp as an inverting & non-inverting amplifier.	2	4
9	Study of op-amp as differentiator & integrator., zero crossing detector & peak detector.	4	3
10	Study of op-amp as Schmitt trigger, precision rectifier, & instrumentation amplifier.	4	3,4
11	Study of a stable and mono stable multi vibrator using IC 555 & power amplifiers	4	4

Text Books:

1. Sergio Franco, 'Design with Op-Amps and analog Integrated Circuits', TMH.
2. Allen Mottershed, 'Electronic Devices & Circuits', PHI.
3. A Anand Kumar, 'Fundamentals of Digital Circuits, PHI.
4. R.P. Jain "Digital Electronics "Tata McGraw Hill, New Delhi

Reference Books:

1. R.A. Gayakwad, 'Op-Amps & Linear Integrated Circuits', PHI, Fourth Edition, 2012.
2. Boylestad R. L. and Nashelsky Louis, 'Electronic Devices & Circuit Theory', Pearson, Tenth Edition, 2009.
3. M. Moris Mano and Michael Ciletti, 'Digital Design', Pearson Publications.
4. Tokheim, "Digital Electronics- Principles and application", 6th edition, Tata McGraw Hill, New Delhi

MC210: CONSTITUTION OF INDIA – BASIC FEATURES AND FUNDAMENTAL PRINCIPLES

Teaching Scheme	**Examination Scheme**
Lectures: 2 Hrs./Week	**Term Work: NA**
Credits: Non-Credit	**Total: NA**

Course Objectives

1. To study the historical background, salient features, and preamble of Indian constitution
2. To study the provision of fundamental right in the Indian constitution.
3. To study the directive principle of state policy and fundamental duties.
4. To study the system of government through parliamentary and federal system.
5. To understand the formation, structure, and legislative framework of central government.
6. To understand the formation, structure, and legislative framework of state government.

Course Outcomes (COs):

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

Course Outcome (s)		Bloom's Taxonomy	
		Level	Descriptor
CO1	Describe background, salient features of constitution of India	1	Remembering
CO2	Explain the system of government, it's structure and legislative framework.	2	Understanding
CO3	Apply the fundamental rights and duties in their life	3	Applying

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	--	--	--	--	--	1	--	--	--	---	--	--	--	--
CO2	--	--	--	--	--	2	--	---	--	---	--	--	--	---
CO3	--	--	--	--	--	2	--	---	--	--	--	--	--	---

Course Contents			
UNIT-I	**INTRODUCTION TO CONSTITUTION OF INDIA**	**Hrs.**	**COs**
	a. Historical background b. Salient features c. Preamble of constitution	7	1
UNIT-II	**FUNDAMENTAL RIGHTS**	**Hrs.**	**COs**
	a. Features of fundamental rights b. Basic rights 1. Right to equality; 2. Right to freedom; 3. Right against exploitation; 4. Right to freedom of religion; 5. Cultural and educational rights; 6. Right to property; 7. Right to constitutional remedies	5	2
UNIT-III	**DIRECTIVE PRINCIPLE OF STATE POLICY AND FUNDAMENTAL DUTIES**	**Hrs.**	**COs**
	Directive principle of state policy: a. Features of directive principle	5	3

	b. Classification of directive principle c. Criticism of directive principle d. Utility of directive principle e. Conflict between Fundamental rights and directive principle **Fundamental duties:** a. List of fundamental duties b. Features of fundamental duties c. Criticism of fundamental duties d. Significance of fundamental duties e. Swaran Singh Committee Recommendations		
UNIT-IV	**SYSTEM OF GOVERNMENT**	**Hrs.**	**COs**
	a. Parliamentary system: Features of parliamentary government, Features of presidential government, merits, and demerit of Parliamentary system b. Federal system: Federal features of constitution, unitary features of constitution c. Centre and state relation: Legislative relation, administrative relations, and financial relation. d. Emergency provision: National emergency, financial emergency, and criticism of emergency provision	5	4
UNIT-V	**CENTRAL GOVERNMENT**	**Hrs.**	**COs**
	a. President: Election of president, powers and functions of president, and Veto power of president b. Vice-president: Election of vice-president, powers, and functions of vice-president c. Prime minister: Appointment of PM, powers and functions of PM, relationship with president d. Central council of ministers: Appointment of ministers, responsibility of ministers, features of cabinet committees, functions of cabinet committees e. Parliament: Organization of parliament, composition of the two houses, duration two houses, membership of parliament, session of parliament, joint sitting of two houses, budget in parliament. f. Supreme court (SC): Organization of supreme court, independence of supreme court, jurisdiction and powers of supreme court	5	5
UNIT-VI	**STATE GOVERNMENT**	**Hrs.**	**COs**
	a. Governor: Appointment of governor, powers and functions of governor, constitutional position b. Chief minister: Appointment of CM, powers and functions of CM, relationship with governor c. State council of ministers: Appointment of ministers, responsibility of ministers, cabinet. d. High court (HC): Organization of HC, independence of HC, jurisdiction and powers of HC e. Sub-ordinate court: Structure and jurisdiction, LokAdalats, Family court, Gram Nyayalayas	5	6

Text Books:

1. Indian Polity for Civil Service Examination, M Laxmikanth, Mc GrawHill Education, Fifth Edition.

2. Introduction to the Constitution of India, Durga Das Basu, LexisNexis, 22nd Edition

SEMESTER IV

EE211: NUMERICAL COMPUTATIONS WITH SIGNALS AND SYSTEMS

Teaching Scheme	**Examination Scheme**	
Lectures: 03 Hrs./Week	**Continuous Assessment:**	**20 Marks**
Tutorial: 01 Hr/Week	**In-Sem Exam:**	**30 Marks**
	End-Sem Exam:	**50 Marks**
Credits: 04	**Total:**	**100 Marks**

Prerequisite Course:

1. Engineering Mathematics

Course Objectives

1. Development of the strong foundation of signals and systems
2. Understand sampling theorem and its implications.
3. Development of strong foundation analytical mathematics
4. Study of various methods of numerical analysis of linear and non-linear problems
5. Use of method for solving the problems in engineering
6. Use of modern computing tool

Course Outcomes (COs):

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

	Course Outcome (s)	**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Demonstrate arithmetic operations on floating point representation, and types of errors in computation and their causes of occurrence and apply appropriate numerical method to solve different nonlinear equations	3	Applying
CO2	Apply different numerical methods for differentiation	3	Applying
CO3	Apply and compare various numerical methods to solve first and second order ODE, PDE and least square approximations	3	Applying
CO4	Understand the classification of signal and systems	2	Understanding
CO5	Apply the signal transformations like Fourier transform, Laplace transform and Z- transform on signals and systems	3	Applying
CO6	Assess Sampling theorem and its implications	3	Applying

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	2	1	1	1	1	-	1	1	1	-
CO2	2	2	1	2	2	1	1	1	1	-	1	1	1	-
CO3	2	2	1	2	1	1	1	1	1	-	1	1	1	-
CO4	3	2	1	2	3	1	1	1	1	-	1	2	2	-
CO5	3	3	1	2	1	1	1	1	1	-	1	1	1	-
CO6	2	2	1	2	1	1	1	1	1	-	1	1	1	-

Course Contents			
UNIT-I	**Computer Arithmetic and Solution of Non-Linear Equations**	**Hrs.**	**COs**
	Floating Point representation, Arithmetic operations with normalized floating-point numbers, errors in numbers, Truncation error, round off error, inherent error, absolute and relative error. Bisection method, and Newton-Raphson method, rate of convergence.	6	CO1
UNIT-II	**Interpolation and Numerical Differentiation**	**Hrs.**	**CO**
	Difference table, Lagrange's interpolation, Newton's Interpolation, iterated linear interpolation technique, Stirling's, and Bessel's central difference formulae	6	CO2
UNIT-III	**Numerical Solution of Partial Differential Equation and Least Square Approximation of Functions**	**Hrs.**	**CO**
	Finite difference, approximation to derivatives. Laplace equation, Iterative methods for the solution of equations. Linear regression, Polynomial regression, fitting exponential, and trigonometric functions.	6	CO3
UNIT-IV	**Basics of signals and Systems**	**Hrs.**	**CO**
	Continuous and discrete time signals: Classification of Signals: Periodic aperiodic, even, and 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. Shifting and scaling operations, Sampling Theorem and Aliasing Effect	6	CO4 CO6
UNIT-V	**Signal Transformation I**	**Hrs.**	**CO**
	Fourier Transformation: Fourier transformation of continuous and discrete time signals and their properties. Parseval's theorem; Convolution in time (both discrete and continuous) and frequency domains with magnitude and phase response of LTI systems.	6	CO5
UNIT-VI	**Signal Transformation II**	**Hrs.**	**CO**
	Laplace Transform: Laplace transformation- analysis with examples and properties. Recapitulation, Analysis, and characterization of LTI systems using Laplace transform: Computation of impulse response and transfer function using Laplace transform. **Z-Transforms:** 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.	6	CO5

Text Books:

[T1] V. Rajaraman," Computer Oriented Numerical Method", Prentice Hall of India.
[T2] S. S. Sastry," Introductory methods of numerical analysis", Prentice Hall of India
[T3] C. Woodford, C. Phillips," Numerical Methods with Worked Examples: MATLAB Edition", Springer, Second Edition", John Wiley & Sons, Incorporated, 2011
[T4] B.P. Lathi, "Signal Processing & Linear Systems", Oxford, Third Edition.
[T5] P. Ramesh Babu & R. Anandanatarajan, "Signals and Systems", SciTech, fourth edition
[T6] S Ghosh, "Signals and Systems", Pearson.
[T7] S. Haykin&B.V. Veen, "Signals and Systems", John Wiley.

References:

[R1] A. Quarteroni, F. Saleri, and P. Gervasio, Scientific computing with MATLA and Octave, Third edition, (Springer, 2010).

[R2] Steven C. Chapra and Raymond P. Canale, "Numerical methods for Engineers", Mc-Graw Hill Publication,2007.

[R3] W.Y. Yang, W. Cao, T.-S. Chung and J. Morris, Applied Numerical methods using MATLAB, (John Wiley, 2005).

[R4] B.S. Grewal," Numerical Methods in Engineering & Science", Khanna Publishers.

[R5] A.V. Oppenheim, A.S. Willsky and S.H. Nawab, "Signals & Systems", Pearson.

[R6] A. NagoorKani, "Signals and Systems", McGraw Hill.

[R7] H.P. Hsu, "Schaum's outline of Signals and systems", McGraw Hill Publication.

E-References

[1] https://nptel.ac.in/courses/111/107/111107105/

[2] https://nptel.ac.in/courses/115/103/115103114/

[3] https://nptel.ac.in/courses/108/104/108104100/

[4] https://nptel.ac.in/courses/117/101/117101055/

[5] https://nptel.ac.in/courses/108/106/108106163/

EE212: NETWORK ANALYSIS

Teaching Scheme	**Examination Scheme**	
Lectures: 03 Hrs./Week	**Continuous Assessment:**	**20 Marks**
Tutorial: 01 Hr/Week	**In-Sem Exam:**	**30 Marks**
	End-Sem Exam:	**50 Marks**
Credits: 04	**Total:**	**100 Marks**

Prerequisite Course: Basic Electrical Engineering

Course Objectives

1.To develop the strong foundation for Electrical Networks.
2.To develop analytical qualities in Electrical circuits by application of various theorems
3.To understand the behaviour of circuits by analysing the transient response using classical methods and Laplace Transform approach.
4. To understand basic concept of Graph theory.
5. To apply knowledge of Network theory for analysis of 2-port networks.
6. To apply knowledge of Network theory for designing Low-pass and high pass filter.

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Demonstrate strong basics for network theory	3	Applying
CO2	Use the knowledge of problem-solving technique for networks by application of theorems for DC and AC circuits.	3	Applying
CO3	Analyze the behaviour of the network by transient response	4	Analysing
CO4	Demonstrate of Standard test inputs and transformed network.	3	Applying
CO5	Understand the behaviour of the network by analysing two ports analysis	2	Understanding
CO6	Apply network for designing and synthesis of Filters	4	Analysing

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	2	-	-	-	2	2	-	-	2	2
CO2	3	3	-	-	2	-	-	-	2	2	-	-	2	2
CO3	3	3	-	-	2	-	-	-	2	2	-	-	2	2
CO4	3	3	-	-	2	-	-	-	2	2	-	-	2	2
CO5	3	3	-	-	1	-	-	-	2	2	-	-	2	2
CO6	3	2	-	-	1	-	-	-	2	1	-	-	2	2

Course contents			
UNIT I	**Basic Network Concept**	**Hrs**	**CO**
	Types of Sources, Source transformation, Series, parallel concept for resistance, capacitance, and inductance, coupled circuits and dot conventions, Kirchhoff's voltage and current law, mesh analysis, nodal analysis, Concept of duality and dual networks. Graph of network: Concept of tree branch, tree link, tie set and cut set.	**8**	CO1
UNIT II	**Network Theorems**	**Hrs**	**CO**
	Superposition, Thevenin, Norton, Maximum Power Transfer Theorem, Reciprocity theorem, Millman theorems applied to both ac/dc circuits.	**8**	CO2
UNIT III	**Transient Phenomena**	**Hrs**	**CO**
	Initial and Final Condition of network, General and Particular Solution, time constant. Transient response of R-L, R-C and R-L-C network in time domain.	**8**	CO3
UNIT IV	**Laplace Domain Analysis**	**Hrs**	**CO**
	Standard test inputs: Step, Ramp, Impulse, Their Laplace transform, Representation of R, L, C in S domain, transformed network, Application of Laplace transform to solve series and parallel R-L, R-C and R-L-C circuits (Source free, Source driven).	**8**	CO4
UNIT V	**Network functions Two port Network concept**	**Hrs**	**CO**
	Network functions for one and two port, calculation of network functions, poles and zeros of network functions, restrictions on poles and zeros, time domain behaviour from the pole and zero location, Necessary conditions for stable driving point function and transfer function, two port parameters: Z, Y, H, and transmission parameter	**8**	CO5
UNIT VI	**Application: Filter Design**	**Hrs**	**CO**
	Classification of filters: Low pass, High Pass, Band pass, Band stop, Symmetrical networks: characteristic impedance, propagation constant, Design of constant K- low pass and constant K- high pass filters using symmetrical networks	**8**	CO6

Text Books:

1. M. E. Van Valkenburg, "Network Analysis", Prentice Hall of India Private Limited, Third Edition.
2. D Roy Choudhary, "Network and Systems", New age international publishers.
3. Abhijit Chakrabarti, "Circuit Theory", DhanpatRai and Company, 7th edition.

References:

1. William H. Hayt, Jr. Jack E. Kemmerly, "Engineering Circuit Analysis" McGraw Hill Publication.
2. N.C. Jagan, "Network Analysis", BS Publication, Hyderabad, Second Edition.
3. John O' Malley, "Schaum's outline of Theorems and Problems of Basic Circuit Analysis", McGraw Hill Publication.

EE213: ELECTRICAL MACHINES I

Teaching Scheme	**Examination Scheme**	
Lectures: 04 Hrs./Week	**Continuous Assessment:**	**20 Marks**
Tutorial: --- Hr/Week	**In-Sem Exam:**	**30 Marks**
	End-Sem Exam:	**50 Marks**
Credits: 04	**Total:**	**100 Marks**

Prerequisite Course:

1. Basic Electrical Engineering.
2. Basic Electrical Circuits.

Course Objectives

1. Understanding the concepts of magnetic circuits and requirement of mainataince.
2. Analysis of single phase and three phase transformers circuits.
3. Understanding the operation of dc machines.
4. Analysis of differences in operation of different dc& induction machine configurations.

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Understand basic laws, concepts of magnetic circuits and its applications.	2	Understanding
CO2	Apply energy conversion principles to Single phase transformer, its equivalent circuit & operations	3	Applying
CO3	Understand basic connections of three phase transformer and parallel operation of transformer and comparison	2	Understanding
CO4	Identify and demonstrate the components of D.C. machine and its working as motor to test the various machine for performance calculation.	2	Understanding
CO5	Apply Characteristics of D.C. Shunt and Series Motors to choose proper motor for proper applications	3	Applying
CO6	Understand Induction motors & its operation on the basis of Speed, Slip, Torque, Power, and efficiency.	2	Understanding

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1	--	--	1	--	--	--	--	1	2	3	2
CO2	3	2	2	1	1	1	--	1	--	--	2	2	3	2
CO3	3	2	1	1	1	1	--	1	--	--	1	2	3	2
CO4	3	2	1	1	1	1	--	1	--	--	1	2	3	2
CO5	3	2	1	1	1	1	--	1	--	--	1	2	3	2
CO6	3	2	1	2	2	1	--	1	--	--	2	2	3	2

Course Contents			
UNIT-I	**MAGNETIC FIELDS, CIRCUITS AND BASIC CONSIDERATIONS**	**Hrs.**	**COs**
	a) Basic principles, conservation of energy, physical phenomenon involved in conversion, energy balance, energy stored in magnetic field. b) Magnetic circuits, analogy between electric and magnetic-circuits, series and parallel magnetic circuits, practical magnetic circuits, permanent magnet, and their applications c) Types of faults in electrical equipments {Electrical equipments such as transformer, CT/PT and rotating electrical machines}, maintenance strategies, breakdown maintenance, planned, preventative and condition-based maintenance.	08	CO1
UNIT-II	**TRANSFORMERS**	**Hrs.**	**CO**
	Single phase Transformer: Review, Concept of ideal transformer. Resistance, leakage reactance and leakage impedance of transformer windings & their effects on voltage regulation and efficiency. Exact and approximate equivalent circuits referred to L.V. and H. V. side of the transformer. Phasor diagrams for no-load and on load conditions. Transformer ratings. Losses in a transformer, their variation with load, voltage & Frequency on no load losses Efficiency and condition for maximum efficiency. All day Efficiency. **Autotransformers**, their ratings and applications, Comparison with two winding transformer with respect to saving of copper and size.	08	CO2
UNIT-III	**SINGLE PHASE & THREE PHASE TRANSFORMERS**	**Hrs.**	**CO**
	a) Single Phase Transformers: Polarity test. Parallel operation of single-phase transformers, conditions to be satisfied, load sharing under various conditions. Cooling of transformers. **b) Three Phase Transformers**: Standard connections of three phase transformers and their suitability for various applications, voltage Phasor diagrams and vector groups. Descriptive treatment of Parallel operation of three phase transformers Scott connection and V-V connections. Three winding (tertiary windings) transformers. Modern trends in transformers, type, and routine tests.	08	CO3
UNIT-IV	**D.C. MACHINES –I**	**Hrs.**	**CO**
	Review of construction, main parts, magnetic circuits, poles, yoke, field winding, armature core, Armature windings: Simple lap and wave winding, commutator, and brush assembly. Generating action, E.M.F equation, magnetization curve, Flashing of Generator. Motoring action. Types of DC motors, significance of back E.M.F torque equation, working at no-load and on-load. Losses, power flow diagram and efficiency. Descriptive treatment of armature reaction.	08	CO4
UNIT-V	**D.C. MACHINES –II**	**Hrs.**	**CO**
	a) Characteristics and Selection of DC Motors for various applications (D.C. Shunt and Series Motors), Starting of DC motors, study of starters for series and shunt motor, solid state starters, speed control of various types of DC motors. b) Commutation: Process of commutation, time of commutation, reactance voltage, straight line commutation, commutation with variable current density, under and over commutation, causes of bad commutation and remedies, inter poles, compensating windings. (Descriptive treatment only)	08	CO5
UNIT-VI	**THREE PHASE INDUCTION MOTOR**	**Hrs.**	**CO**

	Review, Construction of Stator, Squirrel cage & wound rotors, Production of rotating mmf by 3-phase balanced voltage fed to a symmetrical 3-phase winding. Principle of working, simplified theory with constant air gap flux; slip, frequency of rotor emf and rotor currents, mmf produced by rotor currents, its speed w.r.t. rotor and stator mmf. Production of torque, torque-slip relation, condition for maximum torque, torque-slip Characteristics, effect of rotor resistance on torque-slip characteristics. Relation between starting torque, full load torque and maximum torque. Losses in three phase induction motor, power-flow diagram. Relation between rotor input power, rotor copper loss & gross mechanical power developed efficiency.	08	CO6

Text Books:

[T1] Edward Hughes "Electrical Technology", ELBS, Pearson Education.
[T2] Ashfaq Husain, "Electrical Machines", Dhanpat Rai& Sons.
[T3] S. K. Bhattacharya, "Electrical Machine", Tata McGraw Hill publishing Co. Ltd,2nd Edition.
[T4] Nagrath & Kothari, "Electrical Machines", Tata McGraw Hill.
[T5] Bhag S Guru, Husein R. Hiziroglu, "Electrical Machines", Oxford University Press.
[T6] K Krishna Reddy, "Electrical Machines- I and II", SCITECH Publications (India)Pvt. Ltd. Chennai.

References:

[R1] A.E. Clayton and N. N. Hancock, "Performance and Design of Direct Current Machines", CBS Publishers, Third Edition.
[R2] A.E. Fitzgerald, Charles Kingsley, Stephen D. Umans, "Electrical Machines", Tata McGraw Hill Publication Ltd., Fifth Edition.
[R3] A.S. Langsdorf, "Theory and performance of DC machines", Tata McGraw Hill.
[R4] M.G. Say, "Performance and Design of AC. Machines", CBS Publishers and Distributors.
[R5] Charles I Hubert, "Electrical Machines Theory, Application, & Control", Pearson Education, New Delhi, Second Edition.
[R6] Smarajit Ghosh, "Electrical Machines", Pearson Education, New Delhi.
[R7] P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.

E-resources:

Unit	Content	Material Link	NPTEL Lecture /Video/ Transcript/ PDF Number
II & III	**Transformers:** Operating principle, classification, construction	https://nptel.ac.in/courses/108105017/	**1, 2**
	Emf equation, phasor diagrams		**3**
	Equivalent circuit model		**4**
	Losses & efficiency		**5,6**
	Voltage regulation		**7**
	Frequency response, polarity test		**6**
	Autotransformers, Isolation & instrument transformers		**17**
	D.C. Machines: Operating principle, generator & motor action,		**21, 22**

IV & V	construction,	https://nptel.ac.in/courses/108105017/	
	Types of excitations		**22**
	Emf & torque equations		**23**
	Power stages & efficiency		**35**
	Commutation		**25**
	Armature Reaction,		**24**
	Characteristics & applications of d.c generators		**30**
	Starting & speed control of d.c motors,		**31, 32**
	Characteristics & applications of d.c motors		**36, 40**
VI	**Induction Machines:** Three-phase induction motors. Principle of operation, construction, types	https://nptel.ac.in/courses/108105131/	**34, 35**
	Rotating magnetic field, emf equation of an AC Machine		**35**
	Torque developed in an induction motor		**40, 47**
	Equivalent circuit model		**41, 42, 43**
	Torque-speed characteristics		**51, 60**
	Starting & speed control.		**57**
	Single phase induction motors		**65 to 73**
	Starting, application		**65 to 73**

EE214: POWER SYSTEM-I

Teaching Scheme	**Examination Scheme**	
Lectures: 03 Hrs./Week	**Continuous Assessment:**	**20 Marks**
Tutorial: -- Hrs./Week	**In-Sem Exam:**	**30 Marks**
	End-Sem Exam:	**50 Marks**
Credits: 3	**Total:**	**100 Marks**

Prerequisite Course: Students should have knowledge of Basics Electrical Engineering, Power Generation, various insulating materials, and properties and knowledge of fundamental of electrical circuit components.

Course Objectives

1. To make students understand basic structure and requirements of any electric power system.
2. To understand various electrical terms related with power system and understand various types of tariffs.
3. To understand specifications and applications of major electrical equipment present in powerplant.
4. It is aimed to impart knowledge about nature of power systems engineering and the profession impact.
5. To develop a skill to establish background for further studies in power systems.

Course Outcomes (COs):

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

	Course Outcome (s)	**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Understand basic structure and requirements of any electric Power system & various electrical terms related with power system and understand various types of tariffs.	2	Understanding
CO2	Understand major electrical equipment's in power stations	2	Understanding
CO3	Explain various parameters of mechanical design of overhead Lines power system.	2	Understanding
CO4	Working of various equipment & transmission line parameters used in power system.	2	Understanding
CO5	Evaluate transmission line performance and economic operation of power system	5	Evaluating
CO6	Classify types of feeders, cables, voltage and P.F. control Methods	4	Analysing

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	2	2	2
CO2	3	2	-	-	-	-	-	-	-	-	-	2	2	2
CO3	3	2	-	-	-	-	-	-	-	-	-	2	2	2
CO4	3	2	-	-	-	-	-	-	-	-	-	2	2	2
CO5	3	2	-	-	-	-	-	-	-	-	-	2	2	2
CO6	3	2		-	-	-	-	-	-	-	-	2	2	2

COURSE CONTENTS			
UNIT-I	**BASIC STRUCTURE OF POWER SYSTEM**	**Hrs.**	**COs**
	A) Structure of Electrical Power Systems: Structure of Electrical Power System, Interconnected grid system, Different factors associated with generating stations such as Connected load, Maximum Demand, Demand Factor, average load, load factor, diversity factor, plant capacity factor, reserve capacity, plant use factor, Load curve, load duration curve, concept of base load and peak load stations.	06	CO1
UNIT-II	**MAJOR ELECTRICAL EQUIPMENT'S IN POWER STATIONS**	**Hrs.**	**CO**
	Features & use of alternators, necessity of exciters, various excitation systems such as dc excitation, ac excitation and static excitation systems, transformers, voltage regulators, bus-bars, current limiting reactors, circuit breakers, protective relays, current transformers, Potential transformers, Lightning arresters, earthing switches, isolators, carrier current equipment (P.L.C.C.), Control panels, battery rooms, metering and other control room equipment in generating stations	06	CO2
UNIT-III	**MECHANICAL DESIGN OF OVERHEAD LINES**	**Hrs.**	**CO**
	A) Mechanical Design of Overhead Lines: Main components of overhead lines, Line supports, conductor spacing, length of span, calculation of sag for equal and unequal supports and effect of ice and wind loadings. **B) Underground Cables:** Classification, Construction of cable, XLPE cables, insulation resistance, dielectric stress in single core cable, capacitance of single core and three core cables. Grading of cables, inter sheath grading, capacitance grading.	06	CO3
UNIT-IV	**TRANSMISSION LINE PARAMETERS**	**Hrs.**	**CO**
	A) Resistance: Resistance, skin effect and proximity effect **B) Inductance:** Definition of inductance, inductance of single phase two wire line, conductor types, and bundled conductors. Inductance of composite conductor, single circuit three phase line, double circuit three phase line.	06	CO4
UNIT-V	**PERFORMANCE OF TRANSMISSION LINES**	**Hrs.**	**CO**
	Classification of lines based on length and voltage levels such as short, medium and long lines, Representation of 'Tee' and 'Pi' models of lines as two port networks, evaluation and estimation of generalized circuit constants (ABCD) for short and medium lines, Estimation of Efficiency & regulation of short & medium lines.	06	CO5
UNIT-VI	**VOLTAGE AND POWER FACTOR CONTROL**	**Hrs.**	**CO**
	Methods of voltage control, AVRs, tap changing transformers, causes of low power factor, effects of low power factor, Shunt capacitors, Correction, Ferranti effect Surge impedance loading, power flow through transmission lines.	06	CO6

Text Books:

[T1] J. B. Gupta, "Transmission and Distribution", S. K. Kataria & Sons, New Delhi.
[T2] V. K. Mehta, Rohit Mehta, "Principles of Power System", S. Chand Publication
[T3] J. B. Gupta, "Generation and Economic Considerations", S. K. Kataria & Sons, New Delhi.
[T4] Dr. B. R. Gupta, "Generation of Electrical Energy", S. Chand Publication
[T5] A Chakraborty, M. L. Soni, P. V. Gupta, U.S. Bhatnagar, "A text book on Power System Engineering", Dhanpatrai & Co. Delhi.

References:

[R1] Nagrath & Kothari, "Power System Engineering", Tata McGraw Hill Publications.
[R2] D. Das, "Electrical Power System", New Age Publication.
[R3] W.D. Stevenson, "Power System Analysis", Tata McGraw Hill Publications.
[R4] Allen J Wood Bruce F. Wollenberg Gerald "Power generation operation and control" IEEE Wiley
[R5] Alexandra Von Meier "Electric Power Systems: A Conceptual Introduction" Willy Survival Guides in Engineering & Science

https://onlinecourses.nptel.ac.in/noc22_ee17/preview

https://onlinecourses.nptel.ac.in/noc22_ee18/preview

https://onlinecourses.nptel.ac.in/noc22_ee41/preview

Industrial visit: Minimum one visit to HV substations is recommended

EE215: NUMERICAL COMPUTATIONS WITH SIGNALS AND SYSTEMS LABORATORY

Teaching Scheme	**Examination Scheme**	
Lectures: -- Hrs./Week	**Oral:**	**-- Marks**
Tutorial: -- Hrs./Week	**Practical:**	**50 Marks**
Practical: 02 Hrs./Week	**Term Work:**	**-- Marks**
Credits: 1	**Total:**	**50 Marks**

Prerequisite Course:

1. Engineering Mathematics

Course Objectives

1. Development of the strong foundation of signals and systems
2. Understand sampling theorem and its implications.
3. Development of strong foundation analytical mathematics
4. Study of various methods of numerical analysis of linear and non-linear problems
5. Use of method for solving the problems in engineering
6. Use of modern computing tool

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Implement programs for various numerical methods and signals transformation using modern computing tools	3	Applying
CO2	Analyse various types of equations and apply appropriate numerical method to solve different nonlinear equations	4	Analysing
CO3	Apply different numerical methods for interpolation and curve fitting.	3	Applying
CO4	Generate various signals and systems using modern computing tools.	2	Understanding
CO4	Apply the Fourier, Laplace and Z- transform for analyse of continuous-time and discrete-time signals and systems.	3	Applying
CO5	Understand the process of sampling and the effects of under sampling.	2	Understanding

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	3	1	1	1	1	-	1	2	2	-
CO2	3	3	1	2	1	1	1	1	1	-	1	1	1	-
CO3	2	2	1	2	1	1	1	1	1	-	1	1	1	-
CO4	2	2	1	2	2	1	1	1	1	-	1	1	1	-
CO5	2	2	1	2	2	1	1	1	1	-	1	1	1	-
CO6	2	2	1	2	1	1	1	1	1	-	1	1	1	-

Course Contents			
Minimum 08 experiments should be conducted			
Ex. No	**Name of Experiment**	**Hrs.**	**COs**
1	Introduction to computing software (Scilab/MATLAB)	02	CO1
2	Basic operations on matrices	02	CO1
3	Solution of Non-linear equations using Bi-section methods	02	CO2
4	Solution of Non-linear equations using Newton-Raphson method	02	CO2
5	First order curve fitting using Least square approximation	02	CO3
6	Apply Newton Backward Interpolation method	02	CO3
7	Apply Newton Forward Interpolation method	02	CO3
8	Generating various signals and sequence	02	CO4
9	Fourier transforms and inverse Fourier transform	02	CO5
10	Laplace transforms	02	CO5
11	Z-transforms	02	CO5
12	Verification of Sampling Theorem	02	CO6

Text Books:

[T1] I.J. Nagrath, M. Gopal, "Control System Engineering", New Age International Publishers, 5th edition, 2007.
[T2] Katsuhiko Ogata, "Modern control system engineering", Prentice Hall, 2010.
[T3] Nise N. S. "Control Systems Engineering", John Wiley & Sons, Incorporated, 2011

References:

[R1] M. Gopal, "Control Systems: Principles and Design", McGraw Hill Education, 1997.
[R2] B. C. Kuo, "Automatic Control System", Prentice Hall, 1995

E-References

[1] https://nptel.ac.in/courses/107/106/107106081/
[2] https://nptel.ac.in/courses/108/106/108106098/

EE216: NETWORK ANALYSIS LABORATORY

Teaching Scheme	**Examination Scheme**	
Lectures: -- Hrs./Week	**Oral:**	**-- Marks**
Tutorial: -- Hr/Week	**Practical:**	**50 Marks**
Practical: 02 Hr/Week	**Term Work:**	**-- Marks**
Credits: 1	**Total:**	**50 Marks**

Prerequisite Course:

Course Objectives

1. To develop the strong foundation for Electrical Networks.
2. To develop analytical qualities in Electrical circuits by application of various theorems.
3. To understand the behaviour of circuits by analysing the transient response using classical methods and Laplace Transform approach.
4. To understand basic concept of Graph theory.
5. To apply knowledge of Network theory for analysis of 2-port networks.
6. To apply knowledge of Network theory for designing Low-pass and high pass filter.

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Demonstrate strong basics for network theory	3	Applying
CO2	Use the knowledge of problem-solving technique for networks by application of theorems for DC and AC circuits.	3	Applying
CO3	Analyze the behaviour of the network by transient response	4	Analysing
CO4	Demonstrate of Standard test inputs and transformed network.	3	Applying
CO5	Understand the behaviour of the network by analysing two port analysis	2	Understanding
CO6	Apply network for designing and synthesis of Filters	4	Analysing

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	2	-	-	-	2	2	-	-	2	2
CO2	3	3	-	-	2	-	-	-	2	2	-	-	2	2
CO3	3	3	-	-	2	-	-	-	2	2	-	-	2	2
CO4	3	3	-	-	2	-	-	-	2	2	-	-	2	2
CO5	3	3	-	-	1	-	-	-	2	2	-	-	2	2
CO6	3	2	-	-	1	-	-	-	2	1	-	-	2	2

Course Contents			
Enon	**Name of the Experiment**	**Hrs.**	**COs**
1	Study of mesh, nodal analysis	2	CO1
2	Study of Graph network Theory	2	CO1
3	Verification of Superposition theorem in D.C &A.C. circuits.	2	CO2
4	Verification of Thevenin's theorem in DC &A.C. circuits.	2	CO2
5	Verification of Reciprocity theorem in DC&A.C. circuits	2	CO2
6	Verification of Millman's' theorem.	2	CO2
7	Verification of Maximum Power Transfer theorem.	2	CO2
8	Study of time response of R-L, R-C circuit to a step D.C. voltage input.	2	CO3
9	Study of R-L, R-C circuit to a step D.C. voltage input using Laplace domain	2	CO4
10	Study determination of parameter of Two Port Network.	2	CO5
11	Study the Frequency response of constant K- low pass filters	2	CO6
12	Study the Frequency response of constant K- high pass filters.	2	CO6

Text Books:

1. M. E. Van Valkenburg, "Network Analysis", Prentice Hall of India Private Limited, Third Edition.
2. D Roy Choudhary, "Network and Systems", New age international publishers. Abhijit Chakrabarti, "Circuit Theory", DhanpatRai and Company, 7th edition

References:

1. William H. Hayt, Jr. Jack E. Kemmerly, "Engineering Circuit Analysis" McGraw Hill Publication.
2. N.C. Jagan, "Network Analysis", BS Publication, Hyderabad, Second Edition.

John O' Malley, "Schaum's outline of Theorems and Problems of Basic Circuit Analysis", McGraw Hill Publication.

EE217: ELECTRICAL MACHINES I LABORATORY

Teaching Scheme	**Examination Scheme**
Lectures: -- Hrs./Week	**Oral: -- Marks**
Tutorial: -- Hrs./Week	**Practical: 50 Marks**
Practical: 02 Hrs./Week	**Term Work: -- Marks**
Credits: 1	**Total: 50 Marks**

Prerequisite Course:

1. Basic Electrical Engineering.
2. Basic circuital Laws.

Course Objectives

1. Understanding the concepts of magnetic circuits.
2. Analysis of single phase and three phase transformers circuits.
3. Understanding the operation of dc machines.
4. Analysis of differences in operation of different dc& induction machine configurations.

Course Outcomes (COs):

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

Course Outcome (s)		Bloom's Taxonomy	
		Level	**Descriptor**
CO1	Understand basic laws & concepts of magnetic circuits	**2**	Understanding
CO2	Apply energy conversion principles to Single phase transformer, its equivalent circuit & operations	**3**	Applying
CO3	Understand basic connections of three-phase transformer and parallel operation of transformer and comparison	**2**	Understanding
CO4	Identify and demonstrate the components of D.C. machine and its working as a motor to test the various machine for performance calculation.	**4**	Analyze
CO5	Understand the Characteristics and applications of D.C. Shunt and Series Motors and the process of commutation.	**2**	Understanding
CO6	Understand Induction motors & their operation based on Speed, Slip, Torque, Power, and efficiency.	**2**	Understanding

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	--	--	--	--	1	--	--	1	2	3	2
CO2	3	2	2	1	--	--	--	1	--	--	2	2	3	2
CO3	3	2	1	--	1	--	--	1	--	--	1	2	3	2
CO4	3	2	1	1	1	--	--	1	--	--	1	2	3	2
CO5	3	2	1	1	1	--	--	1	--	--	1	2	3	2
CO6	3	2	1	2	2	--	--	1	--	--	2	2	3	2

Course Contents			
Ex. No	**Name of Experiment** (Any 8 Experiments)	**Hrs.**	**COs**
1	O.C. and S.C. test on single phase Transformer.	2	CO1, CO6, CO3
2	Polarity test on single-phase and three-phase transformer	2	CO6, CO3
3	Parallel operation of two single-phase transformers and study of their load sharing under various conditions of voltage ratios and leakage impedances.	2	CO6, CO3
4	Speed control of D.C. Shunt motor and study of starters.	2	CO1, CO4
5	Brake test on D.C. Shunt motor	2	CO3, CO4
6	Load characteristics of D.C. series motor	2	CO2, CO3
7	Load test on a 3-phase induction motor.	2	CO1, CO3
8	No-load & blocked-rotor test on 3-phase induction motor: a) Determination of parameters of equivalent circuit. b) Plotting of circle diagram.	2	CO1, CO4, CO2
9	Calculation of motor performance from (a) Determination of parameters of equivalent circuit & (b) Plotting of circle diagram above.	2	CO3
10	Determination of sequence impedance of the transformer.	2	CO3, CO4

Text Books:

[T1] Edward Hughes "Electrical Technology", ELBS, Pearson Education.
[T2] Ashfaq Husain, "Electrical Machines", Dhanpat Rai & Sons.
[T3] S. K. Bhattacharya, "Electrical Machine", Tata McGraw Hill Publishing Co. Ltd,2nd Edition.
[T4] Nagrath & Kothari, "Electrical Machines", Tata McGraw Hill.
[T5] Bhag S Guru, Husein R. Hiziroglu, "Electrical Machines", Oxford University Press.
[T6] K Krishna Reddy, "Electrical Machines- I and II", SCITECH Publications (India) Pvt. Ltd. Chennai.

References:

[R1] A.E. Clayton and N. N. Hancock, "Performance and Design of Direct Current Machines", CBS Publishers, Third Edition.
[R2] A.E. Fitzgerald, Charles Kingsley, Stephen D. Umans, "Electrical Machines", Tata McGraw Hill Publication Ltd., Fifth Edition.
[R3] A.S. Langsdorf, "Theory and performance of DC machines", Tata McGraw Hill.
[R4] M.G. Say, "Performance and Design of AC. Machines", CBS Publishers and Distributors.
[R5] Charles I Hubert, "Electrical Machines Theory, Application, & Control", Pearson Education, New Delhi, Second Edition.
[R6] Smarajit Ghosh, "Electrical Machines", Pearson Education, New Delhi.
[R7] P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.

EE218: POWER SYSTEM I LABORATORY

Teaching Scheme	**Examination Scheme**	
Lectures: -- Hrs./Week	**Oral:**	**50 Marks**
Tutorial: -- Hr/Week	**Practical:**	**-- Marks**
Practical: 02 Hr/Week	**Term Work:**	**-- Marks**
Credits: 1	**Total:**	**50 Marks**

Prerequisite Course: Students should have knowledge of Basics of Electrical Engineering.

Course Objectives

1. To make students understand basic structure and requirements of any electric power system.
2. To understand various electrical terms related with power system and understand various types of tariffs.
3. To understand specifications and applications of major electrical equipment present in power plant.
4. It is aimed to impart knowledge about nature of power systems engineering and the profession impact.
5. To develop a skill to establish background for further studies in power systems.

Course Outcomes (COs):

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

Course Outcome (s)		Bloom's Taxonomy	
		Level	**Descriptor**
CO1	Understand basic structure and requirements of any electric power system & various electrical terms related with power System and understand various types of tariffs.	2	Understanding
CO2	Understand major electrical equipment's in power stations	2	Understanding
CO3	Explain various parameters of mechanical design of overhead Lines power system.	2	Understanding
CO4	Working of various equipment & transmission line parameters Used in power system.	2	Understanding
CO5	Evaluate transmission line performance and economic operation Of power system	5	Evaluating
CO6	Classify types of feeders, cables, voltage and P.F. control Methods	4	Analysing

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	2	2	2
CO2	3	2	-	-	-	-	-	-	-	-	-	2	2	2
CO3	3	2	-	-	-	-	-	-	-	-	-	2	2	2
CO4	3	2	-	-	-	-	-	-	-	-	-	2	2	2
CO5	3	2	-	-	-	-	-	-	-	-	-	2	2	2
CO6	3	2	-	-	-	-	-	-	-	-	-	2	2	2

Course Contents			
Ex. No	**Name of experiment**	**Hrs.**	**COs**
1	Visit Local Substation	2	CO2
2	Study of cables & find charging current	2	CO6
3	Study of different types of insulators	2	CO3
4	Study of Tariffs		
5	To study the Ferranti Effect of a Transmission line.	2	CO5
6	To find out the string efficiency across the string of insulators	2	CO3, CO5
7	To study the effects on transmission line simulator for Shunt Reactor Compensation for Unloaded Line	2	CO3, CO5
8	Determine A, B, C, D parameters of short and medium transmission line.	2	CO4, CO5
9	Introduction to simulation of power system using various tools	2	CO6
10	Efficiency, Regulation & ABCD parameters of Transmission line	2	CO4, CO5
11	To study various effects on Loading of transmission line	2	CO3, CO5
LAB INSTRUCTION:			
	At least eight experiments should be performed.		

Text Books:

[T1] J. B. Gupta, "Transmission and Distribution", S. K. Kataria & Sons, New Delhi.
[T2] V. K. Mehta, Rohit Mehta, "Principles of Power System", S. Chand Publication
[T3] J. B. Gupta, "Generation and Economic Considerations", S. K. Kataria & Sons, New Delhi. [T4] Dr. B. R. Gupta, "Generation of Electrical Energy's. Chand Publication
[T5] A Chakraborty, M. L. Soni, P. V. Gupta, U.S. Bhatnagar, "A text book on Power System Engineering", DhanpatRai & Co. Delhi.

References:

[R1] Nagrath & Kothari, "Power System Engineering", Tata McGraw Hill Publications. [R2] D. Das, "Electrical Power System", New Age Publication.
[R3] W.D. Stevenson, "Power System Analysis", Tata McGraw Hill Publications.
[R4] Allen J Wood Bruce F. Wollenberg Gerald "Power generation operation and control" IEEE Wiley
[R5] Alexandra Von Meier "Electric Power Systems: A Conceptual Introduction" Willy Survival Guides in Engineering & Science

EE219: SEMINAR / MINI PROJECT

Teaching Scheme	**Examination Scheme**	
Practical: 02 Hrs./Week	**Term-Work:**	**50 Marks**
Credits: 1	**Total:**	**50 Marks**

Prerequisite Course:

Course Objectives

1. Gaining of actual knowledge (terminology, classification, methods, and advanced trends)
2. Learning fundamental principles, generalization, or theories
3. Discussion and critical thinking about topics of current intellectual importance
4. Developing specific skills, competencies, and points of view needed by professionals in the field most closely related to the course.

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Identify advanced technical areas in the fields of science and technology	2	Understanding
CO2	Relate with the current technologies and innovations in Electrical engineering	3	Applying
CO3	Apply theoretical knowledge to actual industrial and research activity	3	Applying
CO4	Discuss and critically analyse about topics of current intellectual importance	4	Analysing
CO5	Document technical report	3	Applying
CO6	Present technical documentation and presentation	5	Evaluating

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	2	1	1	1	1	1	1	1	1	1	1	1	1	1
CO2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
CO3	2	2	1	2	2	1	1	1	1	1	1	1	1	1
CO4	2	2	1	2	2	1	1	1	1	2	1	1	1	1
CO5	2	1	1	1	1	1	1	1	1	2	1	1	1	1
CO6	2	1	1	1	1	1	1	1	1	2	1	1	1	1

Course Contents

A. Guidelines for Students:

1. Seminar / Mini Project group shall consist of not more than 3 students per group
2. Individual student have to present topic.
3. Seminar / Mini Project topic should be innovative, emerging, and current issues addressed.
4. Seminar / Mini Project should collect all information related with topic with authentic and validate proofs.
5. Students should work according to the directions given by guides.

B. Domains for Seminar / Mini Project may be from the following, but not limited to:

- Power Systems
- Power/Smart Grid
- Electric automobile
- Computer/Communication Networking
- IOT
- AI in Electrical Engineering
- Microcontroller based/Embedded systems
- Power electronics and drives
- High Voltage Engineering
- Agriculture Engineering
- Battery Technology's
- Robotics/Mechatronics/Process Automation
- Energy efficiency technique
- Green / Clean energy

C. Monitoring: Suggested Plan for various activities to be monitored by the teacher.

Week 1 & 2: Finalization of Seminar / Mini Project topic with broad literature survey
Week 3 & 4: Literature Survey and Abstract
Week 5 to 6: Software / Hardware development
Week 6 to 7: Intermediate review in front of Internal Assessment Panel
Week 8 & 9: Preparation of results and conclusions
Week 10 & 11: Preparation of report and presentation
Week 12 &13: Present seminar and submit report

Note: - Log book for all these activities shall be maintained. It is mandatory to submit the seminar report.

D. Report writing: A report with following contents shall be prepared:

Contents

1. Cover Page & Title Page
2. Certificate
3. Abstract
4. Acknowledgments
5. List of figures
6. List of tables
7. Abbreviations

8. Contents
9. Chapters
10. Appendix
11. References

Journals to Refer like but not limited to:

- IEEE transactions
- IEEE magazines/ newsletters/ proceedings
- IET Proceedings/ journals/ magazines
- Elsevier journals and magazines
- Electrical power components and systems journal – (ISSN 1532-5016, 1532-5008), published by Taylor and Francis group, USA.
- Cogeneration and distributed generation journal – (ISSN 1066-8683, 1545-7575), published by Fairmont press Inc. USA.
- Digital technical journal – (ISSN 0898-901X), published by Digital equipment corporation, USA.
- Journal of Institution of Engineers India – Electrical Engineering
- The Journal of the Institute of Electrical Engineers of Japan
- The Transactions of the Institute of Electrical Engineers of Japan
- Japanese journal of Applied physics
- Circuits, Systems & Signal Processing –Springer ISSN 0278-081X
- Energy Efficiency – Springer ISSN 1570-646X
- Electrical Engineering · Archiv für Elektrotechnik – Springer ISSN 0948-7921
- Engineering with Computers · An International Journal for Simulation-Based
- Engineering – Springer ISSN 0177-0667
- Journal of Control Theory and Applications –Springer ISSN 1672-6340
- Journal of Dynamical and Control Systems - Springer ISSN 1079-2724
- Journal of Real-Time Image Processing - Springer ISSN 1861-8200
- Mathematics of Control, Signals, and Systems – Springer ISSN 0932-4194

EE220: PROFESSIONAL DEVELOPMENT

Teaching Scheme	**Examination Scheme**	
Practical: 02 Hrs./Week	**Term Work:**	**50 Marks**
Credits: 1	**Total:**	**50 Marks**

Prerequisite Course:

1. Knowledge of programming language

Course Objectives

1. Competence in technical writing
2. Quality Scientific and Technical Documentation
3. Effective report writing
4. Understand basic concepts of research and its methodologies

Course Outcomes (COs):

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

Course Outcome (s)		Bloom's Taxonomy	
		Level	**Descriptor**
CO1	Understand the basic concepts of technical documentation	2	Understanding
CO2	Analyse technical literature	4	Evaluating
CO3	Write effective technical research, thesis, and report	3	Applying
CO4	Use Modern Technical Software	4	Analysing
CO5	Analyse and Visualise Data	4	Analysing

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	1	1	-	1	1	-	1	-	1	1	1	1	1	1
CO2	1	1	-	1	1	-	1	-	1	1	1	1	1	1
CO3	1	1	1	1	2	1	1	2	1	1	1	1	1	1
CO4	1	1	2	2	3	1	1	2	1	1	1	1	2	1
CO5	1	1	2	2	3	1	1	2	1	1	1	1	2	1

Course Contents

Technology has shown tremendous growth during the last two decades and quality of technical education system is under criticism. This course aims at enabling the learners to acquire the capabilities of selecting and defining technical problem, describing the methodology, collecting the data, and analysing and interpreting the results to conduct the demonstration effectively. After successful completion of this course the learner will have a conceptual understanding of research, its need and ethical research practices, the methods, and techniques of qualitative research to the learner. Facilitate

them to apply statistical techniques for analysis of data. And it also helps to know about presenting the data in various forms will be able to write reports on various academic activities including research effectively and efficiently.

Students need to complete the two courses (one from each head)

Recommended online courses for students are as following

A. For Professional Development (Any one of the following)

1. LaTeX & XFig – typesetting software by Prof. Kannan Moudgalya | IIT Bombay
2. Academic Research and Report Writing by Dr. Samir Roy | NITTTR, Kolkata
3. Basic Research by Dr. Premavathy Vijayan | AIHSHEW, Coimbatore
4. Spoken tutorial Courses on XFif Typesetting Software
5. Spoken tutorial Courses on LaTeX Typesetting Software

B. For Technical Development (Any one of the following)

1. Spoken tutorial Courses on SCILAB
2. Spoken tutorial Courses on Python
3. Spoken tutorial Courses on DSPACE
4. Spoken tutorial Courses on eSim
5. Spoken tutorial Courses on HTML
6. MATLAB ONRAMP / ECAD / LabVIEW / Industry 4.0 / IoT

And other Professional / Technical Development Courses.

NOTE: The students should take approval before registering the course from the department.

- ✓ Students are suggested to follow the deadlines of the courses, and submit all the assignments due.
- ✓ Continuous Assessment is based on your Assignment Scores, Final Presentation and Report Submission.
- ✓ Students are motivated to appear for exam and earn Course Completion Certificate.

MC221: INNOVATION - Project based – Science and Technology, Social, Design & Innovation

Teaching Scheme	Examination Scheme	
Lectures: 02 Hrs./Week	**Oral:**	**NA**
Tutorial: -- Hrs./Week	**Practical:**	**NA**
Practical: -- Hrs./Week	**Term Work:**	**NA**
Credits: No Credits	**Total:**	**NA**

Prerequisite Course:

Course Objectives

1. To develop strategic thinking to solve social problems
2. Understand the role of innovation and technical change in enterprise and national level economic performance
3. Understand the technological, human, economic, organizational, social, and other dimensions of innovation
4. Understand the effective management of technological innovation requires the integration of people, processes, and technology
5. Recognize opportunities for the commercialization of innovation

Course Outcomes (COs):

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

Course Outcome (s)		Bloom's Taxonomy	
		Level	**Descriptor**
CO1	Understand the role of innovation and technical change in enterprise and national level economic performance	2	Understanding
CO2	Develop strategic thinking to solve social problems	3	Applying
CO3	Recognize opportunities for the commercialization of innovation	6	Create

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	--	--	--	--	--	--	--	---	--	--	--	--
CO2	--	--	3	2	--	--	--	---	--	---	--	--	--	--
CO3	--	--	--	--	2	2	3	3	3	2	2	2	--	--

Course Contents

Many students, when they enter engineering, are full of enthusiasm to understand new areas, to build systems and to experiment and play with them. This enthusiasm is to be tapped and to direct it to exploration and sustained pursuit by the student, which may result in development of a working system, a prototype, or a device or material, etc. They are expected to come up with novel and useful ideas on social problems. Students may be encouraged to take up projects which are aimed at providing solutions to societal problems, reduce drudgery and improving efficiency in rural work, green technologies, utilization of rural and urban waste, sanitation, and public health, utilizing nonconventional energy sources, technologies for the benefit of the differently abled people and technologies ready to be implemented in the Institute.

Two types of activities may be undertaken under this

(a) Exposure to social problems (which are amenable to technological solutions)

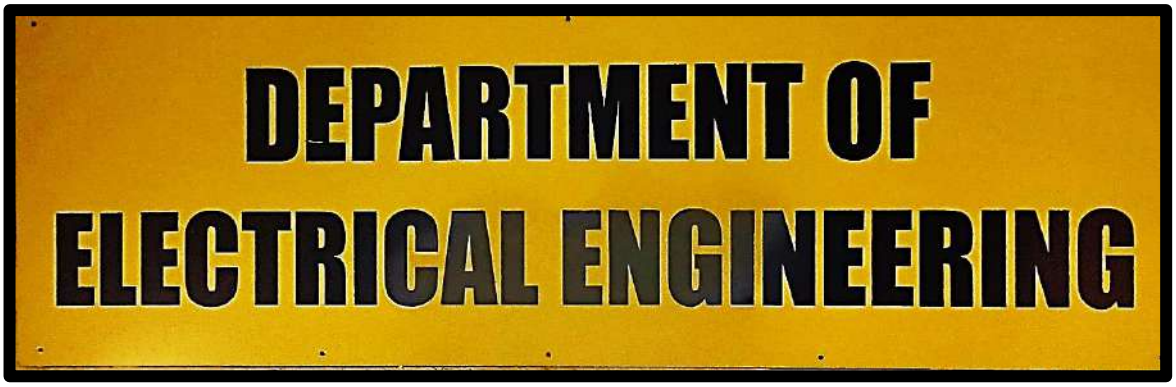
(b) Design & Innovation (to address above problems)

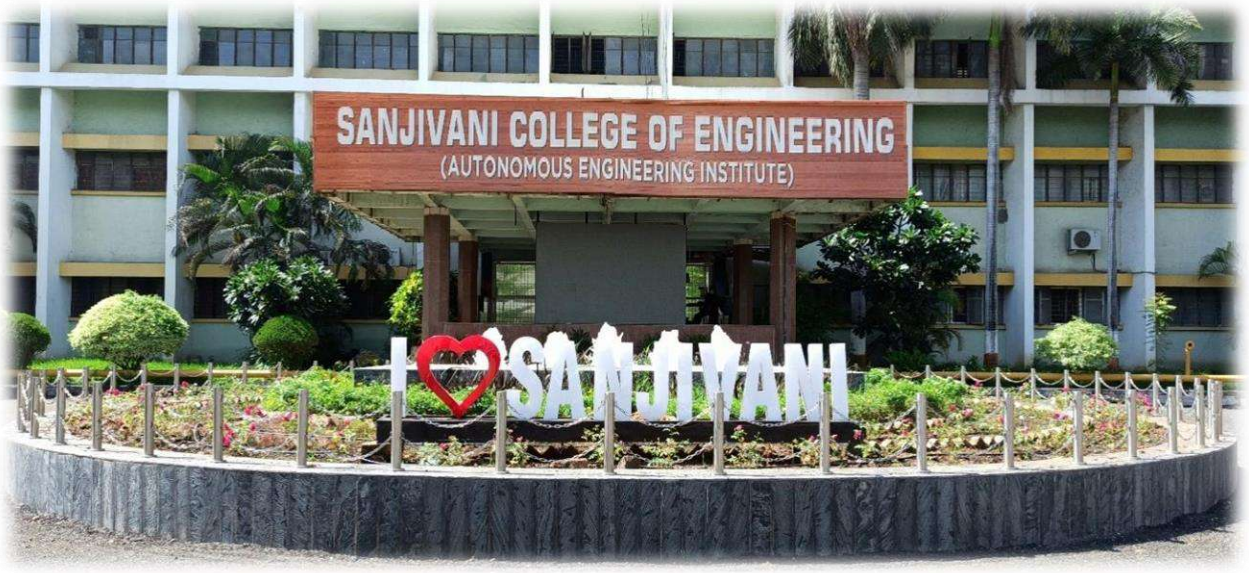
After this student, be encouraged to undertake technology projects of social relevance

SANJIVANI RURAL EDUCATION SOCIETY'S

SANJIVANI COLLEGE OF ENGINEERING KOPARGAON

(An Autonomous Institute Affiliated to Savitribai Phule Pune University, Pune)





DEPARTMENT OF ELECTRICAL ENGINEERING

COURSE STRUCTURE - 2020 PATTERN

THIRD YEAR B. TECH

Academic Year 2022-23

SANJIVANI RURAL EDUCATION SOCIETY'S

SANJIVANI COLLEGE OF ENGINEERING KOPARGAON

(An Autonomous Institute Affiliated to Savitribai Phule Pune University, Pune)

DEPARTMENT OF ELECTRICAL ENGINEERING

Profile: The Electrical Engineering degree program offer the graduates to enter a dynamic and rapidly changing field with career opportunities in Electric Power System, Power Electronics, Robotics and Control, Microprocessors and Controllers, Integrated Circuits, Computer Software. The demand for electrical power and electronic systems is increasing rapidly and electrical engineers are in great demand to meet the requirements of the growing industry. Electrical Engineers are mainly employed in industries using Electrical Power, Manufacturing Electrical Equipment, Accessories, Electronic Systems, Research and Development departments which work on energy saving devices and Software Development.

Many of these disciplines overlap with other engineering branches, spanning a huge number of specializations including hardware engineering, electromagnetic and waves, microwave engineering, nanotechnology, electrochemistry, renewable energies, Artificial Intelligence, mechatronics, and electrical materials science. Identifying these areas today's Electrical Engineer needs to have the capacity of adaptability and creativity in these new technical eras, to meet the industry 4.0.

Electrical Engineering Department of Sanjivani College of Engineering offers the B. Tech. course in Electrical Engineering with an intake of 60 students. The department has well qualified and dedicated faculty and is known for its high academic standards, well-maintained discipline, and complete infrastructure facilities.

Vision of Department

To produce quality electrical engineers with the knowledge of latest trends, research technologies to meet the developing needs of industry & society

Mission of Department

M1: To impart quality education through teaching learning process

M2: To establish well-equipped laboratories to develop R&D culture in contemporary and sustainable technologies in Electrical Engineering

M3: To produce Electrical Engineering graduates with quest for excellence, enthusiasm for continuous learning, ethical behavior, integrity and nurture leadership

Program Outcomes (POs):

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, society, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning in formed by the contextual knowledge to assess social, health, safety, legal and cultural issues, and the consequent responsibilities relevant to the professional engineering practice
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply the set of one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Educational Objectives (PEOs)

The PEOs of undergraduate programme in Electrical Engineering are broadly classified as follows:

PEO 1: Equip the student to analyze and solve real world problems to face the challenges of future.

PEO 2: Pursue higher education, research in Electrical Engineering or other allied fields of their interest for professional development.

PEO 3: Exhibit the leadership skills and ethical value for society

Program Specific Objectives (PSOs)

PSO 1: Apply the fundamentals of mathematics, science and engineering knowledge to identify, formulate, design and investigate complex engineering problems of electric circuits, analog and digital electronics circuits, control systems, electrical machines and Power system.

PSO 2: Apply the appropriate modern engineering hardware, and software tools in electrical engineering to engage in life-long learning and to successfully adapt in multi-disciplinary environments.

COURSE STRUCTURE- 2020 PATTERN
THIRD YEAR B. TECH. ELECTRICAL ENGINEERING

SEMESTER- V

Course			Teaching Scheme Hours/week				Evaluation Scheme-Marks						
							Theory						
Cat.	Code	Title	L	T	P	Credits	ISE	ESE	CIA	OR	PR	TW	Total
PCC	EE301	Microcontrollers And Applications	3	-	-	3	30	50	20	-	-	-	100
PCC	EE302	Electrical Machines II	3	-	-	3	30	50	20	-	-	-	100
PCC	EE303	Power System II	3	-	-	3	30	50	20	-	-	-	100
PCC	EE304	Power Electronics	3	-	-	3	30	50	20	-	-	-	100
PEC	EE305	Professional Elective-I **A.** Renewable Energy Sources **B.** Smart Grid	3	-	-	3	30	50	20	-	-	-	100
LC	EE306	Microcontrollers And Applications Laboratory	-	-	2	1	-	-	-	25	-	-	25
LC	EE307	Electrical Machines II Laboratory	-	-	2	1	-	-	-	-	50	-	50
LC	EE308	Power System II Laboratory	-	-	2	1	-	-	-	25	-	-	25
LC	EE309	Power Electronics Laboratory	-	-	2	1	-	-	-	-	50	-	50
PRJ	EE310	Skill Based Credit Course	1	-	-	1	-	-	-	-	-	50	50
MLC	MC311	Mandatory Learning Course-V **A.** Electrical Energy Conservation and Auditing	1	-	-	No Credit	-	-	-	-	-	-	-
		Total	**17**	**-**	**8**	**20**	**150**	**250**	**100**	**50**	**100**	**50**	**700**

Total Credits: 20
Total Marks: 700

COURSE STRUCTURE- 2020 PATTERN
THIRD YEAR B. TECH. ELECTRICAL ENGINEERING

SEMESTER- VI

Course			Teaching Scheme Hours/week				Evaluation Scheme-Marks						
							Theory						
Cat.	Code	Title	L	T	P	Credits	ISE	ESE	CIA	OR	PR	TW	Total
PCC	EE312	Power System Operation and Control	4	-	-	4	30	50	20	-	-	-	100
PCC	EE313	Feedback Control Systems	3	-	-	3	30	50	20	-	-	-	100
PCC	EE314	Electrical Machine Design	3	-	-	3	30	50	20	-	-	-	100
PEC	EE315	Professional Elective-II **A.** Electrical Drives **B.** Utilization of Electrical Energy **C.** Electromagnetic Fields	3	-	-	3	30	50	20	-	-	-	100
HSMC	HS315	Corporate Readiness	2	-	-	2	-	-	50	-	-	-	50
PROJ	PR316	IPR & EDP	2	-	-	2	-	30	20	-	-	-	50
LC	EE317	Power System Operation and Control Laboratory	-	-	2	1	-	-	-	25	-	-	25
LC	EE318	Feedback Control Systems Laboratory	-	-	2	1	-	-	-	-	50	-	50
LC	EE319	Electrical Machine Design Laboratory	-	-	2	1	-	-	-	25	-	-	25
LC	EE320	Programming Laboratory	-	-	2	1	-	-	-	-	50	-	50
PROJ	EE321	Creational Activity	-	-	2	1	-	-	-	-	-	50	50
MLC	MC322	Mandatory Learning Course-VI **A.** PCB Design	1	-	-	Non Credit	-	-	-	-	-	-	Pass/Fail
		Total	**18**	**-**	**10**	**22**	**120**	**230**	**150**	**50**	**100**	**50**	**700**

SEMESTER V

EE301: MICROCONTROLLERS AND APPLICATIONS

Teaching Scheme		Examination Scheme	
Lectures:	**03 Hrs./Week**	**Continuous Assessment:**	**20 Marks**
Tutorial:	**--- Hr/Week**	**In-Sem Exam:**	**30 Marks**
		End-Sem Exam:	**50 Marks**
Credits:	**03**	**Total:**	**100 Marks**

Prerequisite Course:
Analog and Digital Electronics

Course Objectives

1. To understand the differences between microcontrollers and microprocessors learn microcontroller architecture & describe the features of a typical microcontroller.
2. To use the 8051 addressing modes and instruction set and apply this knowledge to perform programs - arithmetic & logic operations, data & control transfer operations, input & output operations.
3. To define the protocol for serial communication and understand the microcontroller development systems.
4. To build and test a microcontroller-based system; interface the system to switch, keypad, and display.
5. To understand Arduino Board and its applications.
6. To understand embedded systems terminologies in terms of electrical Engineering.

Course Outcomes (COs):

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

Course Outcome (s)		Bloom's Taxonomy	
		Level	Descriptor
CO1	Describe basics of 8051 and its instruction set	2	Understanding
CO2	Construct assembly language programs based on the instruction set of 8051.	6	Creating
CO3	Understand the Timers, Interrupts, serial communication and interfacing with microcontroller.	2	Understanding
CO4	Understand Arduino Board and Interfacing	2	Understanding
CO5	Build programs and interface different component with Arduino board for various applications	3	Applying
CO6	Interface I/O for real life applications using Advance controllers	3	Applying

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	3	2	2	1	2	1	-	1	1	1	1	1	1	1
CO2	3	2	2	2	2	1	-	1	1	1	1	1	1	2
CO3	3	2	2	3	2	3	2	1	2	2	2	2	1	2
CO4	3	2	2	1	2	1	1	1	1	1	1	1	1	1
CO5	3	2	2	2	2	2	2	2	2	2	2	1	1	2
CO6	3	2	2	3	2	3	2	2	2	3	3	2	1	2

Course Contents			
UNIT-I	**INTRODUCTION TO MICROCONTROLLER**	**Hrs.**	**CO**
	Introduction to concept of microcontroller, comparison of Microprocessor and microcontroller, Comparison of all 8-bit microcontrollers, Criteria for selecting a microcontroller, Intel 8051 microcontroller architecture, Pin diagram, Memory organization of 8051, special function registers, Internal structure of I/O ports, operation of I/O ports.	7	CO1, CO2
UNIT-II	**PROGRAMMING OF 8051 - I**	**Hrs.**	**CO**
	Addressing modes of 8051, Instruction set of 8051, Stack and Stack Related instruction, Data exchange, byte level logical operations, bit level logical operations, rotate and swap operations, instruction affecting flags, incrementing, decrementing, arithmetic operations, jump and recall instruction, Call and return subroutines. Introduction to embedded C programming.	6	CO2
UNIT-III	**PROGRAMMING OF 8051- II AND INTERFACING**	**Hrs.**	**CO**
	Counters and timers in 8051, timer modes and its programming. Interrupt registers, Serial communication and its programming. Serial data input, output, Serial data modes, interfacing of 8051 with PC through RS232. Programming and Interfacing of 8051 with 8 bit ADC (0809) and DAC (0808). Interfacing of 8051 with single key, LED, Relay, speed control of dc motors, Stepper motor control (speed /position).	6	CO3
UNIT-IV	**INTRODUCTION TO ARDUINO BOARD**	**Hrs.**	**CO**
	Role of embedded systems, open-source embedded platforms, Atmega328P- features, architecture, sensors and actuators, data acquisition systems, introduction to Arduino IDE- features, IDE overview, programming concepts: variables, functions, conditional statements.	6	CO4
UNIT-V	**INTERFACING OF ARDUINO**	**Hrs.**	**CO**
	Concept of GPIO in Atmega 328P based Arduino board, digital input and output, UART concept, timers, interfacing with LED, LCD andkeypad, serial communication using Arduino IDE, Concept of ADC in Atmega 328P based Arduino board, interfacing with temperature sensor (LM35), LVDT, strain gauge, accelerometer, concept of PWM, DCmotor interface using PWM.	8	CO5
UNIT-VI	**ADVANCE MICROCONTROLLERS**	**Hrs.**	**CO**
	Introduction, survey of different microcontrollers, Specifications, features, applications of different microcontrollers like PIC, NodeMCU, ARM processor, Raspberry pi development board, Concept of SOC.	8	CO6

Text Books:

[T1] Muhammad Ali Mazidi, Janice G. Mazidi and Rolin D. McKinlay, "The Microcontroller and Embedded Systems", Second Edition, Pearson, 2012.
[T2] Ayala K. J., "8051 Microcontroller: Architecture, Programming and applications "Second Edition, Penram international.
[T3] Subrata Ghoshal, "8051 microcontroller", Pearsons Publishers.
[T4] Started with Arduino by Massimo Banzi and Michael Shiloh Published by Maker Media, Inc.
[T5] Arduino microcontroller processing for everyone-Steven F Barret, Morgan and Claypool Publisher

References:

[R1] V Udayashankara and M S MallikarjunaSwamy, "8051 Microcontroller, Hardware, software and applications", TATA McGraw Hill.
[R2] Scott Mackenzie, "8051 Microcontroller", Pearson Education.
[R3] Ajay Deshmukh, "Microcontroller 8051" –TATA McGraw Hill.
[R4] Getting Started With Arduino: A Beginner's Guide by by Brad Kendall (Author), Justin Pot (Editor), Angela Alcorn (Editor)
[R5] Arduino Cookbook, 2nd Edition by Michael Margolis published by O'Reilly Media.

EE302: ELECTRICAL MACHINES II

Teaching Scheme		**Examination Scheme**	
Lectures:	**03 Hrs./Week**	**Continuous Assessment:**	**20 Marks**
Tutorial:	**--- Hr./Week**	**In-Sem Exam:**	**30 Marks**
		End-Sem Exam:	**50 Marks**
Credits:	**03**	**Total:**	**100 Marks**

Prerequisite Course:

1. Basic Electrical Engineering 2. Electrical Machines I

Course Objectives

1. Learn construction & working principle of three phase synchronous machines.
2. Define regulation of alternator & calculate it by direct and indirect methods.
3. Study the methods of starting 3- phase synchronous motor, & its operation under Different conditions.
4. Learn Speed control methods of three phase induction motor.
5. Develop phasor diagram & circle diagram of a c series motor.
6. Develop equivalent circuit of single-phase induction motor.

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Illustrate the operation of induction motor as generalized transformer, its equivalent circuit to select machine for specific applications.	3	Applying
CO2	Analyse Speed control methods of three phase induction motor, and the operation of different special purpose motor.	4	Analyzing
CO3	Analyse circle diagram of AC series motor & Examine applications of Universal motor.	4	Analyzing
CO4	Understand the construction, operation of cylindrical & sailent pole Synchronous motor	2	Understanding
CO5	Estimate operation of synchronous motor at constant load and variable excitation (v curves & ^curves) & constant excitation and variable load.	5	Evaluating
CO6	Determine the voltage regulations of 3ph synchronous generator and analyse the parallel operation of 3ph alternator	4	Analyzing

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	2	1	1	1	1	2	3	3	2
CO2	3	2	1	2	1	2	1	1	1	1	2	2	3	2
CO3	3	2	2	1	2	1	1	1	1	1	1	1	3	1
CO4	2	1	2	2	1	1	1	1	-	1	1	2	3	2
CO5	3	2	1	3	1	2	1	1	1	1	2	1	3	1
CO6	3	2	1	1	1	2	1	1	1	1	2	2	3	2

Course Contents			
UNIT-I	**THREE PHASE INDUCTION MOTOR**	**Hrs.**	**CO**
	Induction motor as a generalized transformer; phasor diagram. Exact & approximate equivalent circuit. No load and blocked rotor tests to determine the equivalent circuit parameters and plotting the circle diagram. Computation of performance characteristics from the equivalent circuit and circle diagram. Performance curves. Necessity of starter for 3-phase induction motors. Starters for slip-ring and cage rotor induction motors; stator resistance starter, auto transformer starter, star delta starter and rotor resistance starter. D.O.L. starter and soft starting, with their relevant torque and current relations. Comparison of various starters, testing of three phase induction motor as per IS 12615.	8	CO1
UNIT-II	**INDUCTION MACHINES AND SPECIAL PURPOSE MOTORS**	**Hrs.**	**CO**
	a) Speed control of three phase induction motor by various methods (Stator side and rotor side controls). Action of 3-phase induction motor as induction generator, applications of induction generator. Introduction to Energy Efficient three phase Induction Motor and Super conducting Generator. b) Construction of single phase induction motor, double field revolving theory. Equivalent circuit and torque-slip characteristics on the basis of double revolving field theory. Methods of self-starting. Types of single phase induction motors. Comparison of 1-phase induction motor with 3-phase induction motor. c) Special Purpose Motors (Descriptive Treatment Only): Construction, principle of working, characteristics ratings and applications of Brushless D.C. motors, Stepper rotors (permanent magnet and variable reluctance type only), Permanent Magnet motor (A.C. & D.C.) and linear induction motors.	8	CO2
UNIT-III	**A.C. SERIES MOTOR**	**Hrs.**	**CO**
	a) Operation of D.C. series motor on a.c. supply, nature of torque developed, problems associated with AC. operation and remedies. b) Compensated series motor: Compensating winding, conductively and inductively compensated motor. Use of compoles for improving commutation. Ratings and applications of Compensated Series motors. c) Universal motors: ratings, performance and applications, comparison of their performance on A.C. and D.C. supply.	8	CO3
UNIT-IV	**THREE PHASE SYNCHRONOUS MACHINES**	**Hrs.**	**CO**
	a) Three phase Synchronous machines: Construction, rotating-field type and rotating-armature type, salient-pole type and non-salient-pole type and their comparison. Excitation Methods. **b) Three phase Synchronous generator (cylindrical rotor type):** Principle of operation. Emf equation and winding factors, rating of generator. Generator on no-load and on balanced load.	8	CO4

	Armature reaction and its effect under different load power factors. Voltage drop due to armature resistance, leakage flux and synchronous reactance. Per phase equivalent circuit and Phasor diagram. Power - power angle relation. **Three phase Synchronous generator (salient pole type):** Armature reaction as per Blondel's two reaction theory for salient-pole machines, Direct-axis and quadrature-axis synchronous reactance's and their determination by slip test. Phasor diagram of Salient-pole generator and calculation of voltage regulation.		
UNIT-V	**THREE PHASE SYNCHRONOUS MOTOR**	**Hrs.**	**CO**
	Principle of operation. Methods of starting. Equivalent circuit, significance of torque angle, Losses, efficiency and Power flow chart. Operation of 3-phase Synchronous motor with constant excitation and variable load, Operation with constant load and variable excitation ('V' Curves and 'inverted V' curves). Phenomenon of hunting and its remedies. Applications of 3-phase synchronous motors. Introduction to synchronous – induction motor. Comparison of 3 phase synchronous motor with 3-phase induction motor.	8	CO5
UNIT-VI	**VOLTAGE REGULATION OF THREE PHASE SYNCHRONOUS GENERATOR**	**Hrs.**	**CO**
	a) Performance of open circuit and short circuit test on synchronous generator, determination of voltage regulation by emf, mmf, and Potier triangle methods. Determination of voltage regulation by direct loading. Short circuit ratio. b) **Parallel operation of 3-phase alternators:** Necessity, conditions, Load sharing between two alternators in parallel (Descriptive treatment only). Process of synchronizing alternator with infinite bus-bar by lamp method (one dark & two equally bright lamp method) and by the use of synchroscope, Synchronizing current, power and torque (no numerical).	8	CO6

Text Books:

[T1] Nagrath and Kothari, Electrical Machines, 2nd Ed., Tata McGraw Hill.
[T2] S. K. Bhattacharya, Electrical Machines, Tata McGraw Hill.
[T3] A.S. Langsdorf, Theory of Alternating Current Machinery, Tata McGraw Hill
[T4] P. S. Bimbhra, Electric Machinery, Khanna Publications.
[T5] B.R. Gupta and Vandana Singhal -Fundamentals of Electric Machines, New Age International (P)
[T6] E. Openshaw Taylor, Performance and design of a.c. commutator motors, Wheeler Publishing.
[T7] V. K. Mehta and Rohit Mehta, Principles of Electrical Machines, S Chand Publications
[T8] Krishna Reddy –Electrical Machines vol.II and III, SCITECH publications.
[T9] Ashfaq Husain, Electrical Machines, Dhanpat Rai and Co.
[T10] M V Deshpande, Electrical Machines, Prentice Hall of India

References:

[R1] M.G. Say, Performance and Design of A.C. Machines (3rd Ed.), ELBS
[R2] J B Gupta - Theory and performance of Electrical Machines, S K Kataria Publications
[R3] Samarjit Ghosh, Electrical Machines, Pearson Publication.
[R4] Bhag S Guru and Huseyin R Hiziroglu, Electrical Machinary and Transformer, 3rd Edition, Oxford University Press
[R5] E G Janardanan, Special Electrical Machines, Prentice Hall of India.

EE303: POWER SYSTEM II

Teaching Scheme		**Examination Scheme**	
Lectures:	**3 Hrs./Week**	**Continuous Assessment:**	**20 Marks**
Tutorial:	**--- Hr/Week**	**In-Sem Exam:**	**30 Marks**
		End-Sem Exam:	**50 Marks**
Credits:	**03**	**Total:**	**100 Marks**

Prerequisite Course:

1. Power System I
2. Electrical Machine
3. Network Analysis

Course Objectives

1. This course provides the knowledge of Power System and its stability.
2. It is aimed to impart knowledge of Real Time system
3. To understand use of per unit system and fault analysis
4. This course provides the knowledge of Power flow study
5. This course provides the knowledge of Power System Stability.

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Demonstrate various parameters in a circle diagram with line parameters.	3	Applying
CO2	Formulate per unit system to solve various problems.	6	Creating
CO3	Calculate currents and voltages in a faulted power system under both symmetrical and asymmetrical faults, and relate fault currents to circuit breaker ratings.	3	Applying
CO4	Evaluate different types of faults for balanced and unbalanced Systems.	5	Evaluating
CO5	Analyze various types of electricity market operation and control issues under congestion management, and analyze power system stability.	4	Analyzing
CO6	Planning for the distribution system and to understand the need of automation and control of distribution System.	2	Understanding

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	1	1	1	1	1	1	1	2	2
CO2	2	2	1	1	1	1	1	1	1	1	1	2	2	2
CO3	3	2	1	1	1	1	1	1	1	1	1	1	2	2
CO4	3	2	2	2	2	2	1	1	2	2	2	2	2	2
CO5	3	2	2	2	2	2	1	1	2	2	1	2	2	2
CO6	2	2	1	1	1	1	1	1	1	1	1	1	2	2

Course Contents			
UNIT-I	**TRANSMISSION LINE PERFORMANCE**	**Hrs.**	**CO**
	Evaluation of ABCD constants and equivalent circuit parameters of Long transmission line. Concept of complex power, power flow using generalized constants, surge impedance loading, Line efficiency, Regulation and compensation, basic concepts. Numerical based on: ABCD constants of Long transmission line, Power flow.	06	CO1
UNIT-II	**PER UNIT SYSTEM AND LOAD FLOW ANALYSIS**	**Hrs.**	**CO**
	Per unit system: Single line diagram, Impedance and reactance diagrams and their uses, per unit quantities, relationships, selection of base, change of base, rsystem. Numerical based on network reduction by using per unit system. **Load Flow Analysis:** Network topology, driving point and transfer admittance, concept of Z-bus and formulation of Y-bus matrix using bus incidence matrix method, Numerical based on Y bus Matrix,power- flow equations generalization to n bus systems, classification of buses, Newton- Raphson method (polar method) Decoupled and Fast decoupled load flow (descriptive treatment only).	06	CO2
UNIT-III	**SYMMETRICAL FAULT ANALYSIS**	**Hrs.**	**CO**
	3-phase short-circuit analysis of unloaded alternator, sub-transient, transient and steady state current and impedances, D.C. Offset, and effect of the instant of short-circuit on the waveforms, estimation of fault current without pre-fault current for simple power systems, selection of circuit breakers and current limiting reactors and their location in power system (Descriptive treatment Only) Numerical problem based on symmetrical fault analysis.	08	CO3
UNIT-IV	**UNSYMMETRICAL FAULT ANALYSIS**	**Hrs.**	**CO**
	Symmetrical components, transformation matrices, sequence components, power in terms of symmetrical components, sequence impedance of transmission line and zero sequence networks of transformer, solution of unbalances by symmetrical components-L, L-G, and L- L-G fault analysis of unloaded alternator and simple power systems with and without fault impedance. Numerical based on symmetrical components and unsymmetrical fault calculation.	08	CO4
UNIT-V	**POWER GENERATION POOL, ITS ECONOMICS AND POWER SYSTEM STABILITY**	**Hrs.**	**CO**
	Basics of Power System Economics & Short-term Operation Planning of Power System, Load curves and load duration curves, Power Pools & Electricity Markets. Inter-area transactions, multi-area power interchanges, Energy brokerage systems, Market design and auction mechanism, Pool versus bilateral markets and price formation, Role of independent generators and system operator. Steady state stability, transient stability, equal area criterion, swing equation, multi-machine stability concept.	06	CO5, CO4
UNIT-VI	**DITRIBUTED GENERATION**	**Hrs.**	**CO**
	Distributed Generation Standards, DG potential, Definitions and terminologies; current status and future trends, Technical and economic impacts, Definitions and terminologies; current status and future trends, Technical and economic impacts DG Technologies, DG from renewable energy sources, DG from non-renewable energy sources, distributed generation applications, Operating Modes, Base load; peaking; peak shaving and emergency power, Isolated, momentary parallel and grid connection.	06	CO6
Text Books:			

[T1]. J. Nagrath and D.P. Kothari – Modern Power System Analysis – Tata McGraw Hill, New Delhi.
[T2]. B R Gupta, "Power System Analysis and Design", S. Chand.
[T3]. Ashfaq Hussain, "Electrical Power Systems", CBS Publication 5th Edition.
[T4]. J.B.Gupta. "A course in power systems" S. K. Kataria Publications.
[T5]. P.S.R. Murthy, "Power System Analysis", B. S. Publications
[T6]. Anthony J. Pansini "Electrical Distribution Engineering", CRC Press.
[T7]. A. J. Wood and B. F. Wallenberg, "Power generation, operation and control", Wiley Interscience, 2nd Edition, 1996
[T8]. H Lee Willis, "Distributed Power Generation Planning and Evaluation", CRC Press.

References:

[R1]. H. Hadi Sadat: Power System Analysis, Tata McGraw-Hill New Delhi.
[R2]. G. W. Stagg and El- Abiad – Computer Methods in Power System Analysis – Tata McGraw Hill, New Delhi.
[R3]. M. E. El-Hawary, Electric Power Systems: Design and Analysis, IEEE Press, New York.
[R4]. Rakash Das Begamudre, "Extra High voltage A.C. Transmission Engineering ", New age publication.
[R5]. M. A. Pai, Computer Techniques in Power System Analysis, Tata McGraw Hill Publication.
[R6]. Stevenson W.D. Elements of Power System Analysis (4th Ed.) Tata McGraw Hill, New Delhi.
[R7]. K. R. Padiyar: HVDC Transmission Systems, New Age International Publishers Ltd, New Delhi.
[R8]. Olle I. Elgard – Electric Energy Systems Theory – Tata McGraw Hill, New Delhi.
[R9]. V. K. Chandra, Power Systems, Cyber tech Publications.

EE304: POWER ELECTRONICS

Teaching Scheme		**Examination Scheme**	
Lectures:	**03 Hrs./Week**	**Continuous Assessment:**	**20 Marks**
Tutorial:	**--- Hr./Week**	**In-Sem Exam:**	**30 Marks**
		End-Sem Exam:	**50 Marks**
Credits:	**03**	**Total:**	**100 Marks**

Prerequisite Course:

1. Knowledge of semiconductor material, basic electronics switches and its characteristics.
2. Basic concepts of circuits, analog and digital electronics

Course Objectives: The course aims to impart the knowledge of the student in:

1. Fundamental of power electronics switching devices and their characteristics
2. Concepts and characteristics of Single phase and Three phase controlled rectifiers
3. Functions of different modes of inverter and modulation techniques
4. Operation, switching regulators and basic topologies of DC - DC converters
5. Operation of AC voltage controller and its types of configuration

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	**Distinguish** the types of power semiconductor devices, and analyze their switching characteristics	2	Understand
CO2	**Demonstrate** the operation of single phase controlled rectifiers, and analyze its characteristics	3	Apply
CO3	**Demonstrate** the operation of three phase controlled rectifiers, and analyze its characteristics	3	Apply
CO4	**Apply** the different modulation techniques to PWM inverters and identify the harmonic reduction methods.	3	Apply
CO5	**Choose** the appropriate DC-DC converters for different applications	3	Apply
CO6	**Understand** operation of cyclo-converter and matrix converter in AC-AC applications.	2	Understand

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	-	-	-	-	1	-	-	1	1
CO2	2	2	2	1	1	-	-	-	-	1	-	-	1	1
CO3	3	2	2	1	1	-	-	-	-	1	-	-	1	1
CO4	3	3	2	2	2	-	-	-	-	1	-	-	2	2
CO5	3	2	1	1	1	-	-	-	-	1	-	-	1	1
CO6	3	3	3	1	1	-	-	-	-	1	-	-	1	1

Course Contents			
UNIT-I	**POWER SEMICONDUCTOR DEVICES**	**Hrs**	**CO**
	Introduction - VI and switching characteristics of power semiconductor devices: Power Diode, Thyristor, BJT, MOSFET, IGBT - SCR two transistor analogies - SCR Protection circuits - SCR firing circuits - SCR Commutation techniques - GTO	09	CO1
UNIT-II	**SINGLE PHASE AC to DC CONVERTERS**	**Hrs**	**CO**
	Principle of phase controlled converter - Single phase half and fully controlled converter with R, RL, RLE load - Derivation of average output current and voltage - Derivation of RMS output current and voltage - Freewheeling diode - Effect of source Inductance - Dual converter	06	CO2
UNIT-III	**THREE PHASE AC to DC CONVERTERS**	**Hrs**	**CO**
	Three phase half and fully controlled converter with R, RL load - Derivation of average output current and voltage – Derivation of RMS output current and voltage	03	CO3
UNIT-IV	**DC to AC CONVERTERS**	**Hrs**	**CO**
	Principle of operation Single phase voltage source inverters - Three phase voltage source inverters - 120^0 and 180^0 mode operation - Voltage control of inverter using PWM, Single PWM, Multiple PWM, Sinusoidal PWM and Modified SPWM - Harmonic reduction techniques - Single phase current source inverter	09	CO4
UNIT-V	**DC to DC CONVERTERS**	**Hrs**	**CO**
	DC Chopper : Principle of chopper operations - Step up and step down chopper - control strategy - Switched mode regulators - Buck, boost, buck boost regulators - Operation of two quadrant and four quadrant DC choppers with R and RL load – Introduction to Voltage, Current and Load commutated chopper	09	CO5
UNIT-VI	**AC to AC CONVERTERS**	**Hrs**	**CO**
	AC Voltage controllers: Single phase AC voltage controller with R and RL load – Control Strategy - Cycloconverter - Step up and step down - Principle of operation of single phase to single phase cycloconverter - Principle of operation of single phase to three phase cycloconverter - Matrix converter	09	CO6
Text Books:			
[T1] M. H. Rashid - Power Electronics 2nd Edition, Pearson publication [T2] Ned Mohan, T.M. Undel and, W.P. Robbins - Power Electronics, 3rd Edition, John Wiley and Sons [T3] B.W. Williams: Power Electronics 2nd edition, John Wiley and sons [T4] Ashfaq Ahmed- Power Electronics for Technology, LPE Pearson Edition. [T5] Dr. P.S. Bimbhra, Power Electronics, Third Edition, Khanna Publication.			
References:			
[R1] Vedam Subramanyam - Power Electronics , New Age International , New Delhi [R2] M. D. Singh and K. B. Khandchandani, Power Electronics, Tata McGraw Hill [R3] Jai P. Agrawal, Power Electronics systems theory and design LPE, Pearson Education, Asia [R4] L. Umanand, Power Electronics – Essentials and Applications Wiley Publication. [R5] V.R. Moorthi, Power Electronics Devices, circuits, and Industrial applications, Oxford University Press			
E-references:			
[E1] NPTEL Web course and video course on Power Electronics by Prof. D.Prasad, IIT, Kharagpur (https://nptel.ac.in/courses/108105066)			

EE305A: RENEWABLE ENERGY SOURCES

Teaching Scheme		**Examination Scheme**	
Lectures:	**03 Hrs./Week**	**Continuous Assessment:**	**20 Marks**
Tutorial:	**--- Hr/Week**	**In-Sem Exam:**	**30 Marks**
		End-Sem Exam:	**50 Marks**
Credits:	**03**	**Total:**	**100 Marks**

Prerequisite Course:

1. Basic Electrical and Electronics Engineering
2. Electrical Technology

Course Objectives

1. To create awareness about the importance of renewable technology for sustainable future.
2. Impart the knowledge of solar power generation and wind power generation.
3. Introduce forth coming renewable technologies and storage systems in renewable generation.
4. To participate in reducing the use of energy wherever possible for each individuals in the society.
5. To enhance the use of renewable energy by understanding its role towards environment.
6. To develop the solar PV array model or a wind mill for any one commercial application through MATLAB.

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Determine need of various power generation systems and critically analyse individual role towards energy utilization for environment conservation.	2	Understanding
CO2	Relate solar power generation and its utilization.	3	Applying
CO3	Analyse wind power generation and its utilization.	4	Analyzing
CO4	Explain biomass power generation and its utilization.	2	Understanding
CO5	Analyse trending renewable energy sources and energy storage systems.	4	Analyzing
CO6	Relate principles of storage technologies and their applications.	3	Applying

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2	1	1	3	3	2	2	2	2	3	2	3
CO2	3	2	2	2	2	2	3	-	-	-	2	3	3	3
CO3	3	2	2	2	1	2	3	-	-	-	2	3	3	3
CO4	3	2	1	2	1	2	2	-	1	1	2	3	3	3
CO5	3	1	2	1	1	2	3	-	-	-	2	3	3	2
CO6	3	2	2	2	2	2	2	1	2	2	2	3	2	2

Course Contents			
UNIT-I	**INTRODUCTION TO RENEWABLE ENERGY SYSTEMS**	**Hrs.**	**CO**
	Energy sources: classification of energy sources, introduction to renewable energy, renewable energy trends, and key factors affecting renewable energy supply, advantages and disadvantages of RES and their uses. Critical analysis of individual role towards energy utilization towards environment conservation.	8	CO1
UNIT-II	**SOLAR ENERGY**	**Hrs.**	**CO**
	PV power generation, basic principle of power generation in PV cell, technology for fabrication of photovoltaic devices, efficiency of PV cell, characteristics curves of PV cell, solar thermal power generation, solar thermal conversion: basics, solar concentrator and tracking system, flat plate collectors-liquid and air type, theory of flat plate collectors, selective coatings, advanced collectors: ETC, Solar Pond. Modelling of solar PV array for a commercial application.	8	CO2
UNIT-III	**WIND ENERGY**	**Hrs.**	**CO**
	Power available in wind, wind turbine power & torque characteristics, typesof rotors, characteristics of wind rotor, local effects, wind shear, turbulence & acceleration effects, measurement of wind, wind speed statistics, energy estimation of wind regimes, capacity factor, aerodynamics of wind turbines, airfoil, lift & drag characteristics, power coefficient & tip speed ratio characteristics, electrical generator machines in wind energy systems. Modelling of a wind mill for commercial application integrated with grid.	8	CO3
UNIT-IV	**BIOMASS ENERGY**	**Hrs.**	**CO**
	Overview of biomass as energy source, biomass as a fuel, physicochemicaland thermal characteristics of biomass as fuel, biochemical conversion of biomass for energy production, liquid biofuel, energy plantation- overview on energy plantation, basis of selecting the plants for energy plantation, waste land utilization through energy plantation.	8	CO4
UNIT-V	**FORTHCOMING RENEWABLE TECHNOLOGIES**	**Hrs.**	**CO**
	Geothermal Energy Generation, ocean-thermal energy generation, tidalenergy generation, magneto hydro dynamic power generation- working, layout, different components, advantages, limitations.	8	CO5
UNIT-VI	**STORAGE TECHNOLOGIES**	**Hrs.**	**CO**
	Introduction, need for storage for RES, basic thermodynamic and electrochemical principles, classification, traditional energy storage system-battery, fuel cell, principle of operation, types, applications for power generation.	8	CO6
Text Books:			
[T1] Boyle, Godfrey, "Renewable Energy", (2nd edition), Oxford University Press, 2004. [T2] G. S. Sawhney, "Non-Conventional Resources of Energy", PHI Publication 2012. [T3] G.D. Rai, Non conventional energy sources, Khanna publication			
References:			

[R1] Gary-L. Johnson Wind Energy Systems Tata Mc-Graw-Hill Book Company.
[R2] S. P. Sukhatme, J. K. Nayak Solar Energy- Principles of Thermal Collection and Storage (3rd ed.),Tata McGraw-Hill Publication.
[R3] Paul Gipe Wind Power, Renewable Energy for Home, Farm, and Business.
[R4] G.N. Tiwari,Solar Energy: Fundamentals, Design, Modeling and Applications Narosa Publication

E-References

[1] https://nptel.ac.in/courses/121/106/121106014/
[2] https://nptel.ac.in/courses/103/103/103103206/
[3] https://onlinecourses.swayam2.ac.in/nou22_ge17/course

EE305B: SMART GRID

Teaching Scheme		**Examination Scheme**	
Lectures:	**03 Hrs./Week**	**Continuous Assessment:**	**20 Marks**
Tutorial:	**--- Hr/Week**	**In-Sem Exam:**	**30 Marks**
		End-Sem Exam:	**50 Marks**
Credits:	**03**	**Total:**	**100 Marks**

Prerequisite Course:

1. Basic knowledge of power systems and power electronics.
2. Basic knowledge of computer and communications networks

Course Objectives

1. To learn the fundamentals, objectives and architecture of the smart grid
2. To describe the aspects of measurement equipment and automation technologies used in smart grid.
3. To describe the power electronic converters and energy storage technologies used in smart grid
4. To impart the knowledge about the communication technology of Smart grid.
5. To explain the concept of micro grid.
6. To get acquainted with the application of smart grid concept to distribution networks.

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Differentiate the Conventional and Smart Grid	2	Understanding
CO2	Formulate solutions in the areas of smart substations, distributed generation and wide area measurements.	3	Applying
CO3	Use the suitable converters and energy storage technologies for smart grid applications	3	Applying
CO4	Select the suitable communication networks for smart grid applications	2	Understanding
CO5	Describe the structure and control of micro grid.	2	Understanding
CO6	Explain the concepts of smart distribution networks	4	Understanding

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	1	-	-	-	-	-	2	3	3
CO2	3	2	3	3	3	1	-	-	-	-	-	2	3	3
CO3	3	2	3	2	3	1	-	-	-	-	-	2	3	3
CO4	3	2	3	3	3	1	-	-	-	-	-	2	3	3
CO5	3	2	3	3	3	1	-	-	-	-	-	2	3	3
CO6	3	2	2	2	3	1	-	-	-	-	-	2	3	3

Course Contents			
UNIT-I	**INTRODUCTION TO SMART GRID**	**Hrs.**	**COs**
	Background and history of smart Grid evolution, Definition and characteristics of smart grid, Benefits of smart grid, Smart Grid vision and its realisation, Motives behind developing the Smart Grid concept, Examples of Smart Grid projects/initiatives, Smart Grid versus conventional electrical networks, Smart Grid basic infrastructure, Functions of smart grid components.	08	CO1
UNIT-II	**SMART GRID MEASUREMENT AND AUTOMATION TECHNOLOGIES**	**Hrs.**	**CO**
	Smart metering, Communications infrastructure and protocols for smart metering, Demand Side Integration, Distribution Automation Equipment - Current transformers, Voltage Transformers, Intelligent Electronic Devices, Fault in the distribution system, Distribution Management System – SCADA, Modelling and Analysis tool, Applications, Transmission System Operation- IEDs, Phasor Measurement unit , Energy Management, wide area applications	10	CO2
UNIT-III	**POWER ELECTRONICS AND ENERGY STORAGE IN SMART GRID**	**Hrs.**	**CO**
	Power electronics in the Smart Grid - Renewable energy generation, Fault current limiting, Shunt compensation, Series compensation, FACTS, HVDC. Energy storage technologies - Batteries, Flow Battery , Fuel and hydrogen electrolyzer, fuel cells, DLC, SMES, Case study.	09	CO3
UNIT-IV	**COMMUNICATION TECHNOLOGY FOR SMART GRID**	**Hrs.**	**CO**
	Communication Technology- IEEE 802 series, Mobile communications Multi-protocol label switching, Power line communication, Standard for information exchange - Standards for smart metering, Modbus, DNP3, IEC 61850, Introduction to cyber security standards.	07	CO4
UNIT-V	**MICROGRIDS**	**Hrs.**	**CO**
	Microgrid Concept and Structure, Building Blocks of a Microgrid, Operation Modes, Control Mechanism of the Connected Distributed Generators in a Microgrid, Speed Control of Classical Distributed Generators, Control of Inverter-based Distributed Generators, Hierarchical Microgrid Control, DC Microgrid Control.	06	CO5
UNIT-VI	**APPLICATION OF SMART GRID CONCEPT TO DISTRIBUTION NETWORKS**	**Hrs.**	**CO**
	Introduction, Smart distribution networks versus conventional distribution Networks, Basic building blocks of a smart distribution network, Evolvement of distribution networks into Smart Grids (FENIX, ADDRESS).	05	CO6

Text Books:

[T1]. Salman K.Salman, "Introduction to Smart Grid: Concepts, technologies and Evolution", IET Engineering Series 94, UK, 2017

[T2]. Janaka Ekanayake et al, "Smart Grid Technology and Applications", John Wiley & Sons, USA, 2012.

[T3]. Hassan Bevrani etal, "Microgrid Dynamics and Control", JohnWiley & Sons, USA, 2017.

References:

[R1]. James Momoh, "SMART GRID Fundamentals of Design and Analysis", IEEE Press, Published by John Wiley & Sons, 2012

[R2]. P.Parjof et al "Smart Grid and Microgrids: Concepts and Applications", John Wiley & Sons, 2022

E-References

[E1] Introduction to Smart Grid (https://onlinecourses.nptel.ac.in/noc19_ee64/preview)

EE306: MICROCONTROLLERS AND APPLICATIONS LABORATORY

Teaching Scheme		**Examination Scheme**	
Lectures:	**-- Hrs./Week**	**Oral:**	**25 Marks**
Tutorial:	**-- Hr/Week**	**Practical:**	**-- Marks**
Practical:	**02 Hr/Week**	**Term Work:**	**--Marks**
Credits:	**01**	**Total:**	**25 Marks**

Prerequisite Course:

1. Analog and Digital Electronics
2. Basic Electrical and Electronics Engineering

Course Objectives

1. To understand the differences between microcontrollers and microprocessors learn microcontroller architecture & describe the features of a typical microcontroller.
2. To use the 8051 addressing modes and instruction set and apply this knowledge to perform programs - arithmetic & logic operations, data & control transfer operations, input & output operations.
3. To define the protocol for serial communication and understand the microcontroller development systems.
4. To build and test a microcontroller-based system; interface the system to switch, keypad, and display.
5. To understand Arduino Board and its applications
6. To understand Embedded systems terminologies in terms of electrical Engineering

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Understand the utilization of modern tools	2	Understand
CO2	Solve assembly language programs based on the instruction set of 8051.	4	Analyze
CO3	Create Assembly Language Program for various applications	6	Create
CO4	Implement 8051 based hardware system and for LED, keyboard and different motors interfacing	3	Apply
CO5	Execute programs and interface different component with Arduino board	5	Evaluate
CO6	Implement Real life applications using Advance controllers	6	Create

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	1	1	1	1	1	1	1	1	2	1
CO2	3	3	2	-	2	1	1	1	1	2	2	1	2	1
CO3	3	2	3	2	2	1	1	1	1	3	2	1	2	1
CO4	3	3	2	-	2	1	1	1	1	1	2	1	2	1
CO5	3	3	2	-	2	1	1	1	1	2	2	1	2	1
CO6	3	2	3	2	2	1	1	1	1	3	2	1	2	1

Course Contents			
Ex. No	**Name of Experiment**	**Hrs**	**CO**
1	Introduction to Keil IDE and Proteus	2	CO1
2	Assembly Language Program for arithmetic operation of 8 bit numbers	2	CO1 CO2
3	Assembly Language Program for rotate, bit, swap and logical operations etc.	2	CO1 CO2
4	Assembly Language program to arrange 8 bit numbers stored in arrayin ascending order and descending order	2	CO1 CO2 CO3
5	Interfacing of DAC 0800 with 8051 microcontroller.	2	CO1 CO2 CO4
6	Interfacing of LED, relay, DC motor or stepper motor with microcontroller. (Proteus simulation)	2	CO1 CO2 CO4
7	Interfacing of LED to blink after every 1 second using arduino board	2	CO1 CO2 CO5
8	Display data using serial communication.	2	CO1 CO2 CO5
9	Interfacing of temperature sensor (LM35) using Arduino Board	2	CO1 CO2 CO5
10	Interfacing of keypad/LCD using Arduino Board	2	CO1 CO2 CO5
11	Implementation of Real life applications using Advance Microcontroller.	2	CO1 CO2 CO6
Any 08 experiments to be performed from above list.			

Text Books:

[T1] Muhammad Ali Mazidi, Janice G. Mazidi and Rolin D. McKinlay, "The Microcontroller andEmbedded Systems", Second Edition, Pearson, 2012.
[T2] Ayala K. J., "8051 Microcontroller: Architecture, Programming and applications"Second Edition,Penram international.
[T3] SubrataGhoshal, "8051 microcontroller", Pearsons Publishers.
[T4] Started with Arduino by Massimo Banzi and Michael Shiloh Published by Maker Media, Inc.
[T5] Arduino microcontroller processing for everyone-Steven F Barret,Morgan and Claypool Publisher.

References:

[R1] V Udayashankara and M S MallikarjunaSwamy, “8051 Microcontroller, Hardware, software andapplications”, TATA McGraw Hill.

[R2] Scott Mackenzie, “8051 Microcontroller”, Pearson Education.

[R3] Ajay Deshmukh, “Microcontroller 8051” –TATA McGraw Hill.

[R4] Getting Started With Arduino: A Beginner's Guide by by Brad Kendall (Author), Justin Pot (Editor),Angela Alcorn (Editor)

[R5] Arduino Cookbook, 2nd Edition by Michael Margolis published by O'Reilly Media

EE307: ELECTRICAL MACHINES II LABORATORY

Teaching Scheme		**Examination Scheme**	
Lectures:	**-- Hrs./Week**	**Oral:**	**-- Marks**
Tutorial:	**-- Hr./Week**	**Practical:**	**50 Marks**
Practical:	**02 Hr./Week**	**Term Work:**	**-- Marks**
Credits:	**01**	**Total:**	**50 Marks**

Prerequisite Course:

1. Basic Electrical Engineering 2. Electrical Machines I

Course Objectives

1. Learn construction & working principle of three phase synchronous machines.
2. Define regulation of alternator & calculate it by direct and indirect methods.
3. Study the methods of starting 3- phase synchronous motor, & its operation under Different conditions.
4. Learn Speed control methods of three phase induction motor.
5. Develop phasor diagram & circle diagram of a c series motor.
6. Develop equivalent circuit of single-phase induction motor.

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Analyze speed control methods of three phase induction motor, and understand the operation of different special purpose motor.	4	Analyzing
CO2	Calculate various parameters of electrical machines	5	Evaluate
CO3	Examine the process and determine voltage regulation of electrical machines	4	Analyzing
CO4	Analyze the response of synchronous motors and alternator	4	Analyzing
CO5	Expose the concept of various types of electrical machines and applications of electrical machines in electrical power engineering and drives	3	Applying
CO6	Analyse power requirements , power capabilities, efficiencies, operating characteristics, control requirements and electrical demand of various machines	4	Analyzing

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	1	1	1	1	1	2	2	3	2
CO2	3	2	2	1	1	1	1	1	1	1	2	2	3	2
CO3	3	2	2	1	1	1	1	1	1	1	2	2	3	2
CO4	3	2	2	1	1	1	1	1	1	1	2	2	3	2
CO5	3	2	2	1	1	1	1	1	1	1	2	2	3	2
CO6	3	2	2	1	1	1	1	1	1	1	2	2	3	2

Course Contents			
Ex. No	**Name of Experiment**	**Hrs**	**CO**
To perform any eight experiments from the following list.			
1	Speed control of three phase induction motor by V/F method	2	CO1 CO5 CO6
2	Speed control of three phase induction motor by rotor resistance control method.	2	CO1 CO5 CO6
3	Load test on Single -phase induction motor.	2	CO2 CO5 CO6
4	Determination of Regulation of alternator by direct loading.	2	CO3 CO5 CO6
5	Determination of regulation of cylindrical rotor alternator by following methods a) EMF method b) MMF method.	2	CO3 CO5 CO6
6	Determination of regulation of cylindrical rotor alternator by Potier method.	2	CO3 CO5 CO6
7	Load test on three phase synchronous motor.	2	CO2 CO5 CO6
8	Determination of regulation of salient pole alternator by slip test.	2	CO3 CO5 CO6
9	Load test on Single-phase series motor.	2	CO2 CO5 CO6
10	No load and blocked-rotor test on a single phase Capacitor-start induction motor and Determination of its equivalent circuit parameters.	2	CO2 CO5 CO6
11	Performance characteristics of single phase series motor using circle diagram.	2	CO2 CO5 CO6
12	Synchronization of three phase alternator by Lamp and Synchroscope methods.	2	CO4 CO5 CO6
13	Simulation of three phase induction motor on MATLAB to obtain its performance.	2	CO1 CO5 CO6
14	V and inverted V curve of synchronous motor at constant load.	2	CO4 CO5 CO6

Text Books:

[T1] Nagrath and Kothari, Electrical Machines, 2nd Ed., Tata McGraw Hill.
[T2] S. K. Bhattacharya, Electrical Machines, Tata McGraw Hill.
[T3] A.S. Langsdorf, Theory of Alternating Current Machinery, Tata McGraw Hill
[T4] P. S. Bimbhra, Electric Machinery, Khanna Publications.
[T5] B.R. Gupta and Vandana Singhal -Fundamentals of Electric Machines, New Age International (P) Ltd.
[T6] E. Openshaw Taylor, Performance and design of a.c. commutator motors, Wheeler Publishing.
[T7] V. K. Mehta and Rohit Mehta, Principles of Electrical Machines, S Chand Publications
[T8] Krishna Reddy –Electrical Machines vol.II and III, SCITECH publications.
[T9] Ashfaq Husain, Electrical Machines, Dhanpat Rai and Co.
[T10] M V Deshpande, Electrical Machines, Prentice Hall of India

References:

[R1] M.G. Say, Performance and Design of A.C. Machines (3rd Ed.), ELBS
[R2] J B Gupta - Theory and performance of Electrical Machines, S K Kataria Publications
[R3] Samarjit Ghosh, Electrical Machines, Pearson Publication.
[R4] Bhag S Guru and Huseyin R Hiziroglu, Electrical Machinary and Transformer, 3rd Edition, Oxford University Press.
[R5] E G Janardanan, Special Electrical Machines, Prentice Hall of India.
[R6] Suvarnsingh Kalsi Application of high Temperature super conductors to electric power equipments (Rotating Machines) Wiley publication.

EE308: POWER SYSTEM II LABORATORY

Teaching Scheme		**Examination Scheme**	
Lectures:	**-- Hrs./Week**	**Oral:**	**25 Marks**
Tutorial:	**-- Hrs./Week**	**Practical:**	**-- Marks**
Practical:	**02 Hrs./Week**	**Term Work:**	**-- Marks**
Credits:	**01**	**Total:**	**25 Marks**

Prerequisite Course:

1. Power System – I
2. Network Analysis

Course Objectives

1. This course provides the knowledge of Power System Operation
2. It is aimed to impart knowledge of Real Time system
3. To understand use of per unit system and fault analysis
4. This course provides the knowledge of Power flow study.
5. This course provides the knowledge of Power System Stability.

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Explain various parameters in a circle diagram with line parameters.	2	Understanding
CO2	Develop per unit system to solve various problems.	3	Applying
CO3	Evaluate admittance matrix with and without mutual impedances.	**5**	Evaluating
CO4	Evaluate different types of faults for balanced and unbalanced Systems.	**5**	Evaluating
CO5	Creating different types Symmetrical & Unsymmetrical Fault Analysis, and analyzing Power System Stability.	6, 4	Creating and Analyzing
CO6	Estimate static measurement of sub-transient and sequence reactance of a synchronous machine.	2	Understanding

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	1	1	1	1	1	1	1	1	1	2	2
CO2	2	2	2	1	1	1	1	1	1	1	1	1	2	2
CO3	2	2	2	1	1	1	1	1	1	1	1	1	2	2
CO4	3	3	3	2	2	2	1	1	2	1	1	2	3	3
CO5	3	3	3	2	2	2	1	1	2	1	1	2	3	3
CO6	2	2	2	1	1	1	1	1	1	1	1	1	2	2

Course Contents			
Ex. No	**Name of Experiment**	**Hrs.**	**CO**
1	Measurement of ABCD parameters of a medium transmission line with magnitude and angle.	2	CO1
2	Measurement of ABCD parameters of a long transmission line with magnitude and angle.	2	CO1
3	Performance study of the effect of VAR compensation using capacitor bank on the transmission line.	2	CO1
4	Formulation and calculation of Y- bus matrix of a given system using software.	2	CO3
5	Static measurement of sub-transient reactance of a salient-pole alternator.	2	CO6
6	Measurement of sequence reactance of a synchronous machine (Negative and zero).	2	CO6
7	Plotting of receiving end circle diagrams to evaluate the performance of medium transmission lines.	2	CO1
8	Solution of a load flow problem using Gauss-Seidel method using software.	2	CO2 CO4 CO5
9	Solution of a load flow problem using Newton-Raphson method using software.	2	CO2 CO3 CO4 CO5
10	Simulation of Symmetrical fault of single machine connected to infinite bus by using Software	2	CO2 CO4 CO5
11	Simulation of Unsymmetrical fault of single machine connected to infinite bus.	2	CO2 CO4 CO5
12	Analyzing of Power System Stability for a given Power System.	2	CO4

Text Books:

[T1]. J. Nagrath and D.P. Kothari – Modern Power System Analysis – Tata McGraw Hill, New
[T2]. B R Gupta, “Power System Analysis and Design”, S. Chand.
[T3]. Ashfaq Hussain, “Electrical Power Systems”, CBS Publication 5th Edition.
[T4]. J.B.Gupta. “A course in power systems” S. K. Kataria Publications.
[T5]. P.S.R. Murthy, “Power System Analysis”, B. S. Publications

References:

[R1]. H. Hadi Sadat: Power System Analysis, Tata McGraw-Hill New Delhi.
[R2]. G. W. Stagg and El- Abiad – Computer Methods in Power System Analysis – Tata McGraw Hill, New Delhi.
[R3]. M. E.El-Hawary, Electric Power Systems: Design and Analysis, IEEE Press, New York.
[R4]. Rakash Das Begamudre, “Extra High voltage A.C. Transmission Engineering ", New age publication.
[R5]. M. A. Pai, Computer Techniques in Power System Analysis, Tata McGraw Hill Publication.
[R6]. Stevenson W.D. Elements of Power System Analysis (4th Ed.) Tata McGraw Hill, New Delhi.
[R7]. K. R. Padiyar: HVDC Transmission Systems, New Age International Publishers Ltd, New Delhi.
[R8]. Olle I. Elgard – Electric Energy Systems Theory – Tata McGraw Hill, New Delhi.
[R9]. V. K. Chandra, Power Systems, Cyber tech Publications.

EE309: POWER ELECTRONICS LABORATORY

Teaching Scheme		Examination Scheme	
Lectures:	**-- Hrs./Week**	**Oral:**	**-- Marks**
Tutorial:	**-- Hr./Week**	**Practical:**	**50 Marks**
Practical:	**02 Hr./Week**	**Term Work:**	**-- Marks**
Credits:	**01**	**Total:**	**50 Marks**

Prerequisite Course:

1. Knowledge of semiconductor material, basic electronics switches and its characteristics.
2. Basic concepts of circuits, analog and digital electronics

Course Objectives: The course aims:-

To impart the knowledge of the student in:

1. Apply the concepts of power electronic converters for efficient conversion/control of power from source to load.
2. Design the power converter with suitable switches meeting a specific load requirement

Course Outcomes (COs):

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

Course Outcome (s)		Bloom's Taxonomy	
		Level	**Descriptor**
CO1	Distinguish the types of power semiconductor devices, and analyze their switching characteristics	2	Understand
CO2	Demonstrate the operation of single phase controlled rectifiers, and analyze its characteristics	3	Apply
CO3	Demonstrate the operation of three phase controlled rectifiers, and analyze its characteristics	3	Apply
CO4	Apply the different modulation techniques to PWM inverters and identify the harmonic reduction methods.	3	Apply
CO5	Choose the appropriate DC-DC converters for different applications	3	Apply
CO6	Understand operation of cyclo-converter and matrix converter in AC-AC applications.	2	Understand

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	-	-	-	-	1	-	-	1	1
CO2	2	2	2	1	1	-	-	-	-	1	-	-	1	1
CO3	3	2	2	1	1	-	-	-	-	1	-	-	1	1
CO4	3	3	2	2	2	-	-	-	-	1	-	-	2	2
CO5	3	2	1	1	1	-	-	-	-	1	-	-	1	1
CO6	3	3	3	1	1	-	-	-	-	1	-	-	1	1

Course Contents			
Ex. No	**Name of Experiment**	**Hrs**	**CO**
1	Static VI characteristic of SCR / GTO	2	CO1
2	Static VI characteristic of MOSFET / IGBT	2	CO1
3	Single phase half and fully controlled converters.	2	CO2
4	Three phase half and fully controlled converters.	2	CO3
5	MOSFET based step up and step down chopper	2	CO5
6	IGBT based Single phase PWM inverters.	2	CO4
7	Single phase cycloconverter	2	CO6
8	Simulations of single- phase half and fully controlled converter	2	CO1
9	Simulations of three- phase half and fully controlled converter	2	CO3
10	Simulation of single and three phase inverter	2	CO4

Text Books:

[T1] M. H. Rashid - Power Electronics 2nd Edition, Pearson publication
[T2] Ned Mohan, T.M. Undel and, W.P. Robbins - Power Electronics, 3rd Edition, John Wiley and Sons
[T3] B.W. Williams: Power Electronics 2nd edition, John Wiley and sons
[T4] Ashfaq Ahmed- Power Electronics for Technology, LPE Pearson Edition.
[T5] Dr. P.S. Bimbhra, Power Electronics, Third Edition, Khanna Publication.

References:

[R1] Vedam Subramanyam - Power Electronics , New Age International , New Delhi
[R2] M. D. Singh and K. B. Khandchandani, Power Electronics, Tata McGraw Hill
[R3] Jai P. Agrawal, Power Electronics systems theory and design LPE, Pearson Education, Asia
[R4] L. Umanand, Power Electronics – Essentials and Applications Wiley Publication.
[R5] V.R. Moorthi, Power Electronics Devices, circuits, and Industrial applications, Oxford University Press.

E-references:

[E1] NPTEL Web course and video course on Power Electronics by Prof. D.Prasad, IIT, Kharagpur (https://nptel.ac.in/courses/108105066)

EE310: SKILL BASED CREDIT COURSE

Teaching Scheme		**Examination Scheme**	
Lectures:	**01 Hrs./Week**	**Term Work:**	**50 Marks**
Credits:	**01**	**Total:**	**50 Marks**

Introduction

It aims towards building the skills of the student who has already acquired knowledge through classroom lectures and encourage them to experiment and apply those concepts to strengthen the learning process. In a skill-based classroom, teachers focus on imparting education through planning and practice. To help students to retain concepts, instructors plan, discuss ideas and provide constructive feedback so that students can reflect on the skills gained in classroom. The credit points give learners, employers and institutions a means of describing and comparing the learning outcomes achieved.

Course Objectives

1. Spark the creativity, and give a way to move beyond traditional methods and think innovatively.
2. Develops critical thinking
3. Enhances the collaborative problem solving
4. Builds effective written and oral communication
5. Develops the effective leadership skills.

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	**Understand** the skills requirement to apply those concepts which has already acquired knowledge into experiments.	2	Understand
CO2	**Understand** the concept and use in solving engineering problems.	2	Understand
CO3	**Apply** core concepts of any applied problems in engineering.	3	Apply
CO4	**Analyse** the problem of which kind and use particular method for finding solution in engineering field.	4	Analyse
CO5	**Awareness** of how to give and receive professional constructive feedback	4	Analyse

Course Contents

Students have to do skilled technical certified online courses of at least 16-20 hours. After completion of online courses, students have to produce *Certificate*. Students shall be awarded credits only when they will complete the courses and submit the 20 pages report on the same. 50 marks will be evaluated based on report, online certification and assignments.

The following platforms / software's are recommended :

Sr. no.	**Platform**
1.	NPTEL
2.	edX
3.	Coursera
4.	Udemy
5.	Sill Battle

6.	IBM
7.	Persistent
8.	Infosys Headstart
9.	MATLAB Software
10.	ETAP Software
11.	NEPLAN Simulation Software
12.	LabVIEW Software
13.	AUTOSAR methodologies
14.	Proteus Software
15.	PSIM Software

MC311: ELECTRICAL ENERGY CONSERVATION AND AUDITING

Teaching Scheme		**Examination Scheme**	
Lectures:	**01 Hrs./Week**	**Continuous Assessment:**	**--**
Tutorial:	**--Hr./Week**	**In-Sem Exam:**	**--**
		End-Sem Exam:	**--**
Credits:	**No Credits**	**Total:**	**--**

Prerequisite Course:
1. Power Systems
2. Electrical Machines

Course Objectives

1. Understand the current energy scenario and importance of energy conservation.
2. Understand the concepts of energy management.
3. Understand the methods of improving energy efficiency in different electrical systems.

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Understand the current energy scenario and importance of energy conservation	2	Understanding
CO2	Impart knowledge in the domain of Basics of Energy and its various forms	3	Applying
CO3	Understand the concepts of energy management.	2	Understanding
CO4	Bring out Energy Conservation Potential and Business opportunities across different user segments under innovative business models	4	Analyzing

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	3	2	1	-	2	1	1	1	1	1	1	2	1	2
CO2	3	2	1	-	2	2	1	2	1	1	1	2	1	2
CO3	3	2	1	-	2	1	1	1	1	1	1	2	2	2
CO4	3	2	1	-	2	2	1	2	1	1	2	2	1	2

Course Contents			
UNIT-I	**ENERGY SCENARIO**	**Hrs.**	**CO**
	Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy security, energy conservation and its importance, Energy Conservation Act-2001 and its features.	-	CO1
UNIT-II	**BASICS OF ENERGY AND ITS VARIOUS FORMS**	**Hrs.**	**CO**
	Electricity tariff, load management and maximum demand control, power factor improvement, Thermal Basics-fuels, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.	-	CO2
UNIT-III	**ENERGY MANAGEMENT & AUDIT**	**Hrs.**	**CO**
	Definition, energy audit, need, types of energy audit. Energy management (audit) approach and understanding energy costs, benchmarking, energy performance, maximizing system efficiencies, fuel & energy substitution, energy audit instruments. Material and Energy balance: methods for preparing process flow.	-	CO3
UNIT-IV	**ENERGY EFFICIENCY IN INDUSTRIAL SYSTEMS**	**Hrs.**	**CO**
	Compressed Air System and Cooling Tower: Types, efficiency, efficient compressor operation, components, capacity assessment, leakage test, factors affecting the performance and saving opportunities in HVAC, Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and conservation opportunities. Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.	-	CO4

Text Books:

[T1] Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online)
[T2] Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online)
[T3] S. C. Tripathy, "Utilization of Electrical Energy and Conservation", McGraw Hill, 1991.
[T4] Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org)

Reference Books:

[R1] W C Turner and Steve Doty: Energy Management Handbook, Seventh Edition,(Fairmont Press Inc., 2007)
[R2] Sumper Andreas and Baggini Angelo: Electrical Energy Efficiency: Technologies and applications (John Wiley 2012)
[R3] Frank Kreith: Handbook on Energy Efficiency and Renewable Energy (CRC Press, 2007)
[R4] George Polimeros: Energy Cogeneration Handbook (Industrial Press, Inc., New York, 1981)

E-references:

Websites:
[E1] National Productivity Council(http://www.npcindia.gov.in)
[E2] Bureau of Energy Efficiency (https://www.beeindia.gov.in)
[E3] Petroleum Conservation Research Association (https://www.pcra.org)

SEMESTER VI

EE312: POWER SYSTEM OPERATION AND CONTROL

Teaching Scheme	**Examination Scheme**	
Lectures: 04 Hrs./Week	**Continuous Internal Assessment:**	**20 Marks**
Tutorial: --- Hr./Week	**In-Sem Exam:**	**30 Marks**
	End-Sem Exam:	**50 Marks**
Credits: 04	**Total:**	**100 Marks**

Prerequisite Course:
1. Basics of Power System

Course Objectives

1) To understand formulation of economic load dispatch tasks and solve it using optimization techniques
2) To develop ability to analyze and use various methods to improve stability of power systems
3) To illustrate the automatic frequency and voltage control strategies for single and two area case and analyze the effects, knowing the necessity of generation control.
4) To illustrate various ways of interchange of power between interconnected utilities and define reliability aspects at all stages of power system
5) To understand the need for generation and control of reactive power
6) To describe the need of computer control in operating power system.

Course Outcomes (COs):

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

	Course Outcome (s)	**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Analyze the control actions to be implemented on the system to meet the minute-to-minute variation of system demand	4	Analyzing
CO2	Suggest the appropriate method of reactive power generation and control	3	Applying
CO3	Select the appropriate device of FACTS Technology in power System	3	Applying
CO4	Analyze the generation-load balance in real time operation and its effect on frequency and develop automatic control strategies with mathematical relations.	5	Evaluating
CO5	Formulate objective functions for optimization tasks such as unit commitment and economic load dispatch and get solution using computational techniques.	5	Evaluating
CO6	Gain knowledge on the need of real time system functions.	2	Understanding

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	1	1	1	1	1	1	1	3	3	3
CO2	3	3	3	2	1	1	1	1	1	1	1	2	2	3
CO3	3	2	2	2	1	1	1	1	1	1	1	2	3	3
CO4	3	3	3	3	2	1	1	1	1	2	1	2	3	3
CO5	3	3	3	3	3	1	1	1	1	2	1	2	3	3
CO6	3	3	3	2	3	2	1	1	1	2	1	2	3	3

Course Contents			
UNIT-I	**POWER SYSTEM STABILITY**	**Hrs.**	**COs**
	Introduction, dynamics of synchronous machines, power angle equation, Simple system, steady state stability, transient stability, equal area criterion (sudden change in mechanical input, effect of clearing time on stability, Sudden short circuit on one of parallel lines), point-by-by point of swing equation, Multi-machine Stability.	**07**	CO1
UNIT-II	**REACTIVE POWER MANAGEMENT**	**Hrs.**	**COs**
	Necessity of reactive power control, reactive power generation by a synchronous machine, effect of excitation, loading capability curve of a generator, compensation in power system: series and shunt compensation using capacitors and reactors, Problems with Series Compensation, synchronous condenser.	**07**	CO2
UNIT-III	**FACTS TECHNOLOGY**	**Hrs.**	**COs**
	Problems of AC transmission system, evolution of FACTs technology, Working principle, circuit diagram, VI characteristics, applications, advantages and limitations of SVC, TCSC, STATCOM and UPFC.	**06**	CO3
UNIT-IV	**AUTOMATIC GENERATION AND VOLTAGE CONTROL**	**Hrs.**	**COs**
	Concept of AGC, complete block diagram representation of load-frequency control of an isolated power system, steady state and dynamic response, control area concept, two area load frequency control. Schematic and block diagram of alternator voltage regulator scheme.	**06**	CO4
UNIT-V	**ECONOMIC LOAD DISPATCH AND UNIT COMMITMENT**	**Hrs.**	**COs**
	A. Economic load dispatch: Introduction, revision of cost curve of thermal and hydro-power plant, plant scheduling method, equal incremental cost method, method of Lagrange multiplier (neglecting transmission losses), Bmn coefficient, economic scheduling of thermal plant considering effect of transmission losses, penalty factor, procedure of load dispatch at state level load dispatch center, Regional Load Dispatch Center, numerical on penalty factor, exact coordination equation. **B. Unit commitment:** Concept of unit commitment, constraints on unit commitment – spinning reserve, thermal and hydro constraints, methods of unit commitment – priority list and dynamic programming, Numerical on priority list method	**08**	CO5
UNIT-VI	**COMPUTER CONTROL OF POWER SYSTEMS**	**Hrs.**	**COs**
	Need of computer control of power systems, Energy management system (EMS), – Supervisory Control and Data Acquisition (SCADA) – Security Analysis and control – various operating states, power system security-security & contingency analysis (Descriptive Treatment only)	**06**	CO6

Text Books:

[T1] Abhijit Chakrabarti, Sunita Halder, "Power System Analysis Operation and Control", Prentice Hall of India.
[T2] J. Nagrath, D. P. Kothari, "Modern Power System Analysis", 4th Edition, Tata McGraw Hill Publishing Co. Ltd.,
[T3] P. S. R. Murthy, "Operation & Control in Power System", B. S. Publication, 2008.
[T4] Allen J. Wood, Bruce F. Wollenberg "Power Generation, Operation, and Control", Wiley India Edition.
[T5] P. Kundur, "Power System Stability and Control", Tata McGraw Hill Publishing Co. Ltd.

References:

[R1] N.V.Ramana, Power system operation and control, Pearson Editions
[R2] S. Sreenivasan, G. Sivanagaraju, Power System Operation and Control , Pearson Editions
[R3] Narain G. Hingorani, Laszlo Gyugyi, "Understanding FACTs" IEEE Press.
[R4] Olle I. Elgerd, "Electrical Energy System Theory", 2nd Edition, Tata McGraw Hill. Publishing Co. Ltd.

E-references:-

[E1] https://nptel.ac.in/courses/108101040
[E2] https://nptel.ac.in/courses/108104052
[E3] https://nptel.ac.in/courses/108105104
[E4] https://freevideolectures.com/course/2354/power-systems-operation-and-control

EE313: FEEDBACK CONTROL SYSTEMS

Teaching Scheme	**Examination Scheme**	
Lectures: 3 Hrs./Week	**Continuous Assessment:**	**20 Marks**
Tutorial: -- Hrs./Week	**In-Sem Exam:**	**30 Marks**
	End-Sem Exam:	**50 Marks**
Credits: 03	**Total:**	**100 Marks**

Prerequisite Course:
Knowledge of engineering mathematics, signals & systems, circuit analysis

Course Objectives

1. To introduce different types of system and identify a set of algebraic equations to represent and model a complicated system into a more simplified form to interpret different physical and mechanical systems in terms of electrical system to construct equivalent electrical models for analysis.
2. To employ time domain and frequency domain analysis to predict the performance parameters of the system for standard input functions.
3. Formulate different types of analysis in frequency domain to explain the nature of stability of the system.

Course Outcomes (COs):

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

	Course Outcome (s)	**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	**Categorize** different types of system and **Apply** the knowledge of Laplace Transform to **Examine** the Transfer Function of Electro-Mechanical systems.	2 3 4	Categorize Apply Examine
CO2	**Evaluate** equivalent transfer function models of various control system blocks **using** block diagram reduction technique and concepts of signal flow graph.	5 3	Evaluate Apply
CO3	**Formulate** different types of **analysis** in time domain and explain the nature of stability of the system	6 4	Formulate Analysis
CO4	**Sketch** root locus of systems & **perform** stability analysis.	3	Perform
CO5	**Demonstration** and stability **analysis** of systems using Bode Polar &Nyquist plots.	3 4	Demonstration Analysis
CO6	**Examine** and able to write the state-space representation of systems and **perform** inter-conversion between state-space and transfer function representation.	4 3	Examine Perform

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO2	-	-	3	-	-	-	-	-	-	-	-	-	-	2
CO3	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO4	-	2	3	-	-	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO5	-	3	-	2	-	-	-	-	-	-	-	-	-	-
CO6	-	2	-	-	2	-	-	-	-	-	-	-	-	-

Course Contents			
UNIT-I	**Modelling of Physical Systems**	**Hrs.**	**COs**
	Laplace Transform review, The Transfer function, Electric network Transfer Function, Translational mechanical system transfer function, Rotational mechanical system transfer function, Electro-mechanical system transfer function, Electrical circuit analogy.	6hrs	CO1
UNIT-II	**Reduction of Multiple Systems**	**Hrs.**	**CO**
	Block diagrams, Analysis and design of feedback system, Signal flow graphs, Mason's rule, Signal flow graphs of state equations.	6hrs	CO2
UNIT-III	**Time Response and Stability of system**	**Hrs.**	**CO**
	Time Response Analysis Standard test signals. Poles, Zeros & System response, First Order System, Second Order System. Stability Concept of Stability. Routh-Hurwitz Criteria and its special cases (additional examples). Relative Stability analysis.	6hrs	CO3
UNIT-IV	**Root Locus Techniques**	**Hrs.**	**CO**
	Introduction, Root locus plots, Summary of general rules for constructing Root-Loci,Root locus analysis for control systems, Root loci for systems with transport lag	6hrs	CO4
UNIT-V	**Frequency Response Techniques**	**Hrs.**	**CO**
	Frequency-response analysis Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin. Closed-loop frequency response.	6hrs	CO5
UNIT-VI	**Introduction to State Space Modelling**	**Hrs.**	**CO**
	The general state-space representation, Applying the state-space representation, Converting the transfer function to state-space, Converting from state-space to transfer function.	6hrs	CO6
Text Books:			
[T1] Katsuhiko Ogata, "Modern control system engineering", Prentice Hall, 2010. [T2] Nise N. S. "Control Systems Engineering", John Wiley & Sons, Incorporated, 2011			

References:
[R1] I.J. Nagrath, M. Gopal, "Control System Engineering", New Age International Publishers, 5th edition, 2007 [R2] B. C. Kuo, "Automatic Control System", Prentice Hall, 1995 [R3] M. Gopal, "Control Systems: Principles and Design", McGraw Hill Education, 1997.
E-References
[1] https://nptel.ac.in/courses/107/106/107106081/

EE314: ELECTRICAL MACHINE DESIGN

Teaching Scheme	Examination Scheme	
Lectures: 03 Hrs./Week	**Continuous Assessment:**	**20 Marks**
Tutorial: --- Hrs./Week	**In-Sem Exam:**	**30 Marks**
	End-Sem Exam:	**50 Marks**
Credits: 03	**Total:**	**100 Marks**

Prerequisite Course:

1. Knowledge of various materials used in electrical machines.
2. Knowledge of types, construction and working of transformer.
3. Knowledge of types, construction and working of three phase induction motor.

Course Objectives

1. To make student understand basic of Electrical Machine design.
2. To design a transformer.
3. To understand the determination of parameters of the transformer.
4. To design Induction motor.
5. To understand the determination of parameters of an Induction motor.
6. To understand computer aided design of electrical machines

Course Outcomes (COs):

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

Course Outcome (s)		Bloom's Taxonomy	
		Level	**Descriptor**
CO1	Select proper commercial materials, their properties and selection criterions, IS standards used in electrical machine design.	2	Understanding
CO2	Calculate main dimensions and Design of single phase and three phase transformer.	6	Creating
CO3	Determine the parameters of transformer.	5	Evaluating
CO4	Calculate main dimensions and design of three phase Induction motor.	6	Creating
CO5	Determine parameters of three phase Induction motor.	5	Evaluating
CO6	Apply computer aided optimization techniques for design of electrical machines	3	Applying

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	1	1	1	1	-	1	1	1	3
CO2	3	3	3	3	3	1	1	1	1	-	2	1	1	1
CO3	3	3	3	3	3	1	1	1	1	-	2	1	1	1
CO4	3	3	3	3	3	1	1	2	2	-	2	1	1	1
CO5	3	3	3	3	3	1	1	1	1	-	2	1	1	1
CO6	3	3	3	3	3	1	1	2	2	-	2	1	3	1

Course Contents			
UNIT I:	**INTRODUCTION**	**Hrs.**	**CO**
	Transformers and three phase induction motors - types, specifications, constructional features, conducting, magnetic and insulating materials, heating and cooling in electrical machines.	6	CO1
UNIT II:	**TRANSFORMER DESIGN (PART I)**	**Hrs.**	**CO**
	Output equation with usual notations, optimum design of transformer for minimum cost and loss. Design of main dimensions, core, yoke and windings of transformer. Methods of cooling and tank design	6	CO2
UNIT III:	**TRANSFORMER DESIGN (PART II)**	**Hrs.**	**CO**
	Estimation of no-load current, losses, efficiency and regulation of transformer, Mechanical forces developed under short circuit conditions, measures to overcome this effect. Introduction to Computer aided design of transformer, generalized flow chart for design of transformer.	6	CO3
UNIT IV:	**INDUCTION MOTOR DESIGN (PART I)**	**Hrs.**	**CO**
	Output equation, specific electrical and magnetic loading, main dimensions, selection of slots, stator design, stator slots, turns per phase, selection of air gap, squirrel cage and wound rotor design.	6	CO4
UNIT V:	**INDUCTION MOTOR DESIGN (PART II)**	**Hrs.**	**CO**
	Calculation of magnetic circuit, MMF calculations, stator teeth, stator core, effect of saturation, magnetizing current, no load current and its core loss component, performance calculations - losses, efficiency, temperature rise, maximum torque from circle diagram.	6	CO5
UNIT VI:	**COMPUTER AIDED DESIGN (CAD) OF ELECTRICAL MACHINES**	**Hrs.**	**CO**
	Limitations and assumptions in traditional designs, need of CAD, analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation.	6	CO6

Text Books:

[T1] M.G. Say – Theory and Performance and Design of A.C. Machines, 3rd Edition, ELBS London.
[T2] A.K.Sawhney – A Course in Electrical Machine Design, 10th Edition, - Dhanpat Rai and sons New Delhi.
[T3] K. G. Upadhyay- Design of Electrical Machines, New age publication
[T4] R. K. Agarwal – Principles of Electrical Machine Design, S. K.Katariya and sons.
[T5] Indrajit Dasgupta – Design of Transformers – TMH

References:

[R1] K.L. Narang , A Text Book of Electrical Engineering Drawings, Reprint Edition : 1993 / 94 – Satya Prakashan, New Delhi.
[R2] A Shanmugasundaram, G. Gangadharan, R. Palani, - Electrical Machine Design Data Book, 3rd Edition, 3rd Reprint 1988 - Wiely Eastern Ltd., - New Delhi
[R3] Vishnu Murti, "Computer Aided Design for Electrical Machines", B.S. Publications.
[R4] Bharat Heavy Electricals Limited, Transformers - TMH.

E-References

[1] https://nptel.ac.in/courses/108/106/108106023/#

EE315A: ELECTRICAL DRIVES

Teaching Scheme	Examination Scheme	
Lectures: 03 Hrs./Week	**Continuous Assessment:**	**20 Marks**
Tutorial: --- Hr./Week	**In-Sem Exam:**	**30 Marks**
	End-Sem Exam:	**50 Marks**
Credits: 03	**Total:**	**100 Marks**

Prerequisite Course:

1. Construction, working and characteristic of different electrical motors and soft starting methods.
2. Power Electronic Applications such as converter, inverter, chopper etc.
3. Basic concept of control system.

Course Objectives

1. To understand motor load dynamics.
2. To analyze the operation of the converter fed and chopper fed dc drives.
3. To elaborate braking methods of D.C. and Induction motor drive.
4. To explain vector control of induction motor.
5. To differentiate synchronous and BLDC motor drive.
6. To identify classes and duty of motor.
   To describe the modes of operation of drive in various applications.

Course Outcomes (COs):

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

Course Outcome (s)		Bloom's Taxonomy	
		Level	**Descriptor**
CO1	Explain motor load dynamics and multi quadrant operation of drives	2	Understanding
CO2	Analyze operation of converter fed and chopper fed DC drives.	4	Analyzing
CO3	Describe braking methods of D.C. and induction motor drive.	2	Understanding
CO4	Explain vector control for induction motor drives	2	Understanding
CO5	Describe synchronous motor drive.	2	Understanding
CO6	Identify classes and duty cycles of motor and applications of drives in industries.	4	Analyzing

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	2	1	2	1	1	--	1	2	3	1
CO2	2	1	2	1	2	--	1	--	1	1	2	3	2	--
CO3	3	2	3	--	1	--	1	--	--	1	3	3	2	2
CO4	2	--	--	2	2	1	1	1	2	1	2	2	2	2
CO5	2	2	2	1	1	--	--	1	1	--	2	2	3	2
CO6	3	1	--	--	2	--	2	--	1	1	1	2	2	--

Course Contents			
UNIT-I	**Basics Of Electric Drives And Control**	**Hrs.**	**CO 1**
	Definition, Advantages of electrical drives, Components of Electric drive system, Selection Factors, status of Electrical Drives (DC & AC), speed control and drive classifications, close loop control of drives, phase locked loop (PLL) control.	**08 Hrs.**	**CO 1**
UNIT-II	**Dynamics Of Electrical Drives**	**Hrs.**	**CO**
	Motor-Load Dynamics, Speed Torque conventions and multi quadrant operation, Equivalent values of drive parameters. Load Torque Components, Nature and classification of Load Torques, Constant Torque and Constant Power operation of a Drive. Steady state stability, Load equalization.	**08 Hrs.**	**CO 2**
UNIT-III	**DC Motor Drives**	**Hrs.**	**CO**
	DC motors and their performance starting, transient analysis, speed control, ward Leonard drives, Controlled rectifier fed drives, [full controlled 3 phase rectifier control of dc separately excited motor], multi quadrant operation, Chopper controlled drives Closed loop speed control of DC motor.	**08 Hrs.**	**CO 3**
UNIT-IV	**Induction Motor Drives**	**Hrs.**	**CO**
	Induction motor analysis, starting and speed control methods- voltage and frequency control, current control, closed loop control of induction motor drives, rotor resistance control, Slip power recovery – Static Kramer and Scherbius Drive, Single phase induction motor starting, braking and speed control.	**06 Hrs.**	**CO 4**
UNIT-V	**Synchronous Motor And Brushless Dc Motor Drives**	**Hrs.**	**CO**
	Synchronous motor types, operation with fixed frequency, variable speed drives, PMAC and BLDC motor drives, Stepper motor drives, switch reluctance motor drives.	**06 Hrs.**	**CO 5**
UNIT-VI	**Selection of Motor Power Rating**	**Hrs.**	**CO**
	Thermal model of motor for heating and cooling, classes of motor duty, determination of motor ratings.	**06 Hrs.**	**CO 6**

Text Books:

[T1] G. K. Dubey, “Fundamentals of Electric Drives”, 2nd Edition, Narosa Publishing House
[T2] N. K. De, P. K. Sen, “Electric Drives”, Prentice Hall of India Eastern Economy Edition
[T3] S. K. Pillai, “Analysis of Thyristor Power Conditioned Motors”, University Press
[T4] R. Krishnan, “Electric Motor Drives – Modeling Analysis and Control”, PHI India
[T5] G.K. Dubey, “Power Semiconductor controlled drives”, PHI publication

References:

[R1] B. K. Bose, “Modern Power Electronics and AC Drives”, Pearson Education
Malcolm Barnes, “Practical Variable Speed Drives and Power Electronics”, Elsevier Newnes Publications
[R2] V. Subrahmanyam, “Electric Drives: Concepts and Application”, Tata Mc-Graw Hill (An imprint of Elsevier)
[R3] M.D. Singh and Khanchandani “Power Electronics”, Tata Mc-Graw Hill
Austin Huges, “Electrical motor and drives: Fundamental, types and applications”, Heinemann Newnes, London
[R4] Tyagi MATLAB for engineers oxford (Indian Edition)

EE315B: UTILIZATION OF ELECTRICAL ENERGY

Teaching Scheme	**Examination Scheme**	
Lectures: 03 Hrs./Week	**Continuous Assessment:**	**20 Marks**
Tutorial: --- Hr/Week	**In-Sem Exam:**	**30 Marks**
	End-Sem Exam:	**50 Marks**
Credits: 03	**Total:**	**100 Marks**

Prerequisite Course:

1. Basic Electrical and Electronics Engineering
2. Effects of electric current
3. Chemical reactions in electrolyte
4. Control circuit design basics, awareness about artificial lighting, refrigeration, air conditioning
5. Characteristics and application of different electric motors, awareness about traction

Course Objectives

1. Ensure that the knowledge acquired can be applied in various fields such as electric heating, illumination, chemical processes, and electric traction.
2. Make the students aware about the importance of maximizing the energy efficiency by optimum utilization of electrical energy.
3. Develop ability amongst the students to design -heating element for resistance furnaces and design- illumination schemes. To develop ability amongst the students to analyze the performance of arc furnaces, electric traction, different sources of light, illumination schemes.
4. Know how about Refrigeration, Air Conditioning.
5. Know about electrochemical processes and applications of these in practical world, modern welding techniques.

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Get knowledge of principle of electric heating, welding and its applications.	2	Understanding
CO2	Understand electrochemical process, electrical circuits used in refrigeration, air conditioning	2	Understanding
CO3	Design different illumination schemes to save energy	3	Applying
CO4	Understand various equipments and accessories of traction system	2	Understanding
CO5	Calculate tractive effort, power, acceleration and velocity of traction	3	Applying
CO6	Analyse electric braking methods, control of traction motors, train lighting system	4	Analysis

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2	1	2	3	2	2	1	-	1	3	2	1
CO2	3	2	2	2	2	2	1	1	1	-	1	3	3	1
CO3	3	2	3	2	2	2	3	2	1	-	2	3	3	1
CO4	3	2	2	2	2	2	1	-	1	-	1	3	3	3
CO5	3	2	2	2	2	2	1	2	1	-	1	3	3	2
CO6	3	3	3	2	2	2	2	2	2	1	2	3	2	2

Course Contents			
UNIT-I	**ELECTRIC HEATING**	**Hrs.**	**COs**
	Modes of heat transfer, mathematical expressions Electric heating: Introduction to electric heating, Advantages of electrical heating Heating methods: - Resistance heating – Direct resistance heating, indirect resistance heating, electric ovens, different types of heating element materials, temperature control of resistance furnaces, and design of heating element (Numerical) Applications of resistance heating Induction heating : Principle, core type and coreless induction furnaces, Ajax Wyatt furnace, Numerical on melting furnaces Applications of induction heating Electric arc heating – Direct and indirect arc heating, types of arc furnaces, equivalent circuit of arc furnace, condition for maximum output, power factor at maximum output (Numerical), Heat control in arc furnace, Applications of arc heating Dielectric heating –Principle, choice of voltage and frequency for dielectric heating (Numerical), Applications of dielectric heating Electric Welding -Welding methods –Electric arc welding and resistance welding, Equivalent circuit of arc furnace (Numerical) Modern welding techniques like ultrasonic welding and laser welding	8	CO1
UNIT-II	**ELECTROCHEMICAL PROCESS**	**Hrs.**	**CO**
	Need of electro-deposition. Applications of Faraday's laws in electro-deposition. Factors governing electro-deposition. Objectives of electroplating. Equipments and accessories for electroplating plant, Electroplating on non-conducting materials, Principle of anodizing and its applications Electrical Circuits Used in Refrigeration, Air Conditioning Brief description of vapour compression refrigeration cycle. Description of electrical circuits used in Refrigerator, Air Conditioner	6	CO2
UNIT-III	**ILLUMINATION**	**Hrs.**	**CO**
	Definitions of luminous flux, solid angle, luminous intensity, illumination, luminous efficacy, depreciation factor, coefficient of utilization, space to height ratio, reflection factor; Laws of illumination. Design of illumination schemes-Factors to be considered for design of illumination scheme, Calculation of illumination at different points, considerations involved in simple design problems for indoor installation, illumination schemes, standard illumination level. Natural day light illumination (brief information) Different sources of light: Incandescent lamp, fluorescent lamp, comparison between them. Incandescent and discharge lamps – their construction and characteristics; mercury vapour lamp, sodium lamp, halogen lamp, compact fluorescent lamp, metal halide lamp, neon lamps, LEDs, LASERs; comparison of all above luminaries.	6	CO3
UNIT-IV	**ELECTRIC TRACTION**	**Hrs.**	**CO**
	Traction systems - Steam engine drive, electric drive, diesel electric drive, types of diesel locomotives, Advantages of electric traction Systems of track electrification: D.C. system, single phase low frequency A.C. system, 3 phase low frequency A.C. systems,	6	CO4

	composite systems – kando systems, single phase A.C. to D.C. system Different accessories for track electrification -overhead wires, conductor rail system, current collector Electric locomotive- Block diagram with description of various equipment and accessories. Details of major equipment in traction substation-transformer, circuit breaker, interrupter		
UNIT-V	**TRACTION MECHANICS**	**Hrs.**	**CO**
	Types of services- Urban, Sub-urban, Main line Speed time curves, trapezoidal and quadrilateral speed-time curves, average and schedule speed (Numerical), Tractive effort. Specific energy consumption. Factors affecting specific energy consumption (Numerical), Mechanics of train movement, coefficient of adhesion (Numerical).	6	CO5
UNIT-VI	**CONTROL OF TRACTION MOTORS AND TRAIN LIGHTING**	**Hrs.**	**CO**
	Desirable characteristic of traction motors. Suitability of D.C. series motor, A.C. series motor, 3 phase induction motor and linear induction motor for traction. Control of traction motors -Series-parallel control, Shunt and bridge transition (Numerical), Electrical breaking, Regenerative breaking in traction, Suitability of different motors for braking. Train lighting system.	6	CO6

Text Books:

[T1] J.B. Gupta, 'Utilization of Electric Power and Electric Traction', S.K. Kataria and sons, Delhi
[T2] E. O. Taylor 'Utilization of Electrical Energy' – Revised in S.I. Units by V.V.L. Rao, Orient Longman
[T3]C. L. Wadhwa, 'Generation, Distribution and Utilization of Electrical Energy', Eastern Wiley Ltd.

References:

[R1] 'Modern Electric Traction' by H. Partab, Dhanpat Rai and Co. (P) Ltd –Delhi

[R2] 'Electrical Powers' S. L. Uppal, Khanna Publication

[R3] 'Generation and Utilization of Electrical Energy' S. Sivanagaraju, M. Balsubba Reddy, D. Srilatha (Pearson)

E-References

[1] https://nptel.ac.in/courses/108105060
[2] https://archive.nptel.ac.in/courses/108/105/108105060/
[3] https://nptel.ac.in/courses/108104140

EE315C: ELECTROMAGNETIC FIELDS

Teaching Scheme	Examination Scheme	
Lectures: 03 Hrs./Week	**Continuous Assessment:**	**20 Marks**
Tutorial: --- Hr/Week	**In-Sem Exam:**	**30 Marks**
	End-Sem Exam:	**50 Marks**
Credits: 03	**Total:**	**100 Marks**

Prerequisite Course:

1. Basic Electrical and Electronics Engineering
2. Electrical Technology
3. Effects of electric current

Course Objectives

6. To understand the basic laws of electromagnetism.
7. To obtain the electric and magnetic fields for simple configurations under static conditions.
8. To analyse time varying electric and magnetic fields.
9. To understand Maxwell's equation in different fonns and different media.
10. To understand the propagation of EM waves.
11. Analyse magnetic fields in transformer and induction motor.

Course Outcomes (COs):

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

	Course Outcome (s)	Bloom's Taxonomy	
		Level	**Descriptor**
CO1	To understand the basic laws of electromagnetism.	2	Understanding
CO2	To obtain the electric and magnetic fields for simple configurations under static conditions.	3	Applying
CO3	To understand different dielectric materials and conductors.	2	Understanding
CO4	To understand magnetic force on different current element.	2	Understanding
CO5	To analyse time varying electric and magnetic fields.	4	Analysis
CO6	To understand the propagation of EM waves.	2	Understanding

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	1	-	-	-	-	-	-	3	2	2
CO2	3	1	1	1	1	-	-	-	-	-	-	3	2	2
CO3	3	1	1	1	1	-	-	-	-	-	-	3	2	2
CO4	3	1	1	1	1	-	-	-	-	-	-	3	2	2
CO5	3	1	1	1	1	-	-	-	-	-	-	3	2	2
CO6	3	2	1	1	1	-	-	-	-	-	-	3	2	2

Course Contents			
UNIT-I	**Vector Calculus and Basic laws of Electromagnetism**	**Hrs.**	**COs**
	Vector algebra-addition, subtraction, components of vectors, scalar and vector multiplications, triple products, three orthogonal coordinate systems (rectangular, cylindrical and spherical). Vector calculus-differentiation, partial differentiation, integration, vector operator, integral theorems of vectors. Conversion of a vector from one coordinate system to another. Faraday's law of electromagnetic induction, Biot-Savart Law, Ampere Law, Magnetic flux and magnetic flux density, Scalar and Vector Magnetic potentials. Steady magnetic fields produced by current carrying conductors.	8	CO1
UNIT-II	**Static Electric Field**	**Hrs.**	**CO**
	Coulomb's law, Electric field intensity, Electrical field due to point charges. Line, Surface and Volume charge distributions. Gauss law and its applications. Absolute Electric potential, Potential difference, Calculation of potential differences for different configurations. Electric dipole, Electrostatic Energy and Energy density.	6	CO2
UNIT-III	**Conductors, Dielectrics and Capacitance**	**Hrs.**	**CO**
	Current and current density, Ohms Law in Point form, Continuity of current, Boundary conditions of perfect dielectric materials. Permittivity of dielectric materials, Capacitance, Capacitance of a two wire line, Poisson's equation, Laplace's equation, Solution of Laplace and Poisson's equation, Application of Laplace's and Poisson 's equations.	6	CO3
UNIT-IV	**Magnetic Forces, Materials and Inductance**	**Hrs.**	**CO**
	Force on a moving charge, Force on a differential current element, Force between differential current elements, Nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions, Magnetic circuits, inductances and mutual inductances.	6	CO4
UNIT-V	**Time Varying Fields and Maxwell's Equations**	**Hrs.**	**CO**
	Faraday's law for Electromagnetic induction, Displacement current, Point form of Maxwell's equation, Integral form of Maxwell's equations, Motional Electromotive forces. Boundary Conditions.	6	CO5
UNIT-VI	**Electromagnetic waves**	**Hrs.**	**CO**
	Derivation of Wave Equation, Uniform Plane Waves, Maxwell's equation in Phasor form, Wave equation in Phasor form, Plane waves in free space and in a homogenous material. Wave equation for a conducting medium, Plane waves in lossy dielectrics, Propagation in good conductors, Skin effect, Poynting's theorem.	6	CO6

Text Books:

[T1] M. N. 0. Sadiku, "Elements of Electromagnetics", Oxford University Publication, 2014.
[T2] A. Pramanik, "Electromagnetism - Theory and applications", PHI Learning Pvt. Ltd, New Delhi 1i,
[T3] A. Pramanik, "Electromagnetism-Problems with solution", Prentice Hall India, 2012.
[T4] G.W. Carter, "The electromagnetic field in its engineering aspects", Longmans, 1954.
[T5] W.J. Duffin, "Electricity and Magnetism", McGraw Hill Publication, 1980.

References:

[R1] “A Course In Electrical Machine Design” by A K Sawhney- Dhanpat Rai &
Publisher Dhanpat Rai & Co.
[R2] “Theory And Performance of Electrical Machines” is a book on Electrical

Engineering And Technology by J. B. Gupta, Publisher: Kataria S. K. & Sons
[R3] 'Superconductivity and Electromagnetism' by Teruo Matsushita (Publisher:Springer)

E-References

[1] https://nptel.ac.in/courses/108104087
[2] https://nptel.ac.in/courses/108106073
[3] https://nptel.ac.in/courses/115106122

HS315: CORPORATE READINESS

Teaching Scheme	**Examination Scheme**
Lectures: 2 Hrs./Week	**Continuous Assessment: 50 Marks**
Credits: 02	**Total: 50 Marks**

Prerequisite Course:
Quantitative aptitude, Verbal and Non-verbal communication

Course Objectives:

1. To develop clarity in the exploration process of student career and to match his skills and interests with a chosen career path.
2. To develop required aptitude skills.
3. To design the functional and chronological resume.
4. To demonstrate the importance of critical thinking ability and expression in group discussions
5. To prepare students for the various professional interviews.
6. To develop different soft skills necessary to get success in their profession.

Course Outcomes (COs):

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

	Course Outcome (s)	**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Remember placement processes of various organizations and modern job search approach.	**BTL 1**	Remember
CO2	Understand Industry Specific skill set with a view to design an Ideal Resume.	**BTL 2**	Understand
CO3	Apply the knowledge of GD & Presentation Skill during Industry Assessments for Placement/Internship/Industry Training/Higher Studies/Competitive Exams etc.	**BTL 3**	Apply
CO4	Analyse and apply the critical thinking ability as required during Aptitude/Technical Tests.	**BTL 4**	Analyse
CO5	Evaluate Technical/General Dataset to interpret insights in it.	**BTL 5**	Evaluate
CO6	Create an ideal personality that fits Industry requirement.	**BTL 6**	Create

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	--	--	--	--	--	--	--	02	00	02	01	01	--	--
CO2	--	--	--	--	--	--	--	02	03	03	03	01	--	--
CO3	--	--	--	--	--	--	--	01	03	03	02	01	--	--
CO4	01	01	--	--	--	--	--	--	--	01	01	--	--	--
CO5	01	01	--	--	--	--	--	--	--	--	--	--	--	--
CO6	--	--	--	--	--	--	--	02	03	03	02	03	--	--

Course Contents			
UNIT-I	Placement Awareness	**Hrs.**	**Cos**
	Discussion over Different Companies for recruitment, their eligibility criteria and placement procedures. Revision and Assessment of Quantitative Aptitude.	06 Hrs.	CO1
UNIT-II	Resume Writing	**Hrs.**	**CO**
	Keywords, resume examples for industry, professional font, active language, important achievements, Proofread and edit. Innovative resume building- video resume.	05 Hrs.	CO2
UNIT-III	Group Discussion and Presentation skills	**Hrs.**	**CO**
	Why GDs are implemented commonly, Aspects which make up a Group Discussion, Tips on group discussion, do's and don'ts of GD and Presentation skills.	05 Hrs.	CO3
UNIT-IV	Logical Reasoning I	**Hrs.**	**CO**
	Coding and Decoding (Visual Reasoning and series), Statement & Conclusions (Syllogisms), Relationships (Analogy), Data arrangements, Crypt arithmetic.	05 Hrs.	CO4
UNIT-V	Logical Reasoning II	**Hrs.**	**CO**
	Data Interpretation, Data Sufficiency	04 Hrs.	CO5
UNIT-VI	Logical Reasoning III	**Hrs.**	**CO**
	Blood relation and dices, Clocks and Calendar, Direction sense and cubes, Logical connectives, Puzzle.	05 Hrs.	CO6

Text Books:

[T1]. A Modern Approach to Verbal & Non-Verbal Reasoning by R.S. Agarwal.
[T2]. Reasoning verbal and Non-Verbal by B. S. Sijwali.
[T3]. Master the Group Discussion & Personal Interview - Complete Discussion on the topics asked by reputed B-schools & IIMs by Sheetal Desarda.

References:

[R1]. Shortcuts in Reasoning (Verbal, Non-Verbal, Analytical).
[R2]. Analytical Reasoning by M. K. Panday.
[R3]. Logical and analytical reasoning by K. Gupta.
[R4]. Multi-dimensional reasoning by Mishra & Kumar Dr. Lal.

E- Books :

[1].https://themech.in/quantitative-aptitude-and-logical-reasoning-books/
[2].https://www.thelocalhub.in/2021/01/reasoning-competitive-exams-pdf.html

E-learning Resources/MOOCs/ NPTEL Course Links:

[1]. https://www.practiceaptitudetests.com/non-verbal-reasoning-tests/
[2]. https://www.educationquizzes.com/11-plus/non-verbal-reasoning/
[3]. https://www.livecareer.com/resume/examples/web-development/e-learning-developer
[4]. https://novoresume.com/career-blog/how-to-write-a-resume-guide

PR316: INTELLECTUAL PROPERTY RIGHTS AND ENTREPRENEURSHIP DEVELOPMENT

Teaching Scheme	Examination Scheme	
Lectures: 02 Hrs./Week	**Continuous Assessment:**	**20 Marks**
	End-Sem Exam:	**30 Marks**
Credits: 02	**Total:**	**50 Marks**

Prerequisite Course:

Course Objectives

1. To introduce student with IPR
2. To explain IPR procedure in India such as Patents, Designs and Trademarks
3. To make aware economic importance of IPRs.
4. To develop ability to search and analyse the IPRs.
5. To Instill a spirit of entrepreneurship among the student participants.
6. To give insights into the Management of Small Family Business.

Course Outcomes (COs):

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

Course Outcome (s)		Bloom's Taxonomy	
		Level	**Descriptor**
CO1	Understand patenting system	2	**Create**
CO2	Understand the procedure to file patent in India	2	**Apply**
CO3	Understanding of financial importance of IPR	2	**Understand**
CO4	Search and analyse the patents, designs and Trademarks	4	**Analyse**
CO5	Identify the Skill sets required to be an Entrepreneur.	4	**Analyse**
CO6	Understand the Role of supporting agencies and Governmental initiatives to promote Entrepreneurship.	4	**Analyse**

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	2	-	-	-	-		-	1	-
CO2	-	-	-	-	-	2	-	-	-	-		-	1	-
CO3	-	-	-	-	-	2	-	-	-	-		-	1	-
CO4	-	-	-	-	-	2	-	-	-	-		-	1	-
CO5	-	-	-	-	-	2	2	2	-	-	3	-	1	-
CO6	-	-	-	-	-	2	2	2	-	-	3	-	1	-

Course Contents

UNIT-I	INTRODUCTION TO IPR	Hrs.	COs
	• Concepts of IPR • The history behind development of IPR • Necessity of IPR and steps to create awareness of IPR	04	CO1

	• Concept of IP Management • Intellectual Property and Marketing • IP asset valuation • Introduction to the leading International Instruments concerning Intellectual Property Rights: the Berne Convention, Universal Copyright Convention, The Paris Convention, Patent Co-operation Treaty, TRIPS, The World Intellectual Property Organization (WIPO) and the UNESCO		
UNIT-II	**PATENTS**		
	• Introduction to Patents • Procedure for obtaining a Patent • Licensing and Assignment of Patents i. Software Licensing ii. General public Licensing iii. Compulsory Licensing • Infringement of Patents • Software patent and Indian scenario	04	CO2
UNIT-III	**DESIGNS**		
	• Registrable and non-Registrable Designs • Novelty & Originality • Procedure for Registration of Design • Copyright under Design • Assignment, Transmission, License • Procedure for Cancellation of Design • Infringement • Remedies	04	CO3
UNIT-IV	**TRADEMARKS AND COPY RIGHTS**		
	A) **Trademarks** • Concept of trademarks • Importance of brands and the generation of "goodwill" • Trademark registration procedure • Infringement of trademarks and Remedies available • Assignment and Licensing of Trademarks **B) Copyright Right** • Concept of Copyright Right • Assignment of Copyrights • Registration procedure of Copyrights • Infringement (piracy) of Copyrights and Remedies • Copyrights over software and hardware	04	CO4
UNIT-V	**ENTREPRENEURSHIP: INTRODUCTION**		
	5.1 Concept and Definitions: Entrepreneur & Entrepreneurship, Entrepreneurship and Economic Development, A Typology of Entrepreneurs.	04	CO5

	5.2 Entrepreneurial Competencies: The Entrepreneur's Role, Entrepreneurial Skills: creativity, problem solving, decision making, communication, leadership quality; Self-Analysis, Culture & values, Risk-taking ability, Technology knowhow. **5.3 Factor Affecting Entrepreneurial Growth:** Economic & Non-Economic Factors, EDP Programmes. **5.4 Steps in Entrepreneurial Process:** Deciding Developing Moving Managing Recognizing.		
UNIT-VI	**RESOURCES FOR ENTREPRENEURSHIP**		
	6.1 Project Report Preparation: Specimen Format of Project Report; Project Planning and Scheduling using PERT / CPM; Methods of Project Appraisal – Feasibility Study both Economic and Market Preparation projected financial statement. **6.2 Role of Support Institutions and Management of Small Business:** Director of Industries, DIC, SIDO, SIDBI, Small Industries Development Corporation (SIDC), SISI, NSIC, NISBUED, State Financial Corporation (SFC) EPC, ECGC. **6.3 Various Governmental Initiatives:** Make in India Start Up India Stand Up India Digital India Skill India **6.4 Case Studies of Successful Entrepreneurs**	04	CO6

Text Books:

[T1]. Neeraj Pandey and Khushdeep Dharni, Intellectual Property Rights, PHI, New Delhi

[T2]. The Indian Patent act 1970.

[T3]. The copy right act 1957

[T4]. Manual of patent office practice and procedure of Govt. of India.

[T5]. Manual of Designs Practice and Procedure of Govt. India

[T6]. Manual of Trademarks Practice and Procedure of Govt. India

[T7]. Semiconductor Integrated Circuits Layout Design (SICLD) Act 2000 of Govt. India

[T8]. Intellectual Property Rights- A Primer, R. Anita Rao & Bhanoji, Rao, Eastern BookCo.

[T9]. The Dynamics of Entrepreneurial Development & Management by Desai, Vasant, Himalaya Publishing House, Delhi.

[T10]. Managing Small Business by Longenecker, Moore, Petty and Palich, Cengage Learning, India Edition.

[T11]. Cases in Entrepreneurship by Morse and Mitchell, Sage South Asia Edition.

[T12]. Entrepreneurship – Indian Cases on Change Agents by K Ramchandran, TMGH.

References:

[R1]. Handbook of Indian Patent Law and Practice,

[R2]. Entrepreneurship: New Venture Creation by David H. Holt

[R3]. Entrepreneurship Development New Venture Creation by Satish Taneja, S.L.Gupta

[R4]. Project management by K. Nagarajan.

EE317: POWER SYSTEM OPERATION AND CONTROL LABORATORY

Teaching Scheme	**Examination Scheme**
Lectures: -- Hrs./Week	**Oral: 25 Marks**
Practical: 02 Hrs./Week	**Term Work: -- Marks**
Credits: 01	**Total: 25 Marks**

Prerequisite Course:

1. Basics of Power System.
2. MATLAB Programming & Simulink.

Course Objectives

1. Introduce the power system planning and operational studies
2. Explain in depth knowledge on network matrices.
3. Discuss the power flow studies using GS and NR method
4. Model and predict the behavior and operation of power system components
5. Demonstrate the economic dispatch and electromagnetic transients in the power system
6. Identify & formulate solutions to problems relevant to power system using software tools.

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Estimate the transmission line parameters and load flow analysis in power system.	5	Evaluate
CO2	Acquire knowledge on Formation of Bus Admittance and Impedance Matrices and Solution of Networks.	6	Create
CO3	To model and analyze the single area and two area power system	5	Evaluate
CO4	Solve the economic dispatch problem of power system with and without losses	4	Analyze
CO5	Examine the stability level of Single and Multi-machine system	5	Evaluate
CO6	Ability to employ different techniques to analyze different power system network conditions.	3	Apply

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	1	1	1	1	1	1	2	3	3
CO2	3	3	3	3	3	1	1	1	1	1	1	2	2	3
CO3	3	3	3	3	3	1	1	1	1	1	1	2	3	3
CO4	3	3	3	3	3	1	1	1	1	1	1	2	3	3
CO5	3	3	3	3	3	1	1	1	1	1	1	2	3	3
CO6	3	3	3	3	3	1	1	1	1	1	1	2	3	3

Course Contents			
Ex. No	**Name of Experiment**	**Hrs.**	**COs**
1	MATLAB Program to Solve Swing Equation using Point-by-Point Method	2	CO1
2	To study equal area criteria for transient stability analysis.	2	CO1 CO2
3	Simulink Model of Single Area Load frequency control without PI Controller	2	CO1 CO2
4	Simulink Model of Single Area Load frequency control with PI Controller	2	CO1 CO2
5	To plot exact dynamic response of two area load frequency control without integral action.	2	CO1 CO2
6	Simulink model for two area load frequency control with integral action.	2	CO1 CO3 CO5
7	Simulink model for evaluating transient stability of single machine connected to infinite bus	2	CO1 CO3 CO6
8	Economic Dispatch using Lambda iteration method	2	CO1 CO3 CO4
9	Modelling of IEEE excitation system, turbine and Governor system	2	CO1 CO5 CO6
10	Modeling of FACTS devices using Simulink	2	CO1 CO5 CO6
11	To see the effect of midpoint reactive power compensation on voltage through static var compensator (SVC) and static synchronous compensation (STATCOM)	2	CO1 CO5 CO6
12	Electromagnetic Transients in Power Systems: Transmission Line Energization	2	CO1 CO5 CO6
Any 08 experiments to be performed from above list.			
Text Books:			
[T1] Hemchandra Madhusudan Shertukde, "Power Systems Analysis Illustrated with MATLAB and ETAP", CRC Press Taylor & Francis Group [T2] Abhijit Chakrabarti, Sunita Halder, "Power System Analysis Operation and Control", Prentice Hall of India. [T3] J. Nagrath, D. P. Kothari, "Modern Power System Analysis", 4th Edition, Tata McGraw Hill Publishing Co. Ltd., [T4] P. S. R. Murthy, "Operation & Control in Power System", B. S. Publication, 2008			
References:			
[R1]. S. Sreenivasan, G. Sivanagaraju, Power System Operation and Control , Pearson Editions [R2]. Narain G. Hingorani, Laszlo Gyugyi, "Understanding FACTs" IEEE Press. [R3]. Allen J. Wood, Bruce F. Wollenberg "Power Generation, Operation, and Control", Wiley India Ed.			
E-references:			

[E1]. http://vp-dei.vlabs.ac.in/ (Virtual Power Lab)

EE318: FEEDBACK CONTROL SYSTEMS LABORATORY

Teaching Scheme	**Examination Scheme**	
Tutorial: -- Hrs./Week	**Practical:**	**50 Marks**
Practical: 02 Hrs./Week	**Term Work:**	**-- Marks**
Credits: 01	**Total:**	**50 Marks**

Prerequisite Course:

1. Knowledge of engineering mathematics, signals & systems, circuit analysis

Course Objectives

7. To introduce different types of system and identify a set of algebraic equations to represent and model a complicated system into a more simplified form to interpret different physical and mechanical systems in terms of electrical system to construct equivalent electrical models for analysis.
8. To employ time domain and frequency domain analysis to predict the performance parameters of the system for standard input functions.
3. Formulate different types of analysis in frequency domain to explain the nature of stability of the system**.**

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Determine transfer function model of any physical system AND use modern computing tools.	3	Applying
CO2	Analyse time domain stability of linear system	4	Analysing
CO3	Determine frequency response of Lead-Lag Compensator	3	Applying
CO4	Analyse frequency response of linear system	4	Analysing
CO5	Transform transfer function to state space model	3	Applying

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	2	2	2	-	-	-	1	2	2	3
CO2	3	2	1	2	2	2	2	-	-	-	1	2	2	3
CO3	3	2	1	2	2	2	2	-	-	-	1	2	2	3
CO4	3	2	1	2	2	2	2	-	-	-	1	2	2	3
CO5	3	2	1	2	2	2	2	-	-	-	1	2	2	3

Course Contents			
A. Minimum three experiments should be conducted			
Ex. No	**Name of Experiment**	**Hrs.**	**COs**
1	Experimental determination of DC servo motor parameters for mathematical modelling, transfer function and characteristics	02	CO1
2	Experimental study of time response characteristics of R-L-C second order system: Validation using simulation.	02	**CO2**
3	Experimental analysis of D.C. Motor Position control System.	02	CO1
4	Experimental determination of frequency response of Lead Compensator	02	**CO4**
5	Experimental determination of frequency response of Lag compensator.	02	CO4
6	Experimental determination of transfer function of any one physical systems (AC servomotor/ Two Tank System/Temperature Control / Level Control)	02	**CO1**
B. Minimum five experiments should be conducted (perform using software)			
Ex. No	**Name of Experiment**	**Hrs.**	**COs**
7	To study the basic of MATLAB / Scilab, Different Toolboxes in MATLAB, and Introduction to Control Systems Toolbox	02	CO1
8	Study of basic MATLAB / Scilab commands and matrix constructors and operations	02	**CO1**
9	Time response of 2^{nd} order system subjected to various test inputs	02	CO2
10	Plot unit step responses of given transfer function and find delay time, rise time, peak time and peak overshoot.	02	**CO2**
11	Effect of addition of pole-zero on root locus of second order system	02	CO2
12	Effect of addition of dominant and non - dominant poles on step response of second order system	02	**CO2**
13	Stability analysis using a) Root locus b) Bode Plot	02	CO4
14	Stability analysis using a)Polar Plot b) Nyquist Plot	02	**CO4**
15	Transformation of transfer function model to state space model and vice versa	02	CO5
Text Books:			
[T1] I.J. Nagrath, M. Gopal, "Control System Engineering", New Age International Publishers, 5th edition, 2007. [T2] Katsuhiko Ogata, "Modern control system engineering", Prentice Hall, 2010. [T3] Nise N. S. "Control Systems Engineering", John Wiley & Sons, Incorporated, 2011			
References:			
[R1] M. Gopal, "Control Systems: Principles and Design", McGraw Hill Education, 1997. [R2] B. C. Kuo, "Automatic Control System", Prentice Hall, 1995			
E-References			
[1] https://nptel.ac.in/courses/107/106/107106081/			

[2] https://nptel.ac.in/courses/108/106/108106098/

EE319: ELECTRICAL MACHINE DESIGN LAB

Teaching Scheme	**Examination Scheme**	
Lectures: -- Hrs./Week	**Oral:**	**25 Marks**
Practical: 02 Hrs./Week	**Term Work:**	**-- Marks**
Credits: 01	**Total:**	**25 Marks**

Prerequisite Course:

1. Knowledge of various materials used in electrical machines.
2. Knowledge of types, construction and working of transformer.
3. Knowledge of types, construction and working of three phase induction motor.

Course Objectives

1. To make student understand basic of Electrical Machine design.
2. To design transformer.
3. To understand determination of parameters of transformer.
4. To design Induction motor.
5. To understand determination of parameters of Induction motor.
6. To understand computer aided design of electrical machines

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Select proper commercial materials, their properties and selection criterions, IS standards used in electrical machine design.	2	Understanding
CO2	Calculate main dimensions and Design of single phase and three phase transformer.	6	Creating
CO3	Determine the parameters of transformer.	5	Evaluating
CO4	Calculate main dimensions and design of three phase Induction motor.	6	Creating
CO5	Determine parameters of three phase Induction motor.	5	Evaluating
CO6	Apply computer aided optimization techniques for design of electrical machines	3	Applying

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	1	1	1	1	-	1	1	1	3
CO2	3	3	3	3	3	1	1	1	1	-	2	1	1	1
CO3	3	3	3	3	3	1	1	1	1	-	2	1	1	1
CO4	3	3	3	3	3	1	1	2	2	-	2	1	1	1
CO5	3	3	3	3	3	1	1	1	1	-	2	1	1	1
CO6	3	3	3	3	3	1	1	2	2	-	2	1	3	1

Course Contents			
Ex. No	**Name of Experiment**	**Hrs.**	**COs**
1	Design reports along with the drawing sheet on transformer parts.	2	1
2	Design reports along with the drawing sheet on transformer Design.	**4**	**2,3**
3	Design reports along with the drawing sheet on Induction Motor parts.	2	4
4	Design reports along with the drawing sheet on Induction Motor Design.	**4**	**5**
5	Details and layout of AC winding with design report. (Sheet optional CAD or Drawing)	4	6
6	Report based on Industrial visit to a manufacturing unit. (Transformer or Induction motor).	**--**	**3,6**

Text Books:

[T1] M.G. Say – Theory and Performance and Design of A.C. Machines, 3rd Edition, ELBS London.
[T2] A.K.Sawhney – A Course in Electrical Machine Design, 10th Edition, - Dhanpat Rai and sons New Delhi.
[T3] K. G. Upadhyay- Design of Electrical Machines, New age publication
[T4] R. K. Agarwal – Principles of Electrical Machine Design, S. K.Katariya and sons.
[T5] Indrajit Dasgupta – Design of Transformers – TMH

References:

[R1] K.L. Narang , A Text Book of Electrical Engineering Drawings, Reprint Edition : 1993 / 94 – Satya Prakashan, New Delhi.
[R2] A Shanmugasundaram, G. Gangadharan, R. Palani, - Electrical Machine Design Data Book, 3rd Edition, 3rd Reprint 1988 - Wiely Eastern Ltd., - New Delhi
[R3] Vishnu Murti, “Computer Aided Design for Electrical Machines”, B.S. Publications.
[R4] Bharat Heavy Electricals Limited, Transformers - TMH.

E-References

[1] https://nptel.ac.in/courses/108/106/108106023/#

EE320: PROGRAMMING LABORATORY

Teaching Scheme	**Examination Scheme**
Tutorial: -- Hrs./Week	**Practical: 50 Marks**
Practical: 02 Hrs./Week	**Term Work: -- Marks**
Credits: 01	**Total: 50 Marks**

Prerequisite Course:

1. Basics of C Programming

Course Objectives

1. To be able to introduce core programming basics and various Operators of Python programming language.
2. To demonstrate about Python data structures like Lists, Tuples, Sets and dictionaries
3. To understand about Functions, Modules and Regular Expressions in Python Programming

Course Outcomes (COs):

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

Course Outcome (s)		Bloom's Taxonomy	
		Level	Descriptor
CO1	Apply the basic concepts of scripting and the contributions of scripting language	3	Applying
CO2	Ability to explore python data structures like Lists, Tuples, Sets and dictionaries	2	Understand
CO3	Apply practical and contemporary applications using Functions, Modules and Regular Expressions.	3	Applying
CO4	Implement Python programs with conditionals and loops.	2	Understand
CO5	Use Python lists, tuples, dictionaries for representing compound data.	4	Analysing
CO6	Read and write data from/to files in Python	3	Applying

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	2	3	1	1	--	1	--	2	--	--
CO2	3	1	1	2	2	2	2	1	1	1	1	2	--	--
CO3	3	2	2	1	2	1	1	1	1	--	1	1	--	--
CO4	3	1	2	2	1	2	1	1	1	1	1	2	--	--
CO5	3	2	1	3	1	1	--	1	--	2	1	1	--	--
CO6	3	2	1	1	2	1	1	--	1	1	1	2	--	--

Course Contents			
Ex. No	**Name of Experiment**	**Hrs.**	**COs**
1	To demonstrate about Basics of Python Programming	2	2,4
2	To demonstrate different operators in Python	**2**	**2,4**
3	To study Conditional statements in Python	2	3, 4
4	To demonstrate the control transfer statements in Python	**2**	**2,4**
5	To perform read and write operations on a file.	2	3, 4
6	To demonstrate the different ways of creating list objects	**2**	**2,4**
7	Demonstrate the different parameters used while writing functions in Python	2	2,4
8	To study in-built functions to use Regular Expressions	**2**	**3,4**
Text Books:			
[T1] Paul Barry, '' Head-First Python: A Brain-Friendly Guide''			
References:			
[R1] Eric Matthes, '' A Hands-On, Project-Based Introduction to Programming'' [R2] Mark Lutz, "Learning Python, 5th Edition			
E-References			
[E1] https://www.python.org/about/gettingstarted/ [E2] https://www.niit.com/india/short-term-courses/data-analytics/python-programming-and-data-exploration-python			

EE321: CREATIONAL ACTIVITY

Teaching Scheme	**Examination Scheme**	
Practical: 02 Hrs./Week	**Term Work:**	**50 Marks**
Credits: 01	**Total:**	**50 Marks**

Prerequisite Course:
Human Values, Communication Skills, Sports Enthusiasm

Course Objectives

4. Overall development of a student's Technically, Mentally, and emotionally.

Course Outcomes (COs):

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

	Course Outcome (s)	**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Influence a better attitude towards the environment and more responsible behaviour	5	Evaluate
CO2	Use of communication skills and team building techniques as students have to work in groups to solve problems.	3	Apply
CO3	Understand working of professional bodies and participate in various activities	2	Understand
CO4	Apply the knowledge to participate in Extra-Curricular and Co-curricular activities	3	Apply
CO5	Opportunity to undertake leadership, question actions and regulations and accept responsibility for their own behaviour.	3	Apply

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	3	1	1	1	-	1	-	-
CO2	2	1	-	-	-	-	1	1	2	3	-	2	2	-
CO3	2	1	-	-	-	-	1	1	1	1	-	2	-	-
CO4	2	1	-	-	-	-	1	1	1	1	-	2	-	2
CO5	2	1	-	-	-	2	1	1	2	1	-	2	-	-

Course Guidelines
Students will be awarded with credits / grades based upon his or her participation in events or/and contribution in various membership committees outside of departmental associations such as IEEE students' chapter, IETE, SAE, e-Baja, M-Baja, ISTE, Annual Social Gathering, Sports, Hackathon, Project/Poster Competition, NSS etc. **The following list of activities is for reference to choose from** • Outdoor Activities • Indoor Activities • Skill Based Activities • Cultural Activities • Sports Activities • Social Activities • Technical Activities The Rubrics for the grades and marks will be different depending on the activities enlisted.

MC322: PCB DESIGN

Teaching Scheme	**Examination Scheme**	
Lectures: 01 Hrs./Week	**End-Sem Exam:**	**PASS / FAIL**
Credits: Non-Credit	**Total:**	**NA**

Prerequisite Course

A Computer or Laptop with any operating system and the Software that will be used to create the PCB

Course Objectives

1. Predict and verify the behaviour and performance of the circuit before implementing it.
2. Allows us to evaluate, compare and optimize alternative designs, plans.

Course Outcomes (COs):

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

	Course Outcome (s)	**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Simulate and perform various analyses for the given Electronic Circuit.	3	Applying
CO2	Design a PCB Layout for the given circuit.	4	Analysing
CO3	Fabricate the PCB and assemble the components.	2	Understand
CO4	Existing circuit designs can be customised as per the requirement.	3	Applying

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	3	-	3	-	-	-	2	-	-	2	3	3
CO2	1	2	3	-	3	-	-	-	2	-	-	2	3	3
CO3	1	2	3	-	3	-	-	-	2	-	-	2	3	3
CO4	1	2	3	-	3	-	-	-	2	-	-	2	3	3

Course Contents

Simulation of electronic circuit uses mathematical models to get the actual behaviour of the printed circuit board or electronic devices. Simulation software allows for modelling of electronic circuit operation. Simulation allows designers to stay within a budget. Any part of the printed circuit board can be analysed. Simulation models can be used both for Analog devices and for digital electronic components testing. PCB simulation software applies mathematical models to predict board operation.

The free and/or open source electronic circuit simulation software on this page allows you to design, analyse and test a circuit virtually in a browser or on a computer. They simulate the behaviour of an electronic device/circuit, and are often used because it is cheaper, quicker and often more practical to simulate a circuit than to physically build one. The programs below may provide either Analog or digital simulation capabilities Proteus, Easy EDA electronic circuit design, circuit simulation and PCB design Do Circuits are some of the simulation software's.

Ex. No	Introduction and List of Experiments	Hrs.	Cos
1	Introduction to the software	2	CO1
2	Design and simulation of Voltage regulator(78XX)	1	CO2
3	Design and simulation of Half wave rectifier using 1N4001 and its implementation on PCB.	1	CO3, CO4
4	Design and simulation of Full wave Bridge rectifier using 1N4001.	1	CO2
5	Design and simulation of Single Stage CE Amplifier.	1	CO2
6	Design and simulation of Op-Amp as Inverting and Non-Inverting Amplifier.	1	CO2
7	Design and simulation of Half Adder circuit.	1	CO2
8	Design and simulation of 1N4001.	1	CO2

Text Books:

[T1] Sergio Franco, 'Design with Op-Amps and Analog Integrated Circuits', TMH.
[T2] Allen Mottershed, 'Electronic Devices & Circuits', PHI.

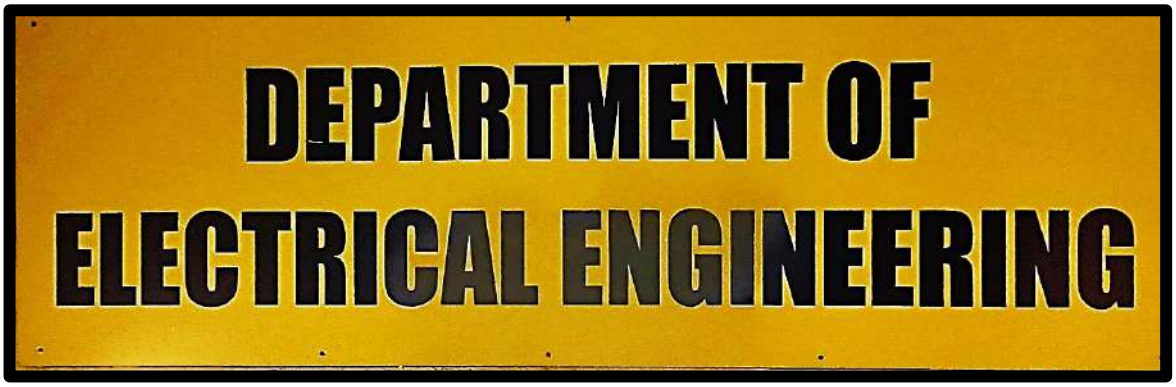
E-References

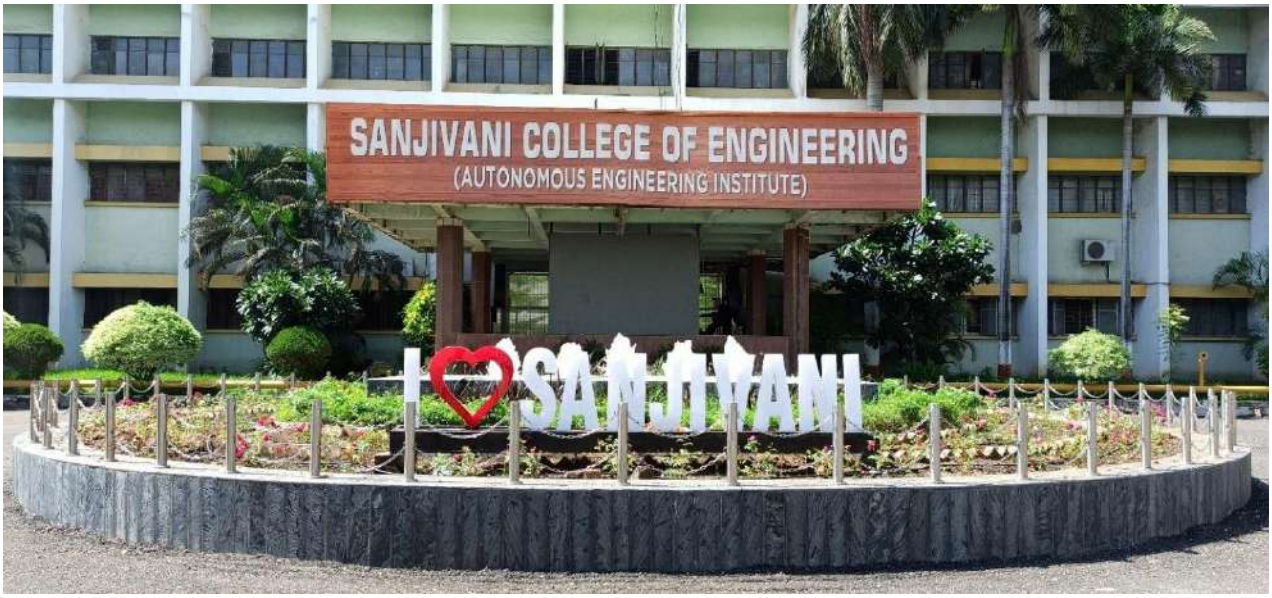
https://docs.easyeda.com/en/Simulation/Chapter4-Introduction-to-using-a-simulator/index.html
https://www.pcbway.com/blog/PCB_Design_Tutorial/How_to_Design_PCB_in_Proteus_1.html

SANJIVANI RURAL EDUCATION SOCIETY'S

SANJIVANI COLLEGE OF ENGINEERING KOPARGAON

(An Autonomous Institute Affiliated to Savitribai Phule Pune University, Pune)





DEPARTMENT OF ELECTRICAL ENGINEERING

COURSE STRUCTURE - 2020 PATTERN

FINAL YEAR B. TECH

Academic Year 2023-24

SANJIVANI RURAL EDUCATION SOCIETY'S

SANJIVANI COLLEGE OF ENGINEERING KOPARGAON

(An Autonomous Institute Affiliated to Savitribai Phule Pune University, Pune)

DEPARTMENT OF ELECTRICAL ENGINEERING

Profile: The Electrical Engineering degree program offer the graduates to enter a dynamic and rapidly changing field with career opportunities in Electric Power System, Power Electronics, Robotics and Control, Microprocessors and Controllers, Integrated Circuits, Computer Software. The demand for electrical power and electronic systems is increasing rapidly and electrical engineers are in great demand to meet the requirements of the growing industry. Electrical Engineers are mainly employed in industries using Electrical Power, Manufacturing Electrical Equipment, Accessories, Electronic Systems, Research and Development departments which work on energy saving devices and Software Development.

Many of these disciplines overlap with other engineering branches, spanning a huge number of specializations including hardware engineering, electromagnetic and waves, microwave engineering, nanotechnology, electrochemistry, renewable energies, Artificial Intelligence, mechatronics, and electrical materials science. Identifying these areas today's Electrical Engineer needs to have the capacity of adaptability and creativity in these new technical eras, to meet the industry 4.0.

Electrical Engineering Department of Sanjivani College of Engineering offers the B. Tech. course in Electrical Engineering with an intake of 60 students. The department has well qualified and dedicated faculty and is known for its high academic standards, well-maintained discipline, and complete infrastructure facilities.

Vision of Department

To produce quality electrical engineers with the knowledge of latest trends, research technologies to meet the developing needs of industry & society

Mission of Department

M1: To impart quality education through teaching learning process

M2: To establish well-equipped laboratories to develop R&D culture in contemporary and sustainable technologies in Electrical Engineering

M3: To produce Electrical Engineering graduates with quest for excellence, enthusiasm for continuous learning, ethical behavior, integrity and nurture leadership

Program Outcomes (POs):

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, society, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning in formed by the contextual knowledge to assess social, health, safety, legal and cultural issues, and the consequent responsibilities relevant to the professional engineering practice
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply the set of one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Educational Objectives (PEOs)

The PEOs of undergraduate programme in Electrical Engineering are broadly classified as follows:

1. **PEO 1:** Equip the student to analyze and solve real world problems to face the challenges of future.

2. **PEO 2:** Pursue higher education, research in Electrical Engineering or other allied fields of their interest for professional development.

3. **PEO 3:** Exhibit the leadership skills and ethical value for society

Program Specific Objectives (PSOs)

1. **PSO 1:** Apply the fundamentals of mathematics, science and engineering knowledge to identify, formulate, design and investigate complex engineering problems of electric circuits, analog and digital electronics circuits, control systems, electrical machines and Power system.

2. **PSO 2:** Apply the appropriate modern engineering hardware, and software tools in electrical engineering to engage in life-long learning and to successfully adapt in multi-disciplinary environments.

COURSE STRUCTURE- 2020 PATTERN
FINAL YEAR B. TECH. ELECTRICAL ENGINEERING

SEMESTER-VII

Course			Teaching Scheme Hours/week				Evaluation Scheme-Marks						
							Theory						
Cat.	Code	Title	L	T	P	Credits	ISE	ESE	CA	OR	PR	TW	Total
PCC	EE401	Switch Gear and Protection	3	-	-	3	30	50	20	-	-	-	100
PCC	EE402	Control System Design	3	-	-	3	30	50	20	-	-	-	100
PCC	EE403	High Voltage Engineering	3	-	-	3	30	50	20	-	-	-	100
PEC	EE404	Professional Elective- III **A.** Electric and Hybrid Vehicle **B.** HVDC Transmission Systems **C.** Digital Signal Processing	4	-	-	4	30	50	20	-	-	-	100
PEC	EE405	Professional Elective-IV **A.** Power Quality **B.** Transmission and Distribution **C.** Intelligent Systems with AI and ML	3	-	-	3	30	50	20	-	-	-	100
LC	EE406	Switch Gear and Protection Laboratory	-	-	2	1	-	-	-	50	-	-	50
LC	EE407	Control System Design Laboratory	-	-	2	1	-	-	-	50	-	-	50
LC	EE408	High Voltage Engineering Laboratory	-	-	2	1	-	-	-	-	50	-	50
PROJ	EE409	Project Stage I	-	-	6	3	-	-	-	50	-	100	150
MLC	MC410	Mandatory Learning Course-VII **A.** Financially Smart	1	-	-	Non Credit	-	-	-	-	-	-	Pass/Fail
		Total	**17**	**-**	**12**	**22**	**150**	**250**	**100**	**150**	**50**	**100**	**800**

SEMESTER VII

EE401: SWITCHGEAR AND PROTECTION

Teaching Scheme		Examination Scheme	
Lectures:	**3 Hrs./Week**	**Continuous Assessment:**	**20 Marks**
Tutorial:	**--- Hr/Week**	**In-Sem Exam:**	**30 Marks**
		End-Sem Exam:	**50 Marks**
Credits:	**03**	**Total:**	**100 Marks**

Prerequisite Course:

1. Power system

Course Objectives

1. To educate the causes of abnormal operating conditions (faults, lightning and switching surges) of the apparatus and system.
2. To introduce the characteristics and functions of relays and protection schemes.
3. To impart knowledge on apparatus protection
4. To introduce static and numerical relays
5. To impart knowledge on arc formation.
6. To impart knowledge on functioning of circuit breakers

Course Outcomes (COs):

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

Course Outcome (s)		Bloom's Taxonomy	
		Level	**Descriptor**
CO1	Identify the various types of faults in Power system and discuss the needs of protective devices.	3	Apply
CO2	Illustrate the operations and applications of various types of protective relays with its characteristics in power system.	2	Understand
CO3	Describe the various schemes employed for apparatus protection in power system	2	Understand
CO4	Elucidate the importance of numerical and static relays in power system	2	Understand
CO5	Demonstrate the arc interruption and analyze the RRRV in circuit breakers	2	Understand
CO6	Illustrate the different types of circuit breakers in power system.	2	Understand

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2	1	1	2	-	-	-	-	-	1	3	1
CO2	2	2	3	1	1	2	-	-	-	-	-	1	3	1
CO3	2	2	3	2	1	2	-	-	-	-	-	1	3	1
CO4	2	2	3	2	1	2	-	-	-	-	-	1	3	1
CO5	2	2	3	2	1	2	-	-	-	-	-	1	3	1
CO6	2	2	2	1	1	2	-	-	-	-	-	1	3	1

Course Contents			
UNIT-I	**PROTECTIVE RELAYING**	**Hrs.**	**COs**

	Principles and need for protective schemes – nature and causes of faults – types of faults – fault current calculation using symmetrical components – Methods of Neutral grounding – Zones of protection and essential qualities of protection – Protection schemes.	8	1
UNIT-II	**ELECTROMAGNETIC RELAYS**	**Hrs.**	**CO**
	Operating principles of relays - the Universal relay – Torque equation – R-X diagram – Electromagnetic Relays – Overcurrent, Directional, Distance, Differential, Negative sequence and Under frequency relays.	10	2
UNIT-III	**APPARATUS PROTECTION**	**Hrs.**	**CO**
	Current transformers and Potential transformers and their applications in protection schemes - Protection of transformer, generator, motor, busbars and transmission line.	8	3
UNIT-IV	**STATIC RELAYS AND NUMERICAL PROTECTION**	**Hrs.**	**CO**
	Static relays – Phase, Amplitude Comparators – Synthesis of various relays using Static comparators – Block diagram of Numerical relays – Overcurrent protection, transformer differential protection, distant protection of transmission lines	8	4
UNIT-V	**FUNDAMENTALS OF ARC INTERRUPTIONS**	**Hrs.**	**CO**
	Ionization of gases, deionization, ARC Formation - DC and AC circuit breaking – Current interruption in AC circuit breakers- Transient recovery voltage (TRV) – derivation of rate of rise of TRV - resistance switching - current chopping - interruption of capacitive current.	8	5
UNIT-VI	**CIRCUIT BREAKERS**	**Hrs.**	**CO**
	Types of circuit breakers – Air blast, Air break, Oil, SF6 and vacuum circuit breakers – Comparison of different circuit breakers – Rating and selection of Circuit breakers.	7	6

Text Books:

[T1]. Sunil S.Rao, "Switchgear and Protection", Khanna Publishers, New Delhi, 14th Edition, 2021, ISBN: 978-9387394728
[T2]. M.L.Soni, P.V.Gupta, U.S.Bhatnagar, A.Chakrabarti, "A Text Book on Power System Engineering", Dhanpat Rai & Co.,Jan 2016, ISBN : 9788177000207
[T3]. Stanley H. Horowitz, Arun G. Phadke , Power System Relaying, John Wiley, 2014, ISBN: 978-0-470-75878-6

References:

[R1] Badri Ram, D. N. Vishwakarma, "Power System Protection and Switchgear" Tata McGraw Hill Publishing Co. Ltd., 3rd edition, 2022, ISBN: 978-9355322852
[R2] H Lee Blackburn , "Protective Relaying- Principles and Applications", Dekker Publications, 3rd edition, 2007, ISBN: 978-0-9568678-0-3
[R3] Mason C.R., "Art and Science of Protective Relaying", Wiley Eastern Limited, 1996, ISBN: 978-0471575528

E-References

[1] Power System Protection and Switchgear (IIT Roorkee)
https://archive.nptel.ac.in/courses/108/107/108107167/

EE402: CONTROL SYSTEM DESIGN

Teaching Scheme		**Examination Scheme**	
Lectures:	**03 Hrs./Week**	**Continuous Assessment:**	**20 Marks**
Tutorial:	**--- Hr/Week**	**In-Sem Exam:**	**30 Marks**
		End-Sem Exam:	**50 Marks**
Credits:	**03**	**Total:**	**100 Marks**

Prerequisite Course:

1. Control System Engineering
2. Matrix Algebra, Z-transform, and Laplace transform

Course Objectives

1. Make students identify various characteristics of nonlinear systems.
2. Develop skills for analysing nonlinear systems.
3. Make students study features and configurations of digital control systems.
4. Understand the practical controllers and compensators

Course Outcomes (COs):

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

	Course Outcome (s)	**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Identify the various nonlinearities and their behaviour observed in real world	2	Understanding
CO2	Analyse the system using state space approach	4	Analysing
CO3	Apply controllability and observability tests on the system	3	Applying
CO4	Use Sampling theorem and other concepts of Digital control systems	3	Applying
CO5	Analyse system with P, I and D controller	4	Analysing
CO6	Apply the compensator concepts to enhance the system performance	3	Applying

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	2	2	-	-	-	-	-	-	1	2	2
CO2	2	3	2	2	1	-	-	-	-	-	-	1	2	2
CO3	2	3	2	2	1	-	-	-	-	-	-	1	2	2
CO4	2	3	3	3	2	-	-	-	-	-	-	1	2	2
CO5	2	3	2	2	2	-	-	-	-	-	-	1	2	2
CO6	2	3	2	1	1	-	-	-	-	-	-	1	2	2

Course Contents

UNIT-I	**Nonlinear Control Systems**	**Hrs.**	**COs**
	Introduction to nonlinear systems, common nonlinearities, describing function method, describing function of an ideal relay, stability analysis with describing function, introduction to Lyapunov stability analysis (basic concepts, definitions, and stability theorem)	06	CO1
UNIT-II	**Introduction to State-Space**	**Hrs.**	**CO**

	Concept of state, state-space representation of dynamical systems in physical variable form, phase variable forms and Jordon / diagonal canonical form, conversion of the transfer function to state-space model and vice versa, state equation and its solution, state transition matrix and its properties, computation of state transition matrix by Laplace transform and Caley Hamilton method.	08	CO2
UNIT-III	**State-Space Design**	**Hrs.**	**CO**
	The concept of controllability and observability, Kalman's and Gilbert's tests for controllability and observability, effect of pole-zero cancellation, duality property, control system design using pole-placement using transformation matrix, direct substitution, and Ackermann's formula, State observers, design of a full- order observer.	08	CO3
UNIT-IV	**Introduction to Digital Control System**	**Hrs.**	**CO**
	Basic block diagram of the digital control system, sampling and reconstruction, Shannon's Sampling theorem, zero-order hold and its transfer function, First-order hold (no derivation), characteristics equation, mapping between s-plane and z-plane, stability analysis in z-plane.	06	CO4
UNIT-V	**P, I and D Controllers**	**Hrs.**	**CO**
	Introduction to Proportional (P), Integral (I) & Derivative (D)controller, individual effect on overall system performance, P-PI & PID control and effect on overall system performance, Numerical examples.	08	CO5
UNIT-VI	**Compensator Design in Frequency Domain**	**Hrs.**	**CO**
	Approach to control system design, cascade compensation networks, phase-lead and phase-lag compensator designs using bode plot, physical realization of compensators.	06	CO6

Text Books:

[T1]. Norman S. Nise, Control System Engineering, 8th Edition, John Wily and Sons, Inc. 2018 ISBN 8126571837.
[T2]. Richard C. Dorf, Robert H. Bishop, Modern Control Systems, 13th Edition, Pearson Ed, ISBN 9780134407623.
[T3]. Benjamin C. Kuo, Digital Control System, Second Edition, Oxford University Press, 2007, ISBN 0195686209
[T4]. I. J. Nagarath, M. Gopal, Control System Engineering, 7th Edition, New Age International (P) Limited, Publishers, 2021, ISBN 8195175589
[T5]. A. Nagoor Kani, Advanced Control Theory, Third Edition, CBS Publishers and Distributes,2020, ISBN 9389396298

References:

[R1] M. Gopal, "Control Systems: Principles and Design", 4th Ed. McGraw Hill Education, 2012, ISBN 9780071333269
[R2] B. C. Kuo, "Automatic Control System", 9th Ed., Prentice Hall, 2014, ISBN 9788126552337

E-Resources:

[E1] Control Engineering, IIT Delhi by Prof. M. Gopal (https://nptel.ac.in/courses/108102043)
[E2] NOC:Nonlinear and Adaptive Control, IIT Delhi by Prof. Shubhendu Bhasin (https://nptel.ac.in/courses/108102113)

EE403: HIGH VOLTAGE ENGINEERING

Teaching Scheme		Examination Scheme	
Lectures:	**03 Hrs./Week**	**Continuous Assessment:**	**20 Marks**
Tutorial:	**--- Hrs./Week**	**In-Sem Exam:**	**30 Marks**
		End-Sem Exam:	**50 Marks**
Credits:	**03**	**Total:**	**100 Marks**

Prerequisite Course: Atomic and molecular structure of gaseous and solid materials, basic properties of conductors and insulators, knowledge of Electrical Engineering Materials.

Course Objectives

1. To enable students to know and compare the various processes of breakdown in solid, liquid and gaseous dielectric materials ·
2. To enable students, understand and apply various methods of generation and measurement of DC, AC, impulse voltage and current.
3. To enable students to know the charge formation and separation phenomenon in clouds, causes of overvoltage and lightening phenomenon ·
4. To develop ability among learners to execute testing on various high voltage equipment's as per standards ·
5. To introduce students to the design, layout, safety precautions, earthing, and shielding of HV laboratory.

Course Outcomes (COs):

Course Outcome (s)		Bloom's Taxonomy	
		Level	Descriptor
CO1	Identify, describe the breakdown theories of gaseous materials.	2	Understand
CO2	Identify, describe the breakdown theories of liquid materials.	2	Understand
CO3	Identify, describe the breakdown theories of solid materials.	2	Understand
CO4	Describe as well as use different methods of generation of high AC, DC, impulse voltage and current.	2	Understand
CO5	Identify the occurrence of overvoltage and to provide remedial solutions.	2	Understand
CO6	Identify and describe different methods of the measurement of high voltage and cueernt.	2	Understand

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	-	2	2	1	-	-	1	1	1	3	1
CO2	3	3	2	1	2	2	1	-	-	1	1	1	3	1
CO3	3	3	1	1	1	2	1	-	-	1	1	1	3	1
CO4	2	2	1	1	1	-	1	-	-	-	1	1	3	1
CO5	2	2	1	2	1	-	1	-	-	-	1	1	3	1
CO6	2	3	1	-	1	-	1	-	-	-	1	1	3	1

Course Contents

UNIT-I	BREAKDOWN IN GASES DIELECTRICS		COs
	Ionization process in gas, Townsend's Theory, current growth equation in presence of primary and secondary ionization processes, Townsend's breakdown criterion, primary and secondary ionization coefficients, limitations of Townsend's theory, Streamer mechanism of breakdown, Paschen's Law and its limitations, Corona discharges for point plane electrode combination with positive and negative pulse application, time lag and factors on which time lag depends. (Numerical on Townsend's theory and Paschen's law).	06	01
UNIT-II	**BREAKDOWN IN LIQUID DIELECTRICS**	**Hrs.**	**CO**
	Pure and commercial liquids, Different breakdown theories: Breakdown in Pure liquid and breakdown in commercial liquids: Suspended Particle theory, Cavitations and bubble theory, Thermal mechanism of breakdown and Stressed Oil volume theory.	06	02

	(Numerical on theories of liquid dielectric materials)		
UNIT-III	**BREAKDOWN IN SOLID DIELECTRICS**	**Hrs.**	**CO**
	Intrinsic breakdown: electronic breakdown, avalanche or streamer breakdown, electro-mechanical breakdown, thermal breakdown, treeing and tracking phenomenon, Chemical and electrochemical breakdown, Partial discharge (Internal discharge), Composite dielectric material, Properties of composite dielectrics, breakdown in composite dielectrics. (Numerical on theories of solid dielectric materials)	06	03
UNIT-IV	**GENERATION OF HIGH CURRENT AND VOLTAGES**	**Hrs.**	**CO**
	Generation of high ac voltages-Cascading of transformers, series and parallel resonance system, Tesla coil. Generation of impulse voltages and current-Impulse voltage definition, wave front and wave tail time, Multistage impulse generator, Modified Marx circuit, Tripping and control of impulse generators, Generation of high impulse current	06	04
UNIT-V	**LIGHTNING AND SWITCHING OVER VOLTAGES**	**Hrs.**	**CO**
	Causes of over voltages, lightning phenomenon, Different types of lightening strokes and mechanisms of lightening strokes, Charge separation theories, Wilson theory, Simpson theory, Reynolds and Mason theory, over voltage due to switching surges and methods to minimize switching surges. Statistical approach of insulation coordination.	06	05
UNIT-VI	**MEASUREMENT OF HIGH VOLTAGE AND HIGH CURRENTS**	**Hrs.**	**CO**
	Sphere gap voltmeter, electrostatic volt meter, generating voltmeter, peak reading voltmeter, resistive, capacitive and mixed potential divider, capacitance voltage transformer, cathode ray oscilloscope for impulse voltage and current measurement, measurement of dielectric constant and loss factor, partial discharge measurements.	06	06

Text Books:

[T1] M. S. Naidu, V. Kamaraju, "High Voltage Engineering", Tata McGraw Hill Publication Co. Ltd. New Delhi, ISBN 0-07-462286-2

[T2] C. L. Wadhwa, "High Voltage Engineering", New Age International Publishers Ltd, ISBN 10: 8122418597 ISBN 13: 9788122418590

References:

[R1] E. Kuffel, W. S. Zaengl, J. Kuffel, "High Voltage Engineering Fundamentals", Newnes Publication, ***ISBN*** 0 7506 3634 3

[R2] Prof. D. V. Razevig Translated from Russian by Dr. M. P. Chourasia, "High Voltage Engineering", Khanna Publishers, New Delhi, ISBN: 978 - 0 - 620 – 3767-7.

[R3] Ravindra Arora, Wolf Gang Mosch, "High Voltage Insulation Engineering", New Age International ISBN 13- 978-8122406191

[R4] High Voltage Engineering Theory and Practice by M. Khalifa Marcel Dekker Inc. New York, ***ISBN*** 10 0824781287

[R5] Subir Ray, "An Introduction to High voltage Engineering" PHI Pvt. Ltd. New Delhi, ***ISBN***, 8120347404

[R6] IS 731-1971:Porcelain insulator for overhead power lines with nominal voltage > 1000 Volt, ***ISBN-13: 978-0824748098***

[R7] Bushings :IS2099-1986,specification for bushings for A.C. Voltages > 1000 Volts, ***ISBN***-13: 978-0824748098

[R8] Pollution test :IEC 60507-1991 on external and internal insulator, ***ISBN***-10: 0824748093

[R9] High voltage test techniques, general definitions and test requirements: IS 2071(part 1) 1993,IEC Pub 60-1(1989), ISBN 60060-1:2010.

E-resources:

[E1] NPTEL https://archive.nptel.ac.in/courses/108/104/108104048/

EE404A Electric and Hybrid Vehicle

Teaching Scheme		**Examination Scheme**	
Lectures:	**04 Hrs./Week**	**Continuous Assessment:**	**20 Marks**
Tutorial:	**--- Hrs./Week**	**In-Sem Exam:**	**30 Marks**
		End-Sem Exam:	**50 Marks**
Credits:	**04**	**Total:**	**100 Marks**

Prerequisite Course:

1. Basic concept of Batteries
2. Electrical motors
3. Power electronic conversion

Course Objectives

1. To make students aware of the need and importance of Electric, Hybrid Electric Vehicles and Fuel cell vehicles.
2. To differentiate and analyze the various energy storage devices and battery charging and management systems.
3. To impart knowledge about architecture and performance of Electric and Hybrid Vehicles
4. To classify the different drives and controls used in electric vehicles.

Course Outcomes (COs):

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

	Course Outcome (s)	**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Recognize history, Social and environmental importance of Hybrid and Electric vehicles	2	Understanding
CO2	Describe the performance and selection of energy storage systems	2	Understanding
CO3	Analyze battery management system	4	Analysing
CO4	Distinguish between the performance and architecture of various drive trains	2	Understanding
CO5	Describe the different Instrumentation and Control used for electric vehicles	2	Understanding
CO6	Understand Indian and Global Scenarios in Electric Vehicles	2	Understanding

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	1	3	-	-	-	-	3	-	-
CO2	2	2	-	-	-	1	3	-	-	-	-	2	-	-
CO3	2	3	-	-	-	-	2	-	-	-	-	3	-	-
CO4	2	1	-	-	-	-	2	-	-	-	-	2	-	-
CO5	2	2	-	-	-	-	1	-	-	-	-	2	-	-
CO6	1	-	-	-	2	2	2	-	-	-	-	3	-	-

Course Contents

UNIT-I	**Introduction**	**Hrs.**	**COs**
	History of Electric Vehicles, Concept of Electrified transportation, Comparison of EVs and IC Engine vehicles, Hybrid Electric Vehicle and Fuel cell Vehicle. Social and environmental importance of Hybrid and Electric vehicles.	5	CO1
UNIT-II	**Energy Storage Systems**	**Hrs.**	**CO**
	Introduction to energy storage requirements in Hybrid and Electric vehicles, battery-based energy storage and its analysis, Fuel cell based energy storage and its analysis, Ultra capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis.	7	CO2
UNIT-III	**Battery charging and Management systems**	**Hrs.**	**CO**
	Introduction, charging algorithm, balancing method for battery pack charging. Battery management system representation: - battery module, measurement unit block, battery equalisation balancing unit, MCU estimation unit, display unit, fault warning block. SoC and SoH, estimation of SoC, battery balancing, Thermal monitoring of Battery unit.	6	CO3
UNIT-IV	**Hybrid and Electric vehicles**	**Hrs.**	**CO**
	Electric vehicles: - Components, configuration, performance, tractive efforts in normal driving, Advantages and challenges in EV design. Hybrid Electric vehicles: - Concept and architecture of HEV drivetrain (Series, parallel and series-parallel).Energy consumption of EV and HEV	5	CO4
UNIT-V	**Drives and control systems**	**Hrs.**	**CO**

	Drives: - Application of BLDC drives and Switched reluctance motor drive for HEV and EV, performance characteristics of drives. Instrumentation and control system related to Hybrid and Electric vehicles, speed control, acceleration characteristics, Electric steering, motion control, braking mechanism, IoT in Electric Vehicles	7	CO5
UNIT-VI	**Indian & Global Scenarios in Electric Vehicles**	**Hrs.**	**CO**
	Technology Scenario, Recent developments and trends in electric vehicles (BYD, Citroen EV, etc), Market Scenario, Policies & Regulations, Payback & Commercial Model, Policies in India Introduction to Vehicle to Home(V2H), Vehicle to Vehicle (V2V) and Vehicle to Grid (V2G) technologies (Descriptive)	6	CO6
***One Industrial Visit to any EV design and manufacturing company is mandatory.**			
Text Books:			
[T1] James Larminie and John Lowry, "Electrical Vehicle", John Wiley and Sons, 2012. [T2] Ronald K. Jurgen, "Electric and Hybrid-Electric Vehicles", SAE International Publisher. [T3] K T Chau, "Energy Systems for Electric and Hybrid Vehicles", The institution of Engineering and Technology Publication [T4] D.A.J Rand, R Woods, R M Dell, "Batteries for Electric Vehicles", Research studies press Ltd, New York, John Willey and Sons [T5] Electric and Hybrid Vehicles-Design Fundamentals, CRC press [T6] Mark Warner, The Electric Vehicle Conversion handbook –HP Books, 2011.			
References:			
[R1] Mehrdad Ehsani, Yimin Gao and Ali Emadi, "Modern Electrical Hybrid Electric and Fuel Cell Vehicles: Fundamental, Theory and design", CRC Press, 2009. [R2] "Automotive handbook 5 th edition", Robert Bosch, SAE international publication.			
E-References			
[1] Junwei Lu, Jahangir Hossain,"Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid", IET Digital Library [2] Automobile Electrical and Electronic systems, Tom Denton, SAE International publications. [3] https://nptel.ac.in/courses/108/106/108106170/			

EE404B: HVDC TRANSMISSION SYSTEMS

Teaching Scheme		Examination Scheme	
Lectures:	**04 Hrs./Week**	**Continuous Assessment:**	**20 Marks**
Tutorial:	**-- Hrs/Week**	**In-Sem Exam:**	**30 Marks**
		End-Sem Exam:	**50 Marks**
Credits:	**04**	**Total:**	**100 Marks**

Prerequisite Course: Power System-I, II, Control System-I & II, Power Electronics

Course Objectives

1. To introduce students with the concept of HVDC Transmission system.
2. To familiarize the students with the HVDC converters and their control system.
3. To expose the students to the harmonics and faults occur in the system and their prevention

Course Outcomes (COs):

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

	Course Outcome (s)	Bloom's Taxonomy	
		Level	**Descriptor**
CO1	Understand the advantages of HVDC transmission over conventional AC transmission.	2	Understand
CO2	Formulate and solve mathematical problems related to rectifier and inverter control methods.	3	Apply
CO3	Analyze the operation of individual components within an HVDC converter system.	4	Analyze
CO4	Explain the process of harmonics generation in power electronic converters	2	Comprehension
CO5	Understand the nature of faults happening on both the AC and DC sides of the converters.	2	Understand
CO6	Understand and classify various types of Multiterminal DC (MTDC) systems, understanding their configurations, and identifying their applications in modern power systems.	2	Understand

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	2	-	-	-	-	2	3	3	3
CO2	3	3	3	3	3	2	-	-	-	-	3	3	3	3
CO3	3	3	3	3	3	2	-	-	-	-	3	3	3	3
CO4	3	3	3	3	3	2	-	-	-	-	3	3	3	3
CO5	2	3	3	3	3	2	-	-	-	-	3	3	3	3
CO6	3	3	3	2	3	2	-	-	-	-	3	3	3	3

Course Contents

UNIT I	INTRODUCTION	Hrs.	CO
	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.	**6**	**CO1**
UNIT II	**ANALYSIS OF HVDC CONVERTERS**	**Hrs.**	**CO**

	Choice of converter configuration, simplified analysis of Graetz circuit, converter bridge characteristics, Characteristics of a twelve-pulse converter, detailed analysis of converters.	**6**	**CO2**
UNIT III	**CONTROL OF HVDC CONVERTERS AND SYSTEMS**	**Hrs.**	**CO**
	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	**6**	**CO3**
UNIT IV	**HARMONICS AND FILTERS**	**Hrs.**	**CO**
	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. 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.	**8**	**CO4**
UNIT V	**FAULT AND PROTECTION SCHEMES IN HVDC SYSTEMS**	**Hrs.**	**CO**
	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	**4**	**CO5**
UNIT VI	**MULTITERMINAL HVDC SYSTEMS**	**Hrs.**	**CO**
	Types of multiterminal (MTDC) systems, parallel operation aspect of MTDC. Control of power in MTDC. Multilevel DC systems. Power upgrading and conversion of AC lines into DC lines, Parallel AC/DC systems, FACTS and FACTS converters.	**6**	**CO6**

Text Books:

[T1]. EHV-AC ,HVDC Transmission & Distribution Engineering, S. Rao, Khanna Publication,ISBN 81-7409-043-6
[T2]. Power System Stability and Control by PrabhaKundur, McGraw hill,ISBN NO 978-0-07-0635159
[T3]. Power System Analysis: Operation and Control, AbhijitChakrabarti and SunitaHalder, PHI Learning Pvt. Ltd ISBN-10,8120327772

References:

[R1]. High Voltage Direct Current Transmission, J. Arrillaga, Peter Pregrinu ISBN-10.0852969414
[R2]. HVDC Power transmission system, K.R.Padiyar, Wiley Eastern Limited ISBN-13: 978-8122437850

E-References

[E1]. NPTEL :: Electrical Engineering - NOC:DC Power Transmission Systems https://archive.nptel.ac.in/courses/108/106/108106160/
[E2]. NPTEL HIGH VOLTAGE DC TRANSMISSION https://nptel.ac.in/courses/108104013

EE404C: DIGITAL SIGNAL PROCESSING

Teaching Scheme		**Examination Scheme**	
Lectures:	**04 Hrs./Week**	**Continuous Assessment:**	**20 Marks**
Practical:	**-- Hr/Week**	**In-Sem Exam:**	**30 Marks**
		End-Sem Exam:	**50 Marks**
Credits:	**04**	**Total:**	**100 Marks**

Prerequisite Course:

1. Knowledge of basic signals and systems

Course Objectives

1. To elaborate Sampling theorem
2. To classify discrete signals and systems
3. To analyze DT signals with Z transform, inverse Z transform and DTFT
4. To describe Frequency response of LTI system
5. To introduce Digital filters and analyze the response
6. To demonstrate DSP Applications in electrical engineering

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Identify various signals based of their characteristics and apply sampling theorem	2 3	Understanding Applying
CO2	Apply Z-transform and inverse Z transform on signals	3	Applying
CO3	Demonstrate various properties of Fourier Transform	3	Applying
CO4	Compute DFT and FFT	3	Applying
CO5	Apply various techniques of IIR filter design and its implementation	3	Applying
CO6	Apply various techniques of FIR filter design and its implementation	3	Applying

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO 1	PO 2	PO 3	PO4	PO5	PO 6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2	-	-	-	-	-	-	1	2	2
CO2	3	2	1	1	2	-	-	-	-	-	-	1	2	2
CO3	3	2	2	1	2	-	-	-	-	-	-	1	2	2
CO4	3	2	2	2	2	-	-	-	-	-	-	1	2	2
CO5	3	2	1	2	2	-	-	-	-	-	-	1	2	2
CO6	3	2	1	2	2	-	-	-	-	-	-	1	2	2

Course Contents

UNIT-I	**Classification of Signals:**	**Hrs.**	**COs**
	Analog, Discrete-time and Digital signals, Basic sequences and sequence operations, Discrete-time systems, Properties of D. T. Systems and Classification, Linear Time Invariant Systems, impulse response, linear convolution and its properties, properties of LTI systems: stability, causality, parallel and cascade connection, Linear constant coefficient difference equations, Periodic Sampling, Sampling Theorem, Frequency Domain representation of sampling, reconstruction of a band limited Signal, A to D conversion Process: Sampling, quantization and encoding.	**(06 Hrs)**	CO1
UNIT-II	**Z-transform, Inverse Z-transform and its properties:**	**Hrs.**	**CO**

	Unilateral Z-transform, Z transform properties: Linearity, time shifting, multiplication by exponential sequence, differentiation, conjugation, time reversal, convolution, initial value theorem, Inverse z transform by inspection, partial fraction, power series expansion and complex inversion, solution of difference equation	**(06 Hrs)**	CO2
UNIT-III	**Discrete Time Fourier Transform** :	**Hrs.**	**CO**
	Representation of Sequences by Fourier Transform, Symmetry properties of D. T., F. T. theorems: Linearity, time shifting, frequency shifting, time reversal, differentiation, convolution theorem, Frequency response analysis of first and second order system, steady state and transient response	**(06 Hrs)**	CO3
UNIT-IV	**Discrete Fourier Transform :**	**Hrs.**	**CO**
	Sampling theorem in frequency domain. The Discrete Fourier Transform, Relation with z transform Properties of DFT: Linearity, circular shift, duality, symmetry, Circular Convolution, Linear Convolution using DFT, Effective computation of DFT and FFT, DIT FFT, DIF FFT, Inverse DFT using FFT	**(06 Hrs)**	CO4
UNIT-V	**Frequency Response of LTI Systems:**	**Hrs.**	**CO**
	Ideal frequency selective filters, Concept of filtering, specifications of filter, IIR filter design from continuous time filters: Characteristics of Butterworth, and Cheybyshev low pass filter, impulse invariant and bilinear transformation techniques, Design examples, Basic structures for IIR Systems: direct form, cascade form	**(06 Hrs)**	CO5
UNIT-VI	**FIR filter design using windows:**	**Hrs.**	**CO**
	specifications of properties of commonly used windows, Design Examples using rectangular, and hanning windows. Basic Structures for FIR Systems: direct form. Comparison of IIR and FIR Filters Applications: Measurement of magnitude and phase of voltage, current, power, frequency and power factor correction, harmonic Analysis and measurement, applications to machine control, DSP based protective relaying.	**(06 Hrs)**	CO6

Text Books:

[T1]. Proakis J., Manolakis D., “Digital signal processing”, 3rd Edition, Prentice Hall, ISBN 81- 203-0720-8
[T2]. P. Ramesh Babu, “Digital Signal Processing”, 6th Edition Scitech Publication, isbn 818371630X
[T3]. Dr.S. D. Apte,”Digital Signal Processing”,2nd Edition Wiley India Pvt. Ltd ISBN: 978-81-265-2142-5
[T4]. W.Rebizant, J.Szafran, A.Wiszniewski, “Digital Signal Processing in Power system Protection and Control”, Springer 2011 ISBN 978-0-85729-801-0

References:

[R1]. Mitra S., “Digital Signal Processing: A Computer Based Approach”, Tata McGraw-Hill, 1998, ISBN 0-07-044705-5
[R2]. A.V. Oppenheim, R. W. Schafer, J. R. Buck, ”Discrete Time Signal Processing”, 2nd Edition Prentice Hall, ISBN 978-81-317-0492-9
[R3]. Steven W. Smith, “Digital Signal Processing: A Practical Guide for Engineers and Scientists”,1st Edition Elsevier, ISBN: 9780750674447

E-References

[E1]. Mikami, N., Kobayashi, M., and Yokoyama, Y. "A New DSP-Oriented Algorithm for Calculation of the Square Root Using a Nonlinear Digital Filter," *IEEE Trans. on Signal Processing*, Vol. 40, No. 7, July 1992.
[E2]. Heinen, P., and Neuvo, Y. "FIR-Median Hybrid Filters," *IEEE Trans. on Acoust. Speech, and Signal Proc.*, Vol. ASSP-35, No. 6, June 1987.
[E3]. Oppenheim, A., Schafer, R., and Stockham, T. "Nonlinear Filtering of Multiplied and Convolved Signals," *Proc. IEEE*, Vol. 56, August 1968.
[E4]. Pickerd, John. "Impulse-Response Testing Lets a Single Test Do the Work of Thousands," *EDN*, April 27, 1995

EE405A: POWER QUALITY

Teaching Scheme		Examination Scheme	
Lectures:	**03 Hrs./Week**	**Continuous Assessment:**	**20 Marks**
Tutorial:	**--- Hrs./Week**	**In-Sem Exam:**	**30 Marks**
		End-Sem Exam:	**50 Marks**
Credits:	**03**	**Total:**	**100 Marks**

Prerequisite Course:

1. Power Electronics, Power System Transients

Course Objectives

1. To describe the types of power quality problem.
2. To analyze the concepts and mitigation of voltages sags/swells.
3. To study the sources and effect of harmonics in power system.
4. To impart knowledge on various methods of power quality monitoring.
5. To understand the concept of flexible AC transmission and the associated problems
6. To understand the needs of custom power devices.

Course Outcomes (COs):

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

Course Outcome (s)		Bloom's Taxonomy	
		Level	**Descriptor**
CO1	Classify the various power quality events and international standards	02	Understand
CO2	Predict the voltage sag problems and suggest preventive techniques.	02	Understand
CO3	Discuss the various source of transient over voltages.	02	Understand
CO4	Classify the harmonic sources and the effects of harmonic distortion.	02	Understand
CO5	Describe modern data acquisition systems and processing methods for condition monitoring	02	Understand
CO6	Explain the basics in filter design to improve power quality.	02	Understand

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	1	2	-	-	-	-	-	3	2	3
CO2	2	3	3	2	2	2	-	-	-	-	-	3	2	3
CO3	2	3	3	2	2	2	-	-	-	-	-	3	2	3
CO4	3	3	3	2	2	2	-	-	-	-	-	3	2	3
CO5	2	3	3	3	3	2	-	-	-	-	-	3	2	3
CO6	3	2	2	2	2	2	-	-	-	-	-	3	2	3

Course Contents

UNIT-I	INTRODUCTION TO POWER QUALITY	Hrs.	COs
	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.	09	1
UNIT-II	**VOLTAGE SAGS AND INTERRUPTIONS**	**Hrs.**	**CO**
	Sources of sags and interruptions - estimating voltage sag performance-Area of Vulnerability, Equipment sensitivity to voltage sags, Transmission system sag performance evaluation, and Utility distribution system sag performance evaluation. Voltage sag due to induction motor starting - Estimation of the sag severity- Solution at the end user level.	09	2
UNIT-III	**OVERVOLTAGES**	**Hrs.**	**CO**
	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. An introduction to computer analysis tools for transients, PSCAD and EMTP.	09	3

UNIT-IV	HARMONICS	Hrs.	CO
	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 distortions - Harmonic indices - Inter harmonics –Harmonic distortion evaluation, IEEE and IEC standards.	09	4
UNIT-V	**POWER QUALITY MONITORING**	**Hrs.**	**CO**
	Monitoring considerations – Power quality measurement equipment - Harmonic / spectrum analyzer - Flicker meters - Disturbance analyzer - Smart power quality monitors - Applications of expert systems for power quality monitoring.	07	5
UNIT- VI	**PASSIVE AND ACTIVE POWER COMPENSATORS**	**Hrs.**	**CO**
	Passive Compensators: Types of passive filters, single tuned and high pass filters, filter design criteria, double tuned filters, damped filters and their design. Active Compensators: Compensation principle, classification of active filters by objective, system configuration, power circuit and control strategy.	05	6

Text Books:

[T1] Roger. C. Dugan, Mark. F. Mc Granagham, Surya Santoso, H.WayneBeaty, 'Electrical Power Systems Quality' McGraw Hill,2003, ISBN: 007138622X

[T2] J. Arrillaga, N.R. Watson, S. Chen, "Power System Quality Assessment",New York : Wiley,2000, ISBN: 978-8126531745

[T3] Bhim Singh, Ambrish Chandra, Kamal Al-Haddad," Power Quality Problems & Mitigation Techniques" Wiley, 2015, ISBN: 978-1118922057

References:

[R1] G.T. Heydt, 'Electric Power Quality', West Lafayette, IN, Stars in a Circle Publications, 2nd Edition 1994, ISBN: 9789993587149

[R2] M.H.J Bollen, 'Understanding Power Quality Problems: Voltage Sags and Interruptions', New York: IEEE Press, 1999, ISBN: 978-8126530397

[R3] Arindam Ghosh, Gerard Ledwich, "Power Quality Enhancement Using Custom Power Devices", Springer US, 2002, ISBN:978-1402071805

E-resources:

[E1] https://archive.nptel.ac.in/courses/108/102/108102179/ Power Quality

[E2] https://nptel.ac.in/courses/108107157 Power Quality Improvement Technique

EE405B: TRANSMISSION AAND DISTRIBUTION

Teaching Scheme		Examination Scheme	
Lectures:	**03 Hrs./Week**	**Continuous Assessment:**	**20 Marks**
Tutorial:	**--- Hr./Week**	**In-Sem Exam:**	**30 Marks**
		End-Sem Exam:	**50 Marks**
Credits:	**03**	**Total:**	**100 Marks**

Prerequisite Course:

1. Knowledge of semiconductor material, basic power electronics switches.
2. Electromagnetic field theory.

Objectives:

The course aims to impart the knowledge of the student in:

1. To understand the need of EHV and UHV systems.
2. To associate the knowledge of electro static field theory
3. To study the voltage distribution in insulator strings and cables.
4. To know methods of governance on the line conductor design, lin height and phase.
5. To study the expressions for the computation of transmission line parameters.
6. To select voltage control methods for extra high voltage AC transmission system.

Course Outcomes (COs):

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

Course Outcome (s)		Bloom's Taxonomy	
		Level	**Descriptor**
CO1	Interpret the basic concepts of EHV and UHV Systems.	2	Understand
CO2	Explain the knowledge of electro static field theory in transmission lines	2	Understand
CO3	Understand the voltage distribution of EHV lines in insulator strings and cables	2	Understand
CO4	Apply the mathematical approach to discuss the effect of corona while designing the EHV lines along with consideration of environmental pollution.	3	Apply
CO5	Illustrate the equivalent circuits for the transmission lines	2	Understand
CO6	Summarize the operation of the different distribution schemes.	2	Understand

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2	2	2	-	-	-	2	1	-	-	2	-
CO2	3	3	3	3	2	-	-	-	1	1	-	-	2	-
CO3	2	3	3	2	2	-	-	-	-	1	-	-	2	-
CO4	2	1	3	2	3	-	-	-	1	1	-	1	3	-
CO5	2	3	3	3	3	-	-	-	1	1	-	1	3	-
CO6	2	2	3	2	3	-	-	-	-	1	-	1	3	-

Course Contents			
UNIT-I	**TRANSMISSION LINE TRENDS AND PRELIMINARIES**	**Hrs.**	**COs**
	Structure of electric power system: generation, transmission and distribution; Types of AC and DC distributors – distributed and concentrated loads – interconnection – EHVAC and HVDC transmission - Introduction to FACTS	06	CO1
UNIT-II	**ELECTRO STATIC FIELD**	**Hrs.**	**CO**
	Electrostatic field: calculation of electrostatic field of EHV/AC lines – Effect on humans, animals and plants – Electrostatic induction in un-energized circuit of double circuit line - Electromagnetic interference.	03	CO4
UNIT-III	**EHV INSULATORS AND CABLES**	**Hrs.**	**CO**
	Insulators - Types, voltage distribution in insulator string, improvement of string efficiency, testing of insulators. Underground cables - Types of cables, Capacitance of Single-core cable, Grading of cables, Power factor and heating of cables, Capacitance of 3- core belted cable.	09	CO2
UNIT-IV	**MECHANICAL DESIGN OF LINES AND GROUNDING**	**Hrs.**	**CO**

	Mechanical design of transmission line – Sag and tension calculations for different weather conditions, Tower spotting, Types of towers, Substation Layout (AIS, GIS), Methods of grounding.	09	CO3
UNIT-V	**TRANSMISSION LINE PARAMETERS**	**Hrs.**	**CO**
	Introduction to transmission line parameters - Resistance of a Transmission Line - Inductance of a transmission Line - Inductance of a 3-Phase Overhead Line - Symmetrical and unsymmetrical spacing and transposition - Capacitance of single and double transmission lines - Application of self and mutual GMD - Skin and proximity effects - corona - Factors Affecting Corona.	09	CO5
UNIT-VI	**MODELLING OF TRANSMISSION LINES**	**Hrs.**	**CO**
	Classification of lines - Short line, medium line and long line - equivalent circuits, phasor diagram, transmission efficiency and voltage regulation, real and reactive power flow in transmission lines, methods of voltage control.	09	CO6

Text Books:

[T1]. Rakesh Das Begamudre, "Extra High Voltage AC Transmission Engineering", Fourth Edition, New Age International publishers, 2014, ISBN 978-81-224-2481-2

[T2]. Allen J Wood & Bruce Wollenberg, "Power Generation Operation & Control, Third Edition, 2016, ISBN 978-0-471-79055-6

[T3]. B.R.Gupta, “Power System Analysis and Design”, Fourth Edition, Chand, 2005, 8121922380

References:

[R1]. Turan Gonen, "Electric Power Transmission System Engineering Analysis and Design", CRC Press, Third Edition, 2014

[R2]. Md. Abdus Salam, Quazi M. Rahman "Power Systems Grounding" Springer publishers, 2018, ISBN 981109165X

[R3]. A Chakraborti, D.P. Kothari and A.K. Mukhopadyay: Performance, Operation and Control of EHV Power Transmission Systems, T.M.H. (Pub) 1999, ISBN 9788185814704

EE405C: INTELLIGENT SYSTEMS WITH AI AND ML

Teaching Scheme		**Examination Scheme**	
Lectures:	**03 Hrs./Week**	**Continuous Assessment:**	**20 Marks**
Tutorial:	**--- Hr/Week**	**In-Sem Exam:**	**30 Marks**
		End-Sem Exam:	**50 Marks**
Credits:	**03**	**Total:**	**100 Marks**

Prerequisite Course:

1. Programming languages, Probability.

Course Objectives

1. To locate soft commanding methodologies, such as artificial neural networks, Fuzzy logic and genetic Algorithms.
2. To observe the concepts of feed forward neural networks and about feedback neural networks.
3. To practice the concept of fuzziness involved in various systems and comprehensive knowledge of fuzzy logic control and to design the fuzzy control.
4. To analyze genetic algorithm, genetic operations and genetic mutations.

Course Outcomes (COs):

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

	Course Outcome (s)	**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Express a good understanding of fundamental principles of machine learning.	2	Understand
CO2	Prepare a model using supervised/unsupervised machine learning algorithms for classification/prediction/clustering.	3	Apply
CO3	Discuss foundation principles, mathematical tools and program paradigms of AI.	2	Understand
CO4	Analyze fuzziness involved in various systems and fuzzy set theory.	4	Analyze
CO5	Apply fuzzy logic control for solution of various optimization problems	3	Apply
CO6	Demonstrate application of AI techniques in solving electrical engineering problems.	3	Apply

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	1	3	-	-	-	2	1	-	-	1	-
CO2	3	2	2	1	2	-	-	-	-	1	-	-	1	-
CO3	3	2	3	3	2	-	-	-	-	1	-	-	1	-
CO4	3	3	3	3	2	-	-	-	1	1	-	1	2	-
CO5	3	3	3	3	2	-	-	-	1	1	-	1	1	-
CO6	3	3	3	3	2	-	-	-	-	1	-	1	1	-

Course Contents

UNIT-I	**Foundations of AI & ML**	**Hrs.**	**CO**
	Python for AI & ML - Basics, Jupyter Notebook, functions, packages, libraries, data structures, arrays, vectors, and data frames. Applied Statistics - Descriptive statistics, inferential statistics, probability, and hypothesis testing.	07	**CO1**
UNIT-II	**Machine Learning**	**Hrs.**	**CO**
	Supervised Learning - Regression, classification, and support vector machines Unsupervised Learning - Clustering and Dimensionality Reduction Ensemble Techniques - Decision trees, random forests, bagging, and boosting Featurization, Model Selection & Tuning - Feature engineering, model selection and tuning, model performance measures, and ways of regularization.	08	**CO2**
UNIT-III	**Artificial Intelligence**	**Hrs.**	**CO**
	Introduction to Neural Networks and Deep Learning - Gradient Descent, Perceptron, Batch Normalization, Activation and Loss Functions, hyperparameter tuning, Tensor Flow, and Keras. Computer Vision - Convolutional Neural Networks (CNN), transfer learning, object detection, and segmentation	08	**CO3**
UNIT-IV	**Fuzzy Logic**	**Hrs.**	**CO**
	Introduction – Fuzzy versus crisp – Fuzzy sets – Membership function – Basic Fuzzy set operations – Properties of Fuzzy sets – Fuzzy cartesian Product – Operations on Fuzzy relations – Fuzzy logic – Fuzzy Quantifiers – Fuzzy Inference – Fuzzy Rule based system – Defuzzification methods.	07	**CO4**
UNIT-V	**Genetic Algorithms**	**Hrs.**	**CO**
	Introduction-Encoding – Fitness Function-Reproduction operators – Genetic Modeling – Genetic operators – Crossover – Single–site crossover – Two-point crossover – Multi point crossover-Uniform crossover – Matrix crossover – Crossover Rate – Inversion & Deletion – Mutation operator –Mutation – Mutation Rate-Bit-wise operators – Generational cycle-convergence of Genetic Algorithm.	08	**CO5**
UNIT-VI	**Applications of AI Techniques:**	**Hrs.**	**CO**
	Load forecasting – Load flow studies – Economic load dispatch – Load frequency control – Single area system and two area system – Small Signal Stability (Dynamic stability) Reactive power control – speed control of DC and AC Motors.	07	**CO6**

Text Books:

[T1] Stuart J. Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall 2010. ISBN-13: 978-0-13-604259-4

[T2] Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press 2020. ISBN-13:978-1108455145

[T3] S. Rajasekaran and G.A.V. Pai Neural Networks, Fuzzy Logic and Genetic Algorithms, PHI, New Delhi, 2003. ISBN-9788120321861

References:

[R1] Rober J. Schalkoff, Artificial Neural Networks, Tata McGraw Hill Edition, 2011. ISBN-9780070571181

[R2] Artificial Intelligence and Intelligent Systems, OXFORD University Press, New Delhi, 2005- N. P. Padhy. ISBN-9780195671544

E-resources:

[E1] NPTEL course: course Name: An Introduction to Artificial Intelligence, Course Link: https://nptel.ac.in/courses/106102220

EE406: SWITCHGEAR AND PROTECTION LABORATORY

Teaching Scheme		**Examination Scheme**	
Practical:	**02 Hrs./Week**	**Oral:**	**50 Marks**
Credits:	**01**	**Total:**	**50 Marks**

Prerequisite Course:
1. Power system

Course Objectives

1. To introduce the characteristics and functions of relays and protection schemes.
2. To impart knowledge on apparatus protection
3. To introduce static and numerical relays
4. To impart knowledge on functioning of circuit breakers

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Test the operation of various protective devices used in power system	3	Apply
CO2	Evaluate the operating characteristics of relays and circuit breaker	4	Analyze
CO3	Test the various protection schemes employed for generator protection	4	Analyze

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	-		-	-	-	3	3	1	2	2	2
CO2	2	2	1	2	2	-	-	-	3	3	1	2	2	2
CO3	2	2	1	2	2	-	-	-	3	3	1	2	2	2

Course Contents

Ex. No	**Name of Experiment**	**Hrs.**	**COs**
1	Testing of Fuse, MCB and MCCB	2	1
2	Performance characteristics of IDMT type Induction over current relay	2	2
3	Performance characteristics of gas actuated buchholz relay for oil filled transformer using Virtual Lab	2	2
4	Performance Characteristics of digital over current relay	2	2
5	Performance Characteristics of Air Circuit Breaker	2	2
6	Performance characteristics of over current relay in Generator Protection Simulator	2	3
7	Performance characteristics of Differential Current Relay in Generator Protection Simulator	2	3
8	Performance characteristics of Over Voltage Relay in Generator Protection Simulator	2	3
9	Performance characteristics of Under Voltage Relay Protection Scheme in Generator Protection Simulator	2	3
10	Performance characteristics of Over/Under Frequency Relay in Generator Protection Simulator	2	3
11	Performance characteristics of Reverse Power Relay in Generator Protection Simulator	2	3

Text Books:

[T1]. Sunil S.Rao, "Switchgear and Protection", Khanna Publishers, New Delhi, 14th Edition, 2021, ISBN: 978-9387394728

[T2]. M.L.Soni, P.V.Gupta, U.S.Bhatnagar, A.Chakrabarti, "A Text Book on Power System Engineering", Dhanpat Rai & Co.,Jan 2016, ISBN : 9788177000207
[T3]. Stanley H. Horowitz, Arun G. Phadke , Power System Relaying, John Wiley, 2014, ISBN: 978-0-470-75878-6

References:

[R1] Badri Ram, D. N. Vishwakarma, "Power System Protection and Switchgear" Tata McGraw Hill Publishing Co. Ltd., 3rd edition, 2022, ISBN: 978-9355322852
[R2] H Lee Blackburn , "Protective Relaying- Principles and Applications", Dekker Publications, 3rd edition, 2007, ISBN: 978-0-9568678-0-3
[R3] Mason C.R., "Art and Science of Protective Relaying", Wiley Eastern Limited, 1996, ISBN: 978-0471575528

E-References

[E1] Power System Protection and Switchgear (IIT Roorkee) https://archive.nptel.ac.in/courses/108/107/108107167/

EE407: CONTROL SYSTEM DESIGN LABORATORY

Teaching Scheme		**Examination Scheme**	
Practical:	**02 Hrs./Week**	**Oral:**	**50 Marks**
Credits:	**01**	**Total:**	**50 Marks**

Prerequisite Course:
1. Control System Engineering
2. MATLAB Programming

Course Objectives

1. Make students identify various characteristics of nonlinear systems.
2. Develop skills for analysing nonlinear systems.
3. Make students study features and configurations of digital control systems.
4. Understand the practical controllers and compensators

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Apply sampling theorem and analyse peculiar non-linearities.	3 4	Applying Analysing
CO2	Apply concepts of state space approach for system design.	3	Applying
CO3	Apply PID controller and various compensators using hardware and software.	3	Applying

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	-	-	-	-	-	-	2	2	2
CO2	3	3	3	3	3	-	-	-	-	-	-	2	2	2
CO3	3	3	3	3	3	-	-	-	-	-	-	2	2	2

Course Contents

Any 8 of the following experiments are to be conducted.

Ex. No	**Name of Experiment**	**Hrs.**	**COs**
1	Demonstration of characteristics of peculiar nonlinearities using software.	02	CO1
2	Demonstration of effect of sampling and verification of sampling theorem.		**CO1**
3	Software programming for determination of state space representation for given transfer function and vice-versa.	02	**CO2**
4	Calculation of state transition matrix, state X (t), Eigen values using MATLAB.	02	**CO2**
5	Test observability and controllability of the system	02	**CO2**
6	Demonstrate digital closed loop position control DC servomotor using optical encoder feedback.	02	**CO3**
7	Transformation of a continuous time system into digital control system and check response using software.	02	**CO3**
8	Evaluate closed loop performance of the control setup for different P, PI, PID controller settings.	02	**CO3**

9	Demonstrate PID simulator on Second order system.	02	**CO3**
10	Demonstrate performance characteristics of different compensators for given system using experimental kit and software.	02	**CO3**

Text Books:

[T1]. Norman S. Nise, Control System Engineering, 8th Edition, John Wily and Sons, Inc. 2018 ISBN 8126571837.
[T2]. Richard C. Dorf, Robert H. Bishop, Modern Control Systems, 13th Edition, Pearson Ed, ISBN 9780134407623.
[T3]. Benjamin C. Kuo, Digital Control System, Second Edition, Oxford University Press, 2007, ISBN 0195686209
[T4]. I. J. Nagarath, M. Gopal, Control System Engineering, 7th Edition, New Age International (P) Limited, Publishers, 2021, ISBN 8195175589
[T5]. A. Nagoor Kani, Advanced Control Theory, Third Edition, CBS Publishers and Distributes,2020, ISBN 9389396298

References:

[R1] M. Gopal, "Control Systems: Principles and Design", McGraw Hill Education ISBN 9780071333269
[R2] B. C. Kuo, "Automatic Control System", Prentice Hall, 2014, ISBN 9788126552337

E-Resources:

[E1] Control Engineering, IIT Delhi by Prof. M. Gopal (https://nptel.ac.in/courses/108102043)
[E2] NOC:Nonlinear and Adaptive Control, IIT Delhi by Prof. Shubhendu Bhasin (https://nptel.ac.in/courses/108102113)

EE416: HIGH VOLTAGE ENGINEERING LAB

Teaching Scheme		**Examination Scheme**	
Practical:	**02 Hrs./Week**	**Practical:**	**50 Marks**
Credits:	**01**	**Total:**	**50 Marks**

Prerequisite Course: Atomic and molecular structure of gaseous and solid materials, basic properties of conductors and insulators, knowledge of Electrical Engineering Materials.

Course Objectives

1. To enable students to know and compare the various processes of breakdown in solid, liquid and gaseous dielectric materials ·
2. To enable students understand and apply various methods of generation and measurement of DC, AC, impulse voltage and current.
3. To enable students to know the charge formation and separation phenomenon in clouds, causes of overvoltage and lightening phenomenon ·
4. To develop ability among learners to execute testing on various high voltage equipments as per standards ·
5. To introduce students to the design, layout, safety precautions, earthing, and shielding of HV laboratory.

Course Outcomes (COs):

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

	Course Outcome (s)	**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Test the operation of various protective devices used in insulating materials.	3	Applying
CO2	Evaluate the operating characteristics of relays and circuit breaker	3	Applying
CO3	Test the various protection schemes employed for generator protection	3	Applying

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	-		-	-	-	3	3	1	2	1	2
CO2	2	2	1	2	2	-	-	-	3	3	1	2	1	2
CO3	2	2	1	2	2	-	-	-	3	3	1	2	1	2

Course Contents

Ex. No	Name of Experiment	Hrs.	COs
1	To find the constants of breakdown equation of transformer oil.(Analytical and graphical method)	02	01
2	Measurement of unknown high a.c. voltage using sphere gap	02	01
3	To obtain breakdown strength of composite insulation system, and observe the effect of parameter like no. of layers, thickness of layer, effect of interfacing.	02	02
4	To find out the breakdown of air in uniform and non uniform field and compare it.	02	02
5	To study surface flashover on corrugated porcelain/polymeric insulation system.	02	03
6	To understand basic principle of corona and obtain audible and visible corona inception and extinction voltage under non uniform field.	02	03
7	To perform experiment on horn gap arrestor and understand arc quenching phenomenon.	02	04
8	To observe development of tracks and trees on polymeric insulation system.	02	04
9	Parametric analysis of Impulse current generator using virtual Laboratory.	02	04

10	10. To perform experiment on rod gap arrestor.	02	05
11	To Study effect of barrier on breakdown voltage of air/ transformer oil.	02	05
12.	Simulation of lightening and switching impulse voltage generator using any simulation software.	02	05
13.	To perform various HV insulation tests on cables as per IS.	02	06
14.	Study of layout /earthing/safety of HV installation /lab in any industry by visit /virtual lab	02	06
15.	Study of any IS for any power apparatus (Power Transformer/Induction Motor/ Alternator etc)	02	06

Text Books:

[T1] M. S. Naidu, V. Kamaraju, "High Voltage Engineering", Tata McGraw Hill Publication Co. Ltd. New Delhi, ISBN 0-07-462286-2

[T2] C. L. Wadhwa, "High Voltage Engineering", New Age International Publishers Ltd, ISBN 10: 8122418597 ISBN 13: 9788122418590

References:

[R1] E. Kuffel, W. S. Zaengl, J. Kuffel, "High Voltage Engineering Fundamentals", Newnes Publication, ***ISBN*** 0 7506 3634 3

[R2] Prof. D. V. Razevig Translated from Russian by Dr. M. P. Chourasia, "High Voltage Engineering", Khanna Publishers, New Delhi, ISBN: 978 - 0 - 620 – 3767-7.

[R3] Ravindra Arora, Wolf Gang Mosch, "High Voltage Insulation Engineering", New Age International ISBN 13- 978-8122406191

[R4] High Voltage Engineering Theory and Practice by M. Khalifa Marcel Dekker Inc. New York, ***ISBN*** 10 0824781287

[R5] Subir Ray, "An Introduction to High voltage Engineering" PHI Pvt. Ltd. New Delhi, ***ISBN***, 8120347404

[R6] IS 731-1971:Porcelain insulator for overhead power lines with nominal voltage > 1000 Volt, ***ISBN-13: 978-0824748098***

[R7] Bushings :IS2099-1986,specification for bushings for A.C. Voltages > 1000 Volts, ***ISBN***-13: 978-0824748098

[R8] Pollution test :IEC 60507-1991 on external and internal insulator, ***ISBN***-10: 0824748093

[R9] High voltage test techniques, general definitions and test requirements: IS 2071(part 1) 1993,IEC Pub 60-1(1989), ISBN 60060-1:2010.

EE409: PROJECT STAGE I

Teaching Scheme		Examination Scheme	
Practical:	**06 Hrs./Week**	**Oral:**	**50 Marks**
		Term Work:	**100 Marks**
Credits:	**03**	**Total:**	**150 Marks**

Prerequisite Course: Mini Project, Seminar

Course Objectives

1. To offer an opportunity to demonstrate their competence in laboratory work.
2. To integrate the knowledge gained in courses studied.
3. To allow the exercise maturity, initiative and creative ability.
4. To apply communication skills, both oral and written, to communicate results, concepts and ideas.
5. To solve problems of a non-routine nature.

Course Outcomes (COs):

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

Course Outcome (s)		Bloom's Taxonomy	
		Level	**Descriptor**
CO1	Ability to plan and implement an investigative or developmental project given general objectives and guidelines.	2	Understanding
CO2	In-depth skill to use some laboratory, modern tools and techniques.	3	Applying
CO3	Ability to analyze data to produce useful information and to draw conclusions by systematic deduction.	4	Analyzing
CO4	Facilitate significant individualized interactions between faculty members and students through a multi-term research experience.	5	Evaluate
CO5	Ability to communicate results, concepts, analyses and ideas in written and oral form.	5	Evaluate
CO6	Conduct an extended independent investigation that results in the production of a research thesis.	6	Create

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO2	2	1	1	1	1	1	1	1	1	2	1	1	1	1	2	1
CO3	2	2	1	2	2	1	1	1	1	2	1	1	1	1	2	1
CO4	2	2	1	2	2	1	1	1	1	2	1	1	1	1	2	1
CO5	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO6	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Course Contents

A. Guidelines for Students:

1. To identify the problems in industry and society.
2. Perform Literature survey on the specific chosen topic through research papers, Journals, books etc. and market survey if required.
3. To narrow down the area taking into consideration his/her strength and interest. The nature of project can be analytical, simulation, experimentation, design and validation.
4. Define problem, objectives, scope and its outcomes.
5. Design scheme of implementation of project.
6. Data collection, simulation, design, hardware if any, needs to be completed.
7. Presentation based on partially completed work.
8. Submission of report based on the work carried out.
9. Student should maintain Project Work Book.

B. Domains for Seminar / Mini Project may be from the following, but not limited to:

- Power Systems
- Power/Smart Grid
- Electric automobile
- Computer/Communication Networking

· IOT · AI in Electrical Engineering · Microcontroller based/Embedded systems · Power electronics and drives · High Voltage Engineering · Agriculture Engineering · Battery Technology's · Robotics/Mechatronics/Process Automation · Energy efficiency technique · Green / Clean energy
The student shall take up a project in the field closely related to Electrical Engineering. Preferably, group of 3/4 students should be formed for project work. The project work should be based on the knowledge acquired by the student during the graduation and preferably it should meet and contribute towards the needs of the society. The project aims to provide an opportunity of designing and building complete system or subsystems based on area where the student likes to acquire specialized skills. Project work in this semester is an integral part of the complete project. In this, the student shall complete the partial work of the project which will consists of problem statement, literature review, project overview and scheme of implementation. As a part of the progress report of project work, the candidate shall deliver a presentation on the advancement in Technology pertaining to the selected project topic.

MC410A: FINANCIAL SMART

Teaching Scheme		**Examination Scheme**	
Lectures:	**01 Hrs./Week**	**End-Sem Exam:**	**NA**
Credits:	**Non-Credit**	**Total:**	**PASS / FAIL**

Prerequisite Course:

Course Objectives:

1. Personal Financial Literacy Program for Young Adults - Being Financially Smart

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Adapt psychology of money and financial management in daily life	3	Adapt
CO2	Set financial goals and plan accordingly	2	Set
CO3	Manage the risk involved in personal and business finance and investment	2	Understand

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	3	-	3	2	-	3	2	-	-
CO2	-	-	-	-	-	3	-	3	2	-	3	2	-	-
CO3	-	-	-	-	-	3	-	3	2	-	3	2	-	-

Course Contents

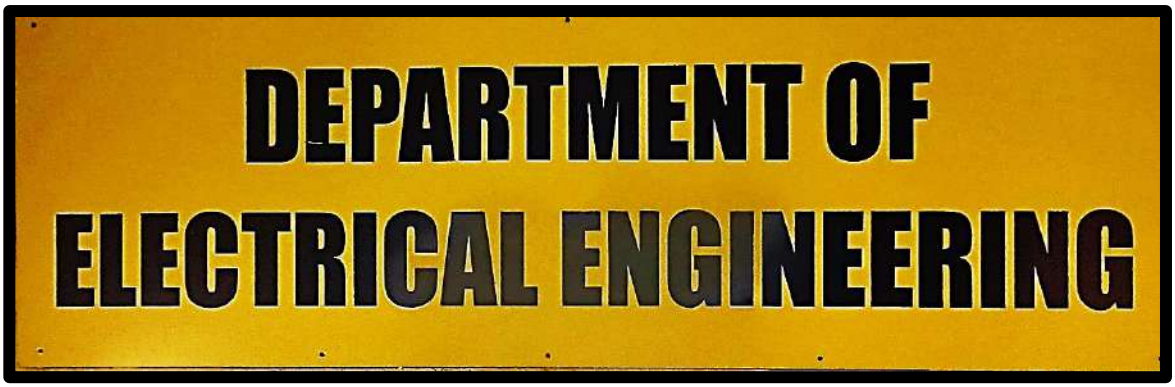
UNIT I	**Behavioural Finance**	**Hrs.**	**COs**
	Section 1 – Let's Talk Money 1. Psychology of Money 2. Your Relationship with Money 3. Human Behaviour in Financial Markets Section 2 –Why Financial Literacy? 1. Importance of Financial Literacy 2. Costly Money Mistakes	3	CO1
UNIT II	**Money Management Skills**	**Hrs.**	**COs**
	Section 1 – Important Concepts 1. Saving vs Investing 2. Inflation 3. Power of Compounding Section 2 – Money Management Techniques 1. S.M.A.R.T.E.R way to Wealth 2. Money Jar Method	3	CO1
	Micro-Project 1 - Exercise		
UNIT III	**Steps of Financial Planning**	**Hrs.**	**Cos**
	Section 1 – Let's Start Planning 1. Need & Components of Financial Planning 2. Personal Income Statement– Cashflow Mgt & NetWorth Mgt. 3. S.M.A.R.T Goal Setting Section 2 - Goal Based Investment Planning 1. Contingency/Emergency Fund Planning 2. Lifestyle/ Retirement Planning 3. Estate Planning	3	CO2
UNIT IV	**Risk & Investment Management**	**Hrs.**	**Cos**
	Section 1 - Risk Management 1.Understanding Risk Management 2. Life Insurance 3. Health Insurance Section 2 - Investment Management 1. Asset Allocation 2. Mutual Funds - Overview	3	CO3

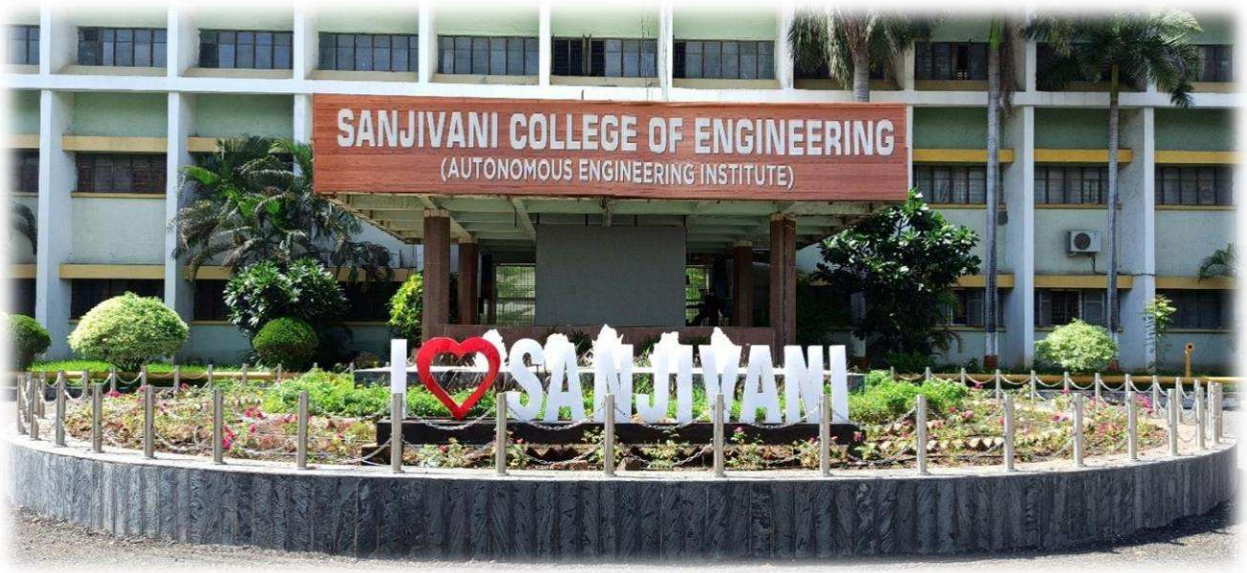
	3. Review & Action		
Micro-Project 2 - Case Study			
UNIT V	**Introduction to Business Finance**	**Hrs.**	**Cos**
	1. H ow to Read an Income Statement 2. How to Read a Balance Sheet	3	CO3
Post -session: - 1. Evaluation 2. Feedback 3. Certification			
Text Books:			
[T1] Industrial Engineering and Management, O.P. Khanna, Dhanpat Rai and Sons, New Delhi, ISBN 10138 [T2] Basic Managerial Skill for All,E. H. McGrah, 52101 [T3] Management of Technology , Tarek Khalil, Tata Mc Graw Hill Publication Pvt. Ltd., 54543 [T4] Prabuddha Ganguli Intellectual Property Rights, Prabuddha Ganguli , TATA McGraw-Hill Publishing Company, [T5] Management Accounting and Financial management,"M. Y. Khan and P. K. jain, Mcgraw Hill			
References:			
[R1] Personnel Management, C. B. Mamoria and V.S.P.Rao,,Himalaya Publishing House, 60852 [R2] Marketing Management, Philip Kotler, Pearson Edition 2008 , 15265 [R3] Financial Management by “I M Pandey”, I M Pandey, Vikas Publishing House Pvt. Ltd., Delhi Philip Kotler-Marketing Management 45416 [R4] Total Quality Management, Kelly John M, InfoTech Standard, Delhi. [R5] The Law of Intellectual Property Rights, Shiv Sahai Singh			

SANJIVANI RURAL EDUCATION SOCIETY'S

SANJIVANI COLLEGE OF ENGINEERING KOPARGAON

(An Autonomous Institute Affiliated to Savitribai Phule Pune University, Pune)





DEPARTMENT OF ELECTRICAL ENGINEERING

COURSE STRUCTURE - 2020 PATTERN

FINAL YEAR B. TECH

Academic Year 2023-24

SANJIVANI RURAL EDUCATION SOCIETY'S

SANJIVANI COLLEGE OF ENGINEERING KOPARGAON

(An Autonomous Institute Affiliated to Savitribai Phule Pune University, Pune)

DEPARTMENT OF ELECTRICAL ENGINEERING

Profile: The Electrical Engineering degree program offer the graduates to enter a dynamic and rapidly changing field with career opportunities in Electric Power System, Power Electronics, Robotics and Control, Microprocessors and Controllers, Integrated Circuits, Computer Software. The demand for electrical power and electronic systems is increasing rapidly and electrical engineers are in great demand to meet the requirements of the growing industry. Electrical Engineers are mainly employed in industries using Electrical Power, Manufacturing Electrical Equipment, Accessories, Electronic Systems, Research and Development departments which work on energy saving devices and Software Development.

Many of these disciplines overlap with other engineering branches, spanning a huge number of specializations including hardware engineering, electromagnetic and waves, microwave engineering, nanotechnology, electrochemistry, renewable energies, Artificial Intelligence, mechatronics, and electrical materials science. Identifying these areas today's Electrical Engineer needs to have the capacity of adaptability and creativity in these new technical eras, to meet the industry 4.0.

Electrical Engineering Department of Sanjivani College of Engineering offers the B. Tech. course in Electrical Engineering with an intake of 60 students. The department has well qualified and dedicated faculty and is known for its high academic standards, well-maintained discipline, and complete infrastructure facilities.

Vision of Department

To produce quality electrical engineers with the knowledge of latest trends, research technologies to meet the developing needs of industry & society

Mission of Department

M1: To impart quality education through teaching learning process

M2: To establish well-equipped laboratories to develop R&D culture in contemporary and sustainable technologies in Electrical Engineering

M3: To produce Electrical Engineering graduates with quest for excellence, enthusiasm for continuous learning, ethical behavior, integrity and nurture leadership

Program Outcomes (POs):

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, society, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning in formed by the contextual knowledge to assess social, health, safety, legal and cultural issues, and the consequent responsibilities relevant to the professional engineering practice
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply the set of one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Educational Objectives (PEOs)

The PEOs of undergraduate programme in Electrical Engineering are broadly classified as follows:

PEO 1: Equip the student to analyze and solve real world problems to face the challenges of future.

PEO 2: Pursue higher education, research in Electrical Engineering or other allied fields of their interest for professional development.

PEO 3: Exhibit the leadership skills and ethical value for society

Program Specific Objectives (PSOs)

PSO 1: Apply the fundamentals of mathematics, science and engineering knowledge to identify, formulate, design and investigate complex engineering problems of electric circuits, analog and digital electronics circuits, control systems, electrical machines and Power system.

PSO 2: Apply the appropriate modern engineering hardware, and software tools in electrical engineering to engage in life-long learning and to successfully adapt in multi-disciplinary environments.

COURSE STRUCTURE- 2020 PATTERN
FINAL YEAR B. TECH. ELECTRICAL ENGINEERING

SEMESTER-VII

Course			Teaching Scheme Hours/week				Evaluation Scheme-Marks						
							Theory						
Cat.	Code	Title	L	T	P	Credits	ISE	ESE	CA	OR	PR	TW	Total
PCC	**EE401**	Switch Gear and Protection	3	-	-	3	30	50	20	-	-	-	100
PCC	**EE402**	Control System Design	3	-	-	3	30	50	20	-	-	-	100
PCC	**EE403**	High Voltage Engineering	3	-	-	3	30	50	20	-	-	-	100
PEC	**EE404**	Professional Elective-III **A.** Electric and Hybrid Vehicle **B.** HVDC Transmission Systems **C.** Digital Signal Processing	4	-	-	4	30	50	20	-	-	-	100
PEC	**EE405**	Professional Elective-IV **A.** Power Quality **B.** Transmission and Distribution **C.** Intelligent Systems with AI and ML	3	-	-	3	30	50	20	-	-	-	100
LC	**EE406**	Switch Gear and Protection Laboratory	-	-	2	1	-	-	-	50	-	-	50
LC	**EE407**	Control System Design Laboratory	-	-	2	1	-	-	-	50	-	-	50
LC	**EE408**	High Voltage Engineering Laboratory	-	-	2	1	-	-	-	-	50	-	50
PROJ	**EE409**	Project Stage I	-	-	6	3	-	-	-	50	-	100	150
MLC	**MC410**	Mandatory Learning Course-VII **A.** Financially Smart	1	-	-	Non Credit	-	-	-	-	-	-	Pass/ Fail
		Total	**17**	**-**	**12**	**22**	**150**	**250**	**100**	**150**	**50**	**100**	**800**

COURSE STRUCTURE- 2020 PATTERN
FINAL YEAR B. TECH. ELECTRICAL ENGINEERING

SEMESTER-VIII

Course			Teaching Scheme Hours/week				Evaluation Scheme-Marks					
Cat.	Code	Title	L	T	P	Credits	Theory		OR	PR	TW	Total
							ISE	ESE				
OEC	EE411	Open Elective I (NPTEL) A. Sensors and Actuators B. Circuit Analysis for Analog Designers C. Industrial Automation and Control D. Problem Solving through programming in C	3	-	-	3	25	75	-	-	-	100
OEC	EE412	Open Elective-II (NPTEL) A. Fundamentals of Semiconductor Devices B. Computer-Aided Design of Electrical Machines C. Introduction To Industry 4.0 And Industrial Internet of Things D. Embedded Sensing, Actuation and Interfacing Systems	3	-	-	3	25	75	-	-	-	100
OEC	EE413	Open Elective III (NPTEL) A. EV - Vehicle Dynamics and Electric Motor Drives B. FACTs Devices C. Power Quality Improvement Technique D. Data Science for Engineers	2	-	-	2	25	75	-	-	-	100
PROJ	EE414	Internship	-	-	12	6	-	-	50	-	100	150
PROJ	EE415	Project Stage-II	-	-	4	2	-	-	50	-	-	50
		Total	**9**	**-**	**16**	**16**	**150**	**150**	**100**	**-**	**100**	**500**

SEMESTER VIII

EE411A: Sensors and Actuators

Teaching Scheme	**Examination Scheme**	
Lectures: NA	**NPTEL Assignment:**	**25 Marks**
	NPTEL Exam:	**75 Marks**
Credits: 3	**Total:**	**100 Marks**

Prerequisite Course:

1. Basic Electronics

Course Objectives

1. Understand basics of sensors, actuators and their operating principle.
2. Educate the students on different types of microfabrication techniques for designing and developing sensors
3. Explain working of various types of electrochemical sensors and actuators. Fourth objective is to provide information about interfacing of sensors and signal conditioning circuits to establish any control system or monitoring system.
4. Provide information about interfacing of sensors and signal conditioning circuits to establish any control system or monitoring system.
5. Provide knowledge about simulation and characterization of different sensors.
6. Provide an understanding on characteristic parameters to evaluate sensor performance.

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Illustrate sensors and Actuators	2	Understand
CO2	Demonstrate types of fabrication techniques	2	Understand
CO3	Classify various types of sensors	2	Understand
CO4	Interpret fabrication process and to comprehend actuators	3	Apply
CO5	Identify design and optimisation techniques	2	Understand
CO6	Explain interfacing methods	2	Understand

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	-	-	-	-	-	-	1	2	1
CO2	3	2	2	1	-	-	-	-	-	-	-	1	2	-
CO3	3	2	2	-	-	-	-	-	-	-	-	1	2	1
CO4	3	2	2	-	-	-	-	-	-	-	-	1	2	-
CO5	3	2	2	1	-	-	-	-	-	-	-	1	2	1
CO6	3	2	2	1	-	-	-	-	-	-	-	1	2	-

Course Contents			
UNIT-I	**Introduction to Sensors and Actuators**	**Hrs.**	**COs**
	Basics of Energy Transformation: Transducers, Sensors and Actuators, Understanding of thin film physics: Application in MOSFET and its variants.	6	CO1
UNIT-II	**Fabrication Techniques**	**Hrs.**	**CO**
	Thin Film Deposition Techniques: Chemical Vapor Deposition (APCVD, LPCVD, UHVCVD, PECVD, ALCVD, HPCVD, MOCVD). Thin Film Deposition Techniques: Physical Vapor Deposition (Thermal Deposition, E-beam Evaporation, Sputtering, Pulsed Laser Deposition)	7	CO2
UNIT-III	**Sensors**	**Hrs.**	**CO**
	Basics understanding of Photolithography for pattering layer. Detailed overview of Etching methods. Understanding various gas sensors: Optical gas sensor, Metal oxide semiconductor gas sensor, Field effect transistor gas sensor, Piezoelectric gas sensor, Polymer gas sensor, Nano-structured based gas sensors	10	CO3
UNIT-IV	**Design and fabrication**	**Hrs.**	**CO**
	Design and fabrication process of Microsensors: Force Sensors, Pressure Sensors, Strain gauges and practical applications. Explain working principles of Actuators. Piezoelectric and Piezoresistive actuators, micropumps and micro actuators with practical applications	10	CO4
UNIT-V	**Design Methods**	**Hrs.**	**CO**
	Understanding basics of microfluidics to assist Photomask design using Clewin Software, pattern transfer techniques, PDMS moulding and degassing, device bonding techniques. Simulation, Optimization and characterization of various sensors using COMSOL Multiphysics	8	CO5
UNIT-VI	**Interfacing with controllers**	**Hrs.**	**CO**
	Understanding of Sensor Interfacing with Microprocessor to build electronic system. Static and Dynamic Characteristic Parameters for Sensors and Actuators, Calibration of Sensor based electronics systems.	7	CO6

Text Books:

[T1] "Sensors and Signal Conditioning" Wiley-Blackwell, 2008 Jacob Fraden, Handbook of modern sensors, Springer, Stefan Johann Rupitsch.(ISBN-10. 9780471332329)

[T2] Microsystem Design, Kluwer Academic Publisher, 2001 J.D. Plummer, M.D. Deal, P.G. Griffin (ISBN 10 -0792372468)

[T3] Sensors and Actuators: Engineering System Instrumentation, Second Edition : de Silva, Clarence W. (ISBN-13: 978-1466506817)

[T4] Marks' Standard Handbook for Mechanical Engineers, 12th Edition Ali M. Sadegh, Ph.D. William M. Worek, Ph.D. (ISBN: 9781259588501)

References:

[R1] Silicon VLSI Technology, Pearson Education, 2001 S.M. Sze (Ed) (ISBN 10: 0130850373)

[R2] Piezoelectric Sensors and Actuators: Fundamentals and Applications, Springer, 2018 Senturia S. D. (ISBN: 978-3-662-57534-5)

E-References

[E1] https://archive.nptel.ac.in/courses/108/108/108108147/

EE411B: CIRCUIT ANALYSIS FOR ANALOG DESIGNERS

Teaching Scheme		**Examination Scheme**	
Lectures:	**NA**	**NPTEL Assignment:**	**25 Marks**
		NPTEL Exam:	**75 Marks**
Credits:	**3**	**Total:**	**100 Marks**

Prerequisite Course:
1. Engineering mathematics
2. Electric network analysis
3. Signals and Systems

Course Objectives

The course is intended to cover topics in circuit analysis that an analog designer uses on a daily basis. After a refresher and building background in linear-time invariant networks, it introduces aspiring analog designers to more advanced topics like inter-reciprocal networks, analog filters, noise analysis of circuits, transmission lines and distributed circuits, and the analysis of circuits with weak non-linearities. Another important topic, which is not covered in this course due to paucity of time, is that of the study of time-varying circuits. This topic is covered in the course ``Introduction to Time-Varying Electrical Networks'', also on NPTEL.

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Solve Tellegen's Theorem and Modified Nodal Analysis	3	Apply
CO2	Study Reciprocity Theorem and Butterworth Approximation and its Filters	3	Apply
CO3	Analyze High Order Filters and Noise in Electronic Circuits	4	Analyze
CO4	Apply Bode's Noise Theorem and Telegrapher's Equation in Electrical Circuits	3	Apply
CO5	Understand Smith Chart used in Harmonics	2	Understand
CO6	Analyze the weak non-linearities in circuits having Harmonic Distortion	4	Analyze

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1	0	2	1	1	1	2	1	3	2	2
CO2	3	3	2	2	0	2	1	1	1	2	1	3	2	1
CO3	3	3	2	3	0	2	1	1	1	2	1	3	2	2
CO4	3	3	2	3	0	2	1	1	1	2	1	3	2	2
CO5	3	3	2	2	0	2	1	1	1	2	1	3	2	2
CO6	3	3	2	3	0	2	1	1	1	2	1	3	3	2

Course Contents			
UNIT-I	**KCL, KVL, Tellegen's Theorem, Modified Nodal Analysis**	**Hrs.**	**COs**
	Motivation for the topics covered in the course, review of linearity and time-variance, Review of electrical network basics, incidence matrix, Tellegen's theorem, Tellegen's theorem (cntd), its use to prove reciprocity in bilateral network. Reciprocity in networks with controlled sources (contd), inter-reciprocal networks, Modified Nodal Analysis (MNA) formulation to write network equations.	**09**	CO1
UNIT-II	**Reciprocity Theorem and Butterworth Approximation and its application in Filters**		
	MNA formulation (contd), MNA stamps of circuit elements, Reciprocity and inter-reciprocity revisited, Reciprocity and inter-reciprocity (contd), the ad-joint network, Introduction to analog filtering, the Butterworth approximation. Butterworth filters (continued), op-amp-RC realization of filters, Bi-quadratic sections using op-amp-RC integrators, frequency and impedance scaling.	**08**	CO2
UNIT-III	**High Order Filters and Noise in Electronic Circuits**		
	Cascade of bi-quads realization of high-order filters, dynamic-range scaling, Effect of non-ideal op-amps on integrator behaviour, Q-enhancement in bi-quads due to finite op-amp gain-bandwidth product. Trans-conductance-capacitance filters, Introduction to noise in electronic circuits, Noise in RLC circuits, Nyquist's theorem, Bode's Noise Theorem.	**06**	CO3
UNIT-IV	**Bode's Noise Theorem and Telegrapher's Equation**		
	Bode's noise theorem (contd), input referred noise sources in networks, Input-referred noise sources (contd) - equivalent noise voltage and current sources, Equivalent noise sources, noise factor. Introduction to distributed networks, the ideal transmission line and Telegrapher's equations, Transmission line circuit analysis, the reflection coefficient, open- and short-circuited lines.	**06**	CO4
UNIT-V	**Smith Chart and Harmonics**		
	The Smith chart (introduction), the need for scattering parameters, Scattering matrices of simple elements, Scattering matrices properties, measurement of a one-port. Scattering matrices (contd), the vector network analyzer, principle behind calibration, Weak non-linearity in electronic circuits, harmonic distortion, HD2 and IM2.	**08**	CO5
UNIT-VI	**Basics of Harmonic Distortion**		
	Harmonic distortion (contd), third-order distortion and inter-modulation, Analysis of weak non-linearities in circuits using the method of current injection, Method of current-injection (contd), application to analysis of distortion in a negative feedback system.	**06**	CO6
E-references:-			
[E1] https://archive.nptel.ac.in/courses/117/106/117106148/ [E2] https://www.classcentral.com/course/swayam-circuit-analysis-for-analog-designers-58421			

EE411 C: Industrial Automation and Control

Teaching Scheme	**Examination Scheme**	
Lectures: 3 Hrs./Week	**NPTEL Assignment:**	**25 Marks**
	NPTEL Exam:	**75 Marks**
Credits: 3	**Total:**	**100 Marks**

Prerequisite Course:

1. Basic knowledge of Electronics and Computer
2. Basic knowledge of sensors and power supply
3. Basic concept of control system.

Course Objectives

1. Understand Automation & System Overview
2. Understand Different functionalities of PLC & SCADA
3. Understanding of the Features of Hydraulic and Pneumatics

Course Outcomes (COs):

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

	Course Outcome (s)	**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Infer the fundamental of Industrial Automation	2	Understanding
CO2	Analyze different measurement techniques and devices.	4	Analyzing
CO3	Apply Control Strategies to Industrial Process	3	Applying
CO4	Prepare PLC Ladder Program for the given application.	3	Applying
CO5	Interface the given I/O devices with appropriate PLC module	3	Applying
CO6	Infer the fundamentals of SCADA system & its Applications	2	Understanding

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	3	3	2	-	-	2	3	3	3	3
CO2	3	3	3	3	3	2	-	-	-	3	2	1	3	3
CO3	3	3	3	3	3	2	-	-	-	3	2	2	3	3
CO4	3	3	2	3	3	2	-	-	-	2	1	1	3	3
CO5	2	2	2	1	2	2	-	-	-	2	1	-	3	3
CO6	3	3	3	3	3	2	-	-	-	2	2	3	3	3

Course Contents			
UNIT-I	**Introduction to Industrial Automation**	**Hrs.**	**CO**
	Need & Role of Automation, Types of Industrial Automation System, Architecture of Industrial Automation Systems	**06**	**CO1**
UNIT-II	**Measurement System**		
	Measurement Systems Specifications, Temperature Measurement, Pressure and Force Measurement, Displacement & Speed Measurement, Flow Measurement, Measurement of Level, Humidity and pH,Signal Conditioning Circuits,Errors and Calibration	**08**	**CO2**
UNIT-III	**Industrial Process and Control**		
	Introduction to Automatic Control,P-I-D Control,PID Control Tuning,Feedforward Control Ratio Control	**08**	**CO3**
UNIT-IV	**Programmable Logic Control**		
	Introduction to Sequence/Logic Control,Programmable Logic Control,Time Delay Systems and Inverse Response Systems,Special Control Structures,Process Control,Introduction to Sequence Control, PLC,RLL Sequence Control, Scan Cycle, Simple RLL Programs,Sequence Control,More RLL Elements, RLL Syntax,A Structured Design Approach to Sequence Control	**08**	**CO4**
UNIT-V	**Interfacing PLC to Hydraulic, Pneumatic**		
	PLC Hardware Environment,Flow Control Valves,Hydraulic Control Systems - I, Hydraulic Control Systems - II, Industrial Hydraulic Circuit,Pneumatic Control Systems - I,Pneumatic Systems - II, Energy Savings with Variable Speed Drives,Introduction To CNC Machines	**06**	**CO5**
UNIT-VI	**Supervisory Control & Data Acquisition (SCADA)**		
	General definition & SCADA Components. Need of SCADA system, application & benefits, Communications in SCADA,The Fieldbus Network,Higher Level Automation Systems	**06**	**CO6**

Text Books:

[T1] Programmable Logic Controllers, Frank D. Petruzella, McGraw-Hill Education,Sixth Edition. ISBN 13: 9781264163342

[T2] Ronald L. Krutz, “Securing SCADA System”, Wiley Publishing 2015,ISBN no 978-0764597879

References:

[R1]Programmable logic controllers & Industrial Automation- Madhuchandra Mitra, Samarjeet Sen Gupta Penram International Pvt. Ltd., Fourth reprint, 2012,ISBN NO 978-8187972631

[R2] Hydraulic Control Systems, Herbert E. Merritt, Wiley, 1991,ISBN: 978-0-471-59617-2

[R3] Electric Motor Drives, Modelling, Analysis and Control, R. Krishnan, Prentice Hall India, 2002,ISBN 0-13-0910147

E-References

[E1] https://onlinecourses.nptel.ac.in/noc24_ee56/course
[E2] https://archive.nptel.ac.in/courses/108/105/108105063/

EE411 D: Problem Solving through programming in C

Teaching Scheme	**Examination Scheme**	
Lectures: NA	**NPTEL Assignment:**	**25 Marks**
	NPTEL Exam:	**75 Marks**
Credits: 3	**Total:**	**100 Marks**

Prerequisite Course:

1. Analytical & Logical skills
2. Fundamentals of C programming

Course Objectives

1. To get acquainted with the fundamental principles, and concepts of Computer Hardware and Software
2. To understand basics of programming and problem solving
3. To build basic programs in C
4. To develop competency for the design, coding and debugging
5. To build the programming skills using C to solve real world problems
6. To learn and understand the basic concepts and use of system software and IDE

Course Outcomes (COs):

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

	Course Outcome (s)	**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Demonstrate the basic knowledge of computer hardware and software.	2	Understand
CO2	To formulate simple algorithms for arithmetic and logical problems.	3	Apply
CO3	To translate the algorithms to programs (in C language).	3	Apply
CO4	To test and execute the programs and correct syntax and logical errors.	4	Analyze
CO5	Evaluate programming logics to solve the problem.	3	Apply
CO6	Ability to apply solving and logical skills to programming in C language and also in other languages.	4	Analyze

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1	1	3	2	-	-	-	1	-	1	1	1
CO2	2	3	2	2	3	2	-	-	-	1	-	1	2	2
CO3	2	3	1	2	3	2	-	-	-	-	-	1	-	-
CO4	2	3	2	2	3	-	-	-	-	2	-	1	1	2
CO5	2	2	1	1	2	2	-	-	-	-	-	-	1	-
CO6	2	3	2	2	3	2	-	-	-	1	-	1	-	1

Course Contents			
UNIT-I	**Introduction to Computing & C Programming**	**Hrs.**	**COs**
	Computer Systems-Hardware and Software, Computer Languages, Algorithm, Flowchart, Representation of Algorithm and Flowchart with examples. History of C, Features of C, Structure of C Program, Character Set, C Tokens-Keywords, Identifiers, Constants, Variables, Data types, Operators. .	8	CO1
UNIT-II	**Pseudo code & Programming Process**	**Hrs.**	**CO**
	Introduction to Problem Solving through programs, Flowcharts/Pseudo codes, the compilation process, Syntax and Semantic errors, Variables and Data Types .	8	CO2
UNIT-III	**Conditional statements**	**Hrs.**	**CO**
	Arithmetic expressions, Relational Operations, Logical expressions; Introduction to Conditional Branching,Conditional Branching and Iterative Loops.	8	CO3
UNIT-IV	**Arrays & strings**	**Hrs.**	**CO**
	Arranging things : Arrays, 2-D arrays, 3-D arrays, Character Arrays and Strings.	7	CO4
UNIT-V	**Functions**	**Hrs.**	**CO**
	Basic Algorithms including Numerical Algorithms, Functions and Parameter Passing by Value, Passing Arrays to Functions, Call by Reference.	7	CO5
UNIT-VI	**Pointers & Structures**	**Hrs.**	**CO**
	Recursion, Structures and Pointers,Self-Referential Structures and Introduction to Lists.	7	CO6

Text Books:

[T1] Computer Programming with C, Special Edition-MRCET, Mc Graw Hill Publishers 2017.

[T2] Computer Science: A Structured Programming Approach Using C, B.A.Forouzan and R.F. Gilberg, Third Edition, Cengage Learning.

References:

[R1] The C Programming Language, B.W. Kernighan and Dennis M.Ritchie, PHI.

[R2] Computer Programming, E.Balagurusamy, First Edition, TMH.

[R3] C and Data structures – P. Padmanabham, Third Edition, B.S. Publications

[R4] Programming in C, Ashok Kamthane. Pearson Education India.

[R5] Let us C ,Yashwanth Kanethkar, 13th Edition, BPB Publications.

E-References

[E1]. https://onlinecourses.nptel.ac.in/noc24_cs42/preview (Problem Solving through programming in C)

EE412 A: Fundamentals of Semiconductor Devices

Teaching Scheme	**Examination Scheme**	
Lectures: NA	**NPTEL Assignment:**	**25 Marks**
	NPTEL Exam:	**75 Marks**
Credits: 3	**Total:**	**100 Marks**

Prerequisite Course:

1. Basic Electronics

Course Objectives

1. To provide the knowledge of basic electronic components and their applications
2. To understand working and applications of Analog and Digital Integrated Circuits.
3. To explore students to the fundamentals of electronic communication.

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Classify basics of semiconductor devices including the physics of energy bands	2	Understand
CO2	Design and analyze doping and carrier statistics and transport leading up to the understanding of common semiconductor devices	3	Apply
CO3	Analyze the opto-electronic devices such as solar cells, photodetectors and LEDs.	4	Analyze
CO4	Analyze the semiconductors are able to grasp the content	4	Analyze
CO5	Analyze practical and commercial technologies which are all around us and which use semiconductor devices.	4	Analyze
CO6	Identify the here will be enough food for thought even for advanced learners such as PhD students and active researchers.	3	Apply

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	2	-	-	-	-	-	-	-	1	2	-
CO2	3	2	2	-	-	-	-	-	-	-	-	1	2	-
CO3	3	2	2	1	-	-	-	-	-	-	-	1	2	1
CO4	3	2	2	1	-	-	-	-	-	-	-	1	2	1
CO5	3	2	2	1	-	-	-	-	-	-	-	1	2	-
CO6	3	2	2	1	-	-	-	-	-	-	-	1	2	-

Course Contents			
UNIT-I	**Introduction to Semiconductor Devices**	**Hrs.**	**COs**
	Importance of semiconductor devices and their diverse applications. Introduction to semiconductors, concept of energy bands and how bands form. Effective mass of electrons, E-k diagram. Concept of holes. Concept of Fermi level, Fermi-Dirac distribution. Doping (extrinsic & intrinsic semiconductor), density of states. Equilibrium electron-hole concentration, temperature-dependence. Carrier scattering and mobility, velocity saturation, Drift-diffusion transport	6	CO1
UNIT-II	**N-N Junction diode statics and dynamic Characteristics**	**Hrs.**	**CO**
	Excess carrier decay & recombination, charge injection, continuity equation, quasi-Fermi level . p-n junction: static behaviour (depletion width, field profile), p-n junction under forward & reverse bias, current equations, generation-recombination current and reference to typical devices	6	CO2
UNIT-III	**Zener Diode**	**Hrs.**	**CO**
	Zener and avalanche breakdown, Capacitance-voltage profiling, metal/semiconductor junction – Ohmic and Schottky contacts, reference to device applications. MOS capacitor, charge/field/energy bands, accumulation, inversion, C-V (high and low frequencies), deep depletion, Real MOS cap: Flat-band & threshold voltage, Si/SiO2 system.	6	CO3
UNIT-IV	Metal-oxide-Semiconductor Field-Effect Transistor.	**Hrs.**	**CO**
	MOSFET: structure and operating principle, derivation of I-V, gradual channel approximation, substrate bias effects, sub-threshold current and gate oxide breakdown. Control of threshold voltage, short channel effects. Moore's Law and CMOS scaling. Introduction to compound semiconductors & alloys, commonly used compound semiconductors, heterostructure band diagrams and basics of MODFET & HEMT, introduction to quantum well, applications of heterostructure device technologies	6	CO4
UNIT-V	**Bipolar Junction Transistor**	**Hrs.**	**CO**
	BJT: working principle, DC parameters and current components, base transport factor, Early Effect, charge control equation & current gain, need for HBT. Applications of BJTs/HBTs in real-life. (Basics of) - transistors for high-speed logic, transistors for high frequency (RF), transistors for high power switching, transistors for memories, transistors for low noise, transistors for the future.	6	CO5
UNIT-VI	**Solar Cell**	**Hrs.**	**CO**
	Solar cells: principle, efficiency, Fill factor, Shockley-Quiesser limit, silicon solar cells, multi-junction solar cell, Photodetectors: operation, figures of merit (responsivity, QE, bandwidth, noise, Detectivity), examples from IR to UV detectors. LEDs: working principle, radiative/non-radiative recombination, various types of efficiencies (EQE, WPE, IQE), light extraction and escape cone. Blue LED and the Nobel Prize, visible LEDs and chromaticity.	6	CO6

Text Books:

[T1] Ben G.Streetman and Sanjay Banerjee, Solid State Electronics Devices, 5th Ed,PHI, 2001.ISBN-978-0131497269

[T2] Introduction to Semiconductor Materials and Devices, by M. S. Tyagi, Wiley Publications., ISBN-

978-8126518678.
References:
[R1] R. S. Muller & T. I. Kamins, Device Electronics for Integrated Circuits, 3rd Edition, John Wiley & Sons, Inc., 2003., 978-0471593980. [R2] Y. Taur & T. H. Ning, Fundamentals of Modern VLSI Devices, 2 nd Edition, Cambridge University Press 1998., ISBN-978-1107635715.
E-References
[E1]. https://onlinecourses.nptel.ac.in/noc24_ee02/preview (**Fundamentals of Semiconductor Devices**)

EE412B: Computer-Aided Design of Electrical Machines

Teaching Scheme	**Examination Scheme**	
Lectures: NA	**NPTEL Assignment:**	**25 Marks**
	NPTEL Exam:	**75 Marks**
Credits: 3	**Total:**	**100 Marks**

Prerequisite Course:

2. Knowledge of various materials used in electrical machines.
3. Knowledge of types, construction and working of transformer.
4. Knowledge of types, construction and working of rotating electrical machines

Course Objectives

7. To understand selection of proper commercial materials for Electrical Machine design.
8. To understand design of transformer.
9. To understand design of DC machine and permanent magnet machine.
10. To understand design of induction motor.
11. To understand design of special purpose motors.
12. To understand uses of computer aided optimization techniques for electrical machine design.

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Select proper commercial materials for desired electrical machine design.	2	Understanding
CO2	Calculate main dimensions and the design parameters of single phase and three phase transformer.	3	Applying
CO3	Calculate main dimensions and the design parameters of DC machine and permanent magnet machine.	3	Applying
CO4	Calculate main dimensions and the design parameters of three phase induction motor.	3	Applying
CO5	Calculate the design parameters of synchronous machines, salient reluctance machines, stepper machines and axial flux machines.	3	Applying
CO6	Understand computer aided optimization techniques for electrical machine design.	2	Understanding

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	2	-	-	-	-	-	-	1	2	1
CO2	3	2	2	1	2	-	-	-	-	-	-	1	2	1
CO3	3	2	2	1	2	-	-	-	-	-	-	1	2	1
CO4	3	2	2	1	2	-	-	-	-	-	-	1	2	1
CO5	3	2	2	1	2	-	-	-	-	-	-	1	2	1
CO6	3	2	2	1	2	-	-	-	-	-	-	1	2	2

Course Contents			
UNIT-I	**FUNDAMENTALS AND PRINCIPLES OF ELECTRICAL MACHINE DESIGN WITH EQUIVALENT CIRCUIT APPROACH**	**Hrs.**	**COs**
	Transformers and rotating electrical machines - specifications, types, constructional features, conducting, magnetic and insulating materials, heating and cooling in electrical machines. Fundamental with ANSYS to design an electrical machine.	6	CO1
UNIT-II	**TRANSFORMER DESIGN**	**Hrs.**	**CO**
	Output equation with usual notations, optimum design of transformer for minimum cost and loss. Design of main dimensions, core, yoke and windings of transformer. Methods of cooling and tank design. Estimation of no-load current, losses, efficiency and regulation of transformer, Mechanical forces developed under short circuit conditions, measures to overcome this effect. Introduction to Computer aided design of transformer, generalized flow chart for design of transformer.	6	CO2
UNIT-III	**DESIGN OF DC MACHINES AND BRUSHLESS PERMANENT MAGNET MACHINES**	**Hrs.**	**CO**
	Design specification, output equation, estimation of power developed by armature, choice of specific magnetic loading and specific electric loading, choice of armature core length and armature diameter, design of armature winding, design of the field system, losses and efficiency. Fundamentals and design specification of Brushless Permanent Magnet Machines.	6	CO3
UNIT-IV	**INDUCTION MOTOR DESIGN**	**Hrs.**	**CO**
	Output equation, specific electrical and magnetic loading, main dimensions, selection of slots, stator design, stator slots, turns per phase, selection of air gap, squirrel cage and wound rotor design. Calculation of magnetic circuit, MMF calculations, stator teeth, stator core, effect of saturation, magnetizing current, no load current and its core loss component, performance calculations - losses, efficiency, temperature rise, maximum torque from circle diagram.	6	CO4
UNIT-V	**DESIGN OF SYCHRONOUS MACHINES AND SPECIAL PURPOSE MACHINES**	**Hrs.**	**CO**
	Design specification with fundamentals of Synchronous Machines, Salient Reluctance Machines, Stepper Machines and Axial Flux Machines.	6	CO5
UNIT-VI	**COMPUTER AIDED DESIGN (CAD) OF ELECTRICAL MACHINES**	**Hrs.**	**CO**
	Computer-Aided Design and explanation about the details of flow chart. Limitations and assumptions in traditional designs, need of CAD, analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, Fundamental with ANSYS, problem formulation, ANSYS solution and post-processing, Finite Element Equations, uses of commands in ANSYS and graphical user interface (GUI).	6	CO6

Text Books:

[T1] Erdogan Madenci and Ibrahim Guven-The Finite Element Method and Applications in Engineering Using ANSYS, Springer (ISBN:9788184897463 and SCOEK Library Accession No. 70461)

[T2] A.K.Sawhney – A Course in Electrical Machine Design, 10th Edition, - Dhanpat Rai and sons New Delhi. (ISBN: 978-81-7700-101-3 and SCOEK Library Accession No. 65058, 65059)

[T3] R. K. Agarwal – Principles of Electrical Machine Design, S. K.Katariya and Sons. (ISBN: 978-93-80027-12-8 and SCOEK Library Accession No. 64134, 64135)

[T4] M.G. Say – The Performance and Design of A.C. Machines, 3rd Edition, CBS Publishers &

Distributors Pvt. Ltd. (ISBN: 81-239-1027-4 and SCOEK Library Accession No. 64080)
[T5] Prof. Sham Tickoo – AutoCAD 2021 for Engineers and Designers (ISBN: 978-93-8998-97-2) and SCOEK Library Accession No. 64570 , 64571)

References:

[R1] CADD Centre India-ANSYS Reference Guide (SCOEK Library Accession No. 0024404)
[R2] K. G. Upadhyay- Design of Electrical Machines, New age International (P) Limited, Publishers London (ISBN:978-81-224-2282-5, and SCOEK Library Accession No. 64876)
[R3] Indrajit Dasgupta – Design of Transformers, Mc Graw Hill Education (ISBN-13:978-0-07-043640-4 and SCOEK Library Accession No. 64309)
[R4] T. A. Lipo, "Introduction to AC Machine Design", IEEE Press – Wiley Publications, 2017.
[R5] J. R. Hendershot and T. J. E. Miller, "Design of Brushless Permanent – Magnet Motors", Motor Design Books LLC, 2nd edition, 2010.
[R6] J. Pyrhonen, T. Jokinen, and V. Hrabovcova, "Design of Rotating Electrical Machines", John Wiley and Sons Inc., 2nd edition, 2013.
[R7] R. Krishnan, "Switched Reluctance Motor Drives", CRC Press LLC, USA, 2001.
[R8] Shanmugasundaram a Electrical Machine Design Data Book / Ashanmugasundaram ; 2nd Ed. ; Vol. ; : New Age, 2015 (SCOEK Library Accession No. 64876, 64877, 64878 and 64879)

E-References

[E1] https://nptel.ac.in/courses/108102372

[E2] https://onlinecourses.nptel.ac.in/noc24_ee50

[E3] https://onlinecourses.nptel.ac.in/noc23_ee140

EE412 C: Introduction to Industry 4.0 & Industrial Internet of Things

Teaching Scheme	**Examination Scheme**	
Lectures: NA	**NPTEL Assignment:**	**25 Marks**
	NPTEL Exam:	**75 Marks**
Credits: 3	**Total:**	**100 Marks**

Prerequisite Course: Basic knowledge of computer and internet.
Basic knowledge of Industrial Automation and Control

Course Objectives

1. Understand the concepts of Automation system.
2. Understand the concepts of Industry 4.0, different sensors and Artificial Intelligence.
3. Understand the concepts of Industrial IIOT and Business module.
4. Understand the Real case studies using IIOT in different Industry.

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Categorize and describe major types of Automation System	2	Understand
CO2	Describe Automatic Control and Supervisory Control	2	Understand
CO3	Infer the Industrial IoT Business Model and Reference Architecture of IOT-Business Models.	2	Understand
CO4	Analyse Introduction Machine Learning and Data Science.	3	Apply
CO5	Illustrate the various security applications used in Fog Computing and Cloud Computing in Industrial IOT (IIOT).	3	Apply
CO6	Identify the suitable IIOT schemes for various industrial domains.	3	Apply

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	-	2	2	-
CO2	3	2	2	-	-	-	-	-	-	-	-	2	2	-
CO3	3	2	2	1	-	2	-	-	-	-	-	3	2	2
CO4	3	2	2	1	1	2	-	-	-	-	-	3	2	2
CO5	3	2	2	1	2	2	-	-	-	-	-	3	2	2
CO6	3	2	2	1	2	2	-	-	-	-	-	3	2	2

Course Contents			
UNIT-I	**Sensing & Actuation**	**Hrs.**	**COs**
	Introduction: Sensing & actuation, Communication-Part I, Part II, Networking-Part I, Part II Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories.	4	CO1
UNIT-II	**Basics of Industry 4.0**	**Hrs.**	**CO**
	Industry 4.0: Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis.	4	CO2
UNIT-III	**Cyber security in industry 4.0**	**Hrs.**	**CO**
	Cybersecurity in Industry 4.0, Basics of Industrial IOT: Industrial Processes-Part I, Part II, Industrial Sensing & Actuation, Industrial Internet Systems IOT-Introduction, Industrial IoT: Business Model and Reference Architecture: IOT-Business Models-Part I, Part II, IOT Reference Architecture-Part I, Part II.	8	CO3
UNIT-IV	**Machine learning and data science**	**Hrs.**	**CO**
	Industrial IoT- Layers: IIOT Sensing-Part I, Part II, IOT Processing-Part I, Part II, IIoT Communication-Part I, Industrial IoT- Layers: IIoT Communication-Part II, Part III, IIoT Networking-Part I, Part II, Part III, Industrial IoT: Big Data Analytics and Software Defined Networks, IIoT Analytics - Introduction, Machine Learning and Data Science - Part I, Part II, R and Julia Programming, Data Management with Hadoop.	8	CO4
UNIT-V	**Industrial IOT**	**Hrs.**	**CO**
	Industrial IoT: Big Data Analytics and Software Defined Networks: SDN in IIoT-Part I, Part II, Data Centre Networks, Industrial IoT: Security and Fog Computing: Cloud Computing in IIoT-Part I, Part II, Industrial IoT: Security and Fog Computing - Fog Computing in IIoT, Security in IIoT-Part I, Part II, Industrial IoT- Application Domains: Factories and Assembly Line, Food Industry	8	CO5
UNIT-VI	**IoT Applications**	**Hrs.**	**CO**
	Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management Industrial IoT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies : Milk Processing and Packaging Industries, Manufacturing Industries , Student Projects , Virtual Reality Lab, Steel Technology Lab.	6	CO6
Text Books:			
[T1] Arshdeep Bahga "Internet of Things: A Hands-On Approach" First Edition Orient Blackswan Private Limited - New Delhi ISBN NO 8173719543 [T2] Maciej Kranz, "Building the Internet of Things". Publish by Wiley First edition 978-1119285663 [T3] Cuno Pfister "Getting Started with the Internet of Things." First edition Make Community, LLC ISBN NO 978-1449393571.			
References:			
[R1] S. Misra, A. Mukherjee, and A. Roy, 2020. Introduction to IOT First edition, Cambridge University Press. ISBN NO 1108959741. [R2] Peter Waher Learning Internet of Things "First edition published by Packet Pub Ltd ISBN NO 978-1783553532.			

EE412D: EMBEDDED SENSING, ACTUATION AND INTERFACING SYSTEMS

Teaching Scheme	**Examination Scheme**	
Lectures: NA	**NPTEL Assignment:**	**25 Marks**
	NPTEL Exam:	**75 Marks**
Credits: 03	**Total:**	**100 Marks**

Prerequisite Course:

1. Circuit Analysis
2. Control System
3. Analog and Digital Electronics

Course Objectives

1. To develop practical technical skills among the students
2. To integrate various sensing, actuation units and other required accessories with embedded controller
3. To build a complete modern embedded control system for intended applications

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Interpret characteristics and applications of embedded systems, sensors and actuators	**2**	Understand
CO2	Apply various interfacing Aspects of Sensors and Actuators to Embedded Controller and their Communication Protocols and advancements in Linearity Improvement and Error Reduction	**3**	Apply
CO3	Choose Advanced Techniques for Direct Interfacing of Resistive and Capacitive Sensors with Embedded controller	**3**	Apply
CO4	Interpret Advancement in Design of Interfacing Circuits for Lossy Capacitive Sensors and Miniaturization Technology for Smart Sensors and Actuators	**3**	Apply
CO5	Apply and operate Miniaturized Sensors, Actuators and their Interfacing Electronics and Renewable Energy Harvesters to Develop Self-Powered Embedded System	**3**	Apply
CO6	Relate case studies of Embedded Sensing, Actuation and Interfacing System in Automotives Domain and Healthcare Domain	**3**	Apply

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	1	-	-	-	-	-	-	1	1	1
CO2	2	2	1	2	1	-	-	-	-	-	-	1	1	1
CO3	2	2	1	2	1	-	-	-	-	-	-	1	1	1
CO4	2	2	1	2	1	-	-	-	-	-	-	1	1	1
CO5	2	2	2	2	1	-	-	-	-	-	-	1	1	1
CO6	2	2	2	2	1	-	-	1	-	-	-	1	1	1

Course Contents			
UNIT-I	**Introduction to Embedded Systems, Sensors and Actuators**	**Hrs.**	**COs**
	Overview of embedded system; Importance of sensors, actuators and interfacing circuits in embedded control system; Characteristics; Applications-Various types of important sensors, actuators and their working principles: e.g, thermal, mechanical, electrical, magnetic, optical, chemical, smart material and meta material based.	6	CO1
UNIT-II	**Interfacing Aspects**	**Hrs.**	**COs**
	Signal conditioning circuits; Various Op-Amp based interfacing circuit implementation: Amplifier, Filter, ADC, DAC etc.; Various Serial Communication protocols for interfacing. Resistive sensor examples; Non-idealities in basic interfacing circuits; Linearization techniques; Error reduction schemes due to environmental effects and remote communication.	6	CO2
UNIT-III	**Advanced Techniques for Direct Interfacing**	**Hrs.**	**COs**
	Embedded controller-based excitation system; Direct interfacing schemes of various resistive sensors topologies (e.g., single, differential and bridge type) to microcontrollers; Interfacing scheme for sensor array, Capacitive sensor examples; Interfacing scheme for different capacitive sensor configurations; Direct interfacing schemes.	6	CO3
UNIT-IV	**Advancement in Design of Interfacing Circuits And Miniaturization Technology**	**Hrs.**	**COs**
	Lossy Capacitive sensor characteristics; Various advanced interfacing schemes for lossy capacitive sensor, Background of miniaturization; Miniaturized device fabrication process technology for Smart sensors and actuators	6	CO4
UNIT-V	**Interfacing Electronics and Renewable Energy Harvesters**	**Hrs.**	**COs**
	Various types of important MEMS sensors and actuators: Design and operation; Interfacing Electronics for MEMS Devices; System-on-Chip integration; Applications,Various renewable energy harvesting techniques; Interfacing power management circuits; Applications towards development of self-powered smart system	6	CO5
UNIT-VI	**Application Case Studies**	**Hrs.**	**COs**
	Application Case Studies of Embedded Sensing, Actuation and Interfacing System in Automotives Domain and Healthcare Domain	6	CO6
Text Books:			
[T1]. Nathan Ida, 'Sensors, Actuators, and their Interfaces', 1st ed., SciTech Publishing, 2014, ISBN: 9781613530061 [T2]. Stuart R. Ball, 'Analog Interfacing to Embedded Microprocessor Systems', Elsevier, 2004, ISBN:9780750677233, 0750677236 [T3]. B. George, J. Roy, V. Jagadeesh Kumar, S. C. Mukhopadhyay, 'Advanced Interfacing Techniques for Sensors', 1st ed., Springer, 2017, ISBN:9783319553696, 3319553690 [T4]. John G. Webster and Ramón Pallás-Areny, 'Sensors and Signal Conditioning', John Wiley & Sons, 2nd ed., 2000, ISBN:9781118585931, 1118585933			
References:			
[R1]. Marc Madou, 'Fundamentals of Microfabrication and Nanotechnology', CRC press, 3rd ed., 2018,			

ISBN:9781351990615, 1351990616
[R2]. S. Nihtianov, A. Luque, 'Smart Sensors and MEMS', 1st ed., Elsevier, 2014, ISBN:9780081020562, 0081020562
[R3]. Bela G Liptak, 'Instrument Engineers Handbook' CRC press, 4th ed., 2003, ISBN:9781000820621, 1000820629
[R4]. William B. Ribbens, 'Understanding Automotive Electronics: An Engineering Perspective', Elsevier, 8th ed., 2017, ISBN:9780080481494, 0080481493

E-References

[E1]. https://onlinecourses.nptel.ac.in/noc24_ee68/preview Embedded Sensing, Actuation and Interfacing Systems, By Prof. Banibrata Mukherjee | IIT Kharagpur
[E2]. https://nptel.ac.in/courses/108105376 Embedded Sensing, Actuation and Interfacing Systems, By Prof. Banibrata Mukherjee | IIT Kharagpur

EE413 A: EV - Vehicle Dynamics and Electric Motor Drives

Teaching Scheme	**Examination Scheme**	
Lectures: NA	**NPTEL Assignment:**	**25 Marks**
	NPTEL Exam:	**75 Marks**
	Total:	**100 Marks**
Credits: 2		

Prerequisite Course:

1. Basic Knowledge of Electric and Hybrid Vehicles

Course Objectives

1. Understand the operation of battery driven electric vehicles.
2. Understand the vehicle dynamics, Motors, Power Electronics, PWM, Control
3. Analyze and demonstrate EV technologies through Matlab Simulink

Course Outcomes (COs):

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

	Course Outcome (s)	**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Analyze Vehicle Dynamics: Modelling and Simulation	4	Analyzing
CO2	Apply Fundamental of Drives and Power Electronics to DC Drives	3	Applying
CO3	Apply Basics of Induction Motor and V/f Control	3	Applying
CO4	Analyze Realization of Power Electronic Converters and PWM for IM drives	4	Analyzing
CO5	Evaluate Modelling of PMSM Drives	5	Evaluating
CO6	Evaluate Vector Control of PMSM Drives	5	Evaluating

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	-	-	-	-	3	-	-	-	-	-	1	1	-
CO2	3	-	1	2	-	2	-	-	-	-	-	1	1	-
CO3	3	3	3	3	-	1	-	-	-	-	-	1	2	-
CO4	3	3	3	3	-	1	-	-	-	-	-	1	2	-
CO5	3	3	1	2	3	-	-	-	-	-	-	1	2	-
CO6	3	3	1	2	3	-	-	-	-	-	-	1	2	-

Course Contents			
Unit No.	**Course Contents**	**Hrs**	**CO's**
Unit 1	Introduction to Electric Vehicle, Vehicle Dynamics: Modelling and Simulation	6	CO1
Unit 2	Fundamental of Drives and Power Electronics for DC Drives	6	CO2
Unit 3	Modeling and Control of DC Motor Drives	6	CO3
Unit 4	Basics of Induction Motor and V/f Control, Realization of Power Electronic Converters and PWM for IM drives	6	CO4
Unit 5	Modelling of PMSM Drives	6	CO5
Unit 6	Vector Control of PMSM Drives	6	CO6
Text Books:			
[T1] Iqbal Husain, ELECTRIC and HYBRID VEHICLES, Design Fundamentals, CRC Press,2003, ISBN : 978-1439811757			
References:			
[R1] M. Ehsani, Y. Gao, S. Gay and A. Emadi,Modern Electric, Hybrid Electric, and Fuel CellVehicles, CRC Press, 2005, ISBN-13 978-0849331541			
E-References			
[E1]https://onlinecourses.nptel.ac.in/noc24_ee30/course?user_email=rrbibave@gmail.com			

EE413B-FACTS Device

Teaching Scheme	**Examination Scheme**	
Lectures: NA	**NPTEL Assignment:**	**25 Marks**
	NPTEL Exam:	**75 Marks**
Credits: 2	**Total:**	**100 Marks**

Prerequisite Course:

1. Power System
2. Power Electronics

Course Objectives

1. Understand the concepts of Flexible Power Transmission
2. Understand Ideal shunt and practical shunt compensation using Thyristors (TCR) and Bridge Converters (STATCOM)
3. Understand the concepts of ideal series, practical series using Thyristors (TCSC) and Converters (SSSC)
4. Understand the concepts of UPQC and IPFC

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Classify the different types of FACTS controllers	2	Understand
CO2	Design and analyze of multilevel inverters with suitable PWM techniques	3	Apply
CO3	Analyze the dynamics of stability of voltage regulation using SVC and STATCOM with the variation of line reactance.	4	Analyze
CO4	Analyze the functional operation and control of GCSC, TSSC and TCSC.	4	Analyze
CO5	Analyze system behaviour with hybrid shunt-series compensators.	4	Analyze
CO6	Identify the FACTS devices for different application on system control	3	Apply

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	1	2	-
CO2	3	2	2	-	-	-	-	-	-	-	-	1	2	-
CO3	3	2	2	1	-	-	-	-	-	-	-	1	2	1
CO4	3	2	2	1	-	-	-	-	-	-	-	1	2	1
CO5	3	2	2	1	-	-	-	-	-	-	-	1	2	-
CO6	3	2	2	1	-	-	-	-	-	-	-	1	2	-

Course Contents			
UNIT-I	**FACTS: Concept & Power Electronic Controllers**	**Hrs.**	**COs**
	History or Origin of FACTS, Background and Issues, System Architectures and Limitations, Benefits of FACTS, FACTS Applications and Implementations, Classifications of FACTS Controllers and their single line diagrams.	3	CO1
UNIT-II	**Power Electronic Controllers and PWM techniques**	**Hrs.**	**CO**
	Introduction to MLI, Classification of MLI-Flying Capacitor or Capacitor Clamped MLI and Cascaded H-Bridge MLI. PWM Techniques and its classification- Carrier-based PWM Techniques - Phase-shifted PWM(PS-PWM), Level-shifted PWM(LS-PWM), Hybrid PS-LS PWM, Third Harmonic Injection PWM, Hybrid PWM for Asymmetric CHB MLI), Space Vector Modulation for NPC schemes Closed Loop Control- Voltage mode control, Current mode control, Instantaneous Current Control and Hysteresis-Band Current Control.	3	CO2
UNIT-III	**Static Shunt Compensators**	**Hrs.**	**CO**
	Shunt Compensator- Thyristor Control Reactor (TCR), Thyristor Switched Capacitor (TSC), Static Var compensator (SVC), Fixed Capacitor-Thyristor Controlled Reactor (FC-TCR) and STATCOM. General control scheme of SVC, The Regulation Slope, Dynamic Performance, Transient Stability Enhancement, Power Oscillation Damping and Var Reserve (operating point) Control, Design of DSTATCOMs.	4	CO3
UNIT-IV	**Static Series Compensators**	**Hrs.**	**CO**
	Series Capacitive Compensation, Converter Type Series Compensators, Analysis of series compensator, Voltage Stability and Transient Stability Improvement using series compensator and effects on Power Oscillation Damping. Type Series Compensators - GTO Thyristor-controlled Series Capacitor (GCSC), Thyristor-Switched Series Capacitor (TSSC) and Thyristor-Controlled Series Capacitor (TCSC). Principle of Operation SSSC, Control Range and VA Rating of SSSC, Hybrid SSSC, Real power Compensation and Internal Control of SSSC TCSC Operation, its V-I Characteristics, Internal Control scheme for GCSC, TCSC and TSSC.	4	CO4
UNIT-V	**Unified Power quality Conditioner (UPQC) and Unified Power Flow Controller (UPFC).**	**Hrs.**	**CO**
	Introduction of UPQC, Classification of UPQC- Supply System-Based Classification of UPQCs and Rating-Based Classification of UPQCs, Principle Operation of UPQC, Control of UPQC and Rating and Control of UPQC, Synchronous Reference Frame (SRF) Theory for UPQC.	3	CO5

	Introduction of UPFC, Transmission Control Capabilities, Power Flow Control Capability of UPFC, Real and Reactive Power Flow Control, Control Structure, Functional Control of the Shunt and series Converter and Basic Control System for P and Q Control.		
UNIT-VI	**Interline Power Flow Controller (IPFC) and application of FACTS device**	**Hrs.**	**CO**
	Introduction of Interline Power Flow controller (IPFC Operating Principles and Control Structure.	3	CO6

Text Books:

[T1] Narain G.Hingorani, Laszio. Gyugyl, "Understanding FACTS Concepts and Technology of Flexible AC Transmission System", Print 2000, Standard Publishers, Delhi 2001, ISBN- 978-0780334557.

[T2] A.T.John, "Flexible AC Transmission System", Institution of Electrical and Electronic Engineers (IEEE), 1999, ISBN-978-0852967713.

References:

[R1] Mohan Mathur, R., Rajiv. K. Varma, "Thyristor – Based Facts Controllers for Electrical Transmission Systems", 1st Edition, IEEE press and John Wiley & Sons, Inc, ISBN- 978-0471206439.

[R2] K.R.Padiyar," FACTS Controllers in Power Transmission and Distribution", New Age International(P) Ltd., Publishers New Delhi, Reprint 2009, ISBN-978-1848290105

E-References

[E1]. https://nptel.ac.in/courses/108107114 (FACTS Devices)

EE413C-Power Quality Improvement Technique

Teaching Scheme	**Examination Scheme**	
Lectures: NA	**NPTEL Assignment:**	**25 Marks**
	NPTEL Exam:	**75 Marks**
Credits: 2	**Total:**	**100 Marks**

Prerequisite Course:

1. Fundamentals of Power Systems and Power Electronics

Course Objectives

1. Develop understanding of power quality attributes.
2. Make students describe problems associated with poor power quality.
3. Make students describe mitigation techniques for improving power quality.
4. Learn various equipment of monitoring and assessment.

Course Outcomes (COs):

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

Course Outcome (s)		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Understand power quality and attribute of power quality	2	Understand
CO2	Describe voltage flicker and mitigation of it	3	Apply
CO3	Analyze the effect of power system events on voltage sag and its characteristics	3	Apply
CO4	Identify the sources of harmonics and harmonics produced	4	Analyze
CO5	Select proper method for harmonic mitigation along with methods of power quality monitoring.	3	Apply
CO6	Carry out power quality monitoring using power quality analyzer	4	Analyze

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1	1	1	-	-	-	-	-	-	1	1	1
CO2	2	3	2	2	-	-	-	-	-	-	-	1	2	2
CO3	2	3	1	2	1	-	-	-	-	-	-	1	-	-
CO4	2	3	2	2	-	-	-	-	-	-	-	1	1	2
CO5	2	2	1	1	-	-	-	-	-	-	-	-	1	-
CO6	2	3	2	2	-	-	-	-	-	-	-	1	-	1

Course Contents			
UNIT-I	**Basics of Power Quality**	**Hrs.**	**COs**
	Concept of Power Quality: Frequency variations, voltage variations- sag and swell, waveform distortion –dc offset, harmonics, inter-harmonics, notching and noise. Representation of harmonics, waveform, harmonic power, measures of harmonic distortion; Current and voltage limits of harmonic distortions: IEEE, IEC, EN, NORSO	8	CO1
UNIT-II	**RMS Voltage variations, Flickers and Transient Over-Voltages**	**Hrs.**	**CO**
	RMS voltage variations in power system and voltage regulation per unit system, complex power. Principles of voltage regulation. Basic power flow and voltage drop. Various devices used for voltage regulation and impact of reactive power management. Various causes of voltage flicker and their effects. Short term and long term flickers. Ferro-resonance Various means to reduce flickers. Flicker meter and monitoring. Transient over voltages, sources, impulsive transients, switching transients, Effect of surge impedance and line termination, control of transient voltages. PWM Inverter: Voltage sourced active filter, current sourced active filter, constant frequency control, constant tolerance band control, variable tolerance band control. Unified power quality conditioner, voltage source and current source configurations, principle of operation for sag, swell and flicker control	8	CO2
UNIT-III	**Voltage Sag, Swell and Interruption**	**Hrs.**	**CO**
	Definitions of voltage sag and interruptions. Voltage sags versus interruptions. Economic impact of voltage sag, Major causes and consequences of voltage sags. Voltage sag characteristics. Voltage sag assessment. Influence of type of fault, fault location and fault level on voltage sag. Phase angle jumps. Types of sags (Type 1 to type 7). Areas of vulnerability. Assessment of equipment sensitivity to voltage sags. Voltage sag limits for computer equipment, CBEMA, ITIC, SEMI F 42 curves. Measurement of voltage sag half cycle RMS, one cycle rms methods. Representation of the results of voltage sags analysis. Voltage sag indices. Mitigation measures for voltage sags, such as UPS, DVR, SMEs, CVT etc., utility solutions and end user solutions.	8	CO3
UNIT-IV	**Harmonics & Its mitigation**	**Hrs.**	**CO**
	Causes of Harmonics: 2-pulse, 6-pulse and 12-pulse converter configurations, input current waveforms and their harmonic spectrum; Input supply harmonics of AC regulator, integral cycle control, cycloconverter, transformer, rotating machines, ARC furnace, TV and battery charger. Elimination/ Suppression of Harmonics: High power factor converter, multi-pulse converters using transformer connections (delta, polygon).	7	CO4
UNIT-V	**Power filters**	**Hrs.**	**CO**
	Active Power Filters: Compensation principle, classification of active filters by objective, system configuration, power circuit and control strategy. Passive Filters: Types of passive filters, single tuned and high pass filters, filter design criteria, double tuned filters, damped filters and their design. Hybrid Shunt Active power filter: Principle of operation, analysis and modelling.	7	CO5
UNIT-VI	**Power Quality Monitoring & Assessment**	**Hrs.**	**CO**
	Need of power quality monitoring and approaches followed in power quality monitoring. Power quality monitoring objectives and requirements. Initial site survey. Power quality instrumentation. Power quality analyzer	7	CO6

	specification requirement as per EN50160 Standard. Selection of power quality equipment for cost effective power quality monitoring, Selection of power quality monitors, selection of monitoring location and period. Selection of transducers. Harmonic monitoring, Transient monitoring, event recording and flicker monitoring. Power Quality assessment, Power quality indices and standards for assessment disturbances, waveform distortion.		

Text Books:

[T1] R. C. Dugan, Mark F. McGranaghan, Surya Santoso, and H. Wayne Beaty, "Electrical Power System Quality", 2nd Edition, McGraw-Hill Publication. ISBN-10: *968-0079156787*
[T2] M. H. J. Bollen, "Understanding Power Quality Problems, Voltage Sag and Interruptions", New York: IEEE Press, 2000, Series on Power Engineering.ISBN-10: 9788131503638

References:

[R1] Enriques Acha, Manuel Madrigal, "Power System Harmonics: Computer Modeling and Analysis," John Wiley and Sons Ltd. *ISBN*-10: 9332549443.
[R2] Ewald F. Fuchs, Mohammad A. S. Masoum, "Power Quality in Power Systems and Electrical Machines," Elsevier Publication.ISBN-10:9780070141536
[R3] Arrillaga, M. R. Watson, "Power System Harmonics", John Wiley and Sons. *ISBN-10. 8178002094* ; ISBN-13. 936-81780025362
[R4] G. J. Heydt, "Electric Power Quality", Stars in Circle Publications.*ISBN-10. 935632543550*
[R5] EN50160 and IEEE 1100, 1346, 519, and 1159 standards.

E-References

[E1] https://onlinecourses.nptel.ac.in/noc24_ee34/course (Power Quality Improvement Technique)

EE413D-Data Science for Engineers

Teaching Scheme	**Examination Scheme**	
Lectures: NA	**NPTEL Assignment:**	**25 Marks**
	NPTEL Exam:	**75 Marks**
Credits: 2	**Total:**	**100 Marks**

Prerequisite Course:
Mathematics, Python Programming

Course Objectives

1. Understand R as a programming language
2. Understand the mathematical foundations required for data science
3. Understand the first level data science algorithms
4. Understand a data analytics problem solving framework
5. Understand a practical capstone case study

Course Outcomes (COs):

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

	Course Outcome (s)	**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Describe a flow process for data science problems	1	Remember
CO2	Classify data science problems into standard typology	2	Understand
CO3	Apply and Develop R codes for data science solutions	3	Apply
CO4	Analyze and Correlate results to the solution approach followed unconstrained Multivariate Optimization Gradient	4	Analyze
CO5	Evaluate the solution approach of data science	5	Evaluate
CO6	Create use cases to validate approach and identify modifications required for logistics regression	6	Create

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	1	2	-
CO2	3	2	-	-	-	-	-	-	-	-	-	1	2	-
CO3	3	2	2	1	-	-	-	-	-	-	-	1	2	1
CO4	3	2	2	1	-	-	-	-	-	-	-	1	2	1
CO5	3	2	2	1	-	-	-	-	-	-	-	1	2	-
CO6	3	2	2	1	-	-	-	-	-	-	-	1	2	-

Course Contents			
UNIT-I	**Introduction to R as programming language**	**Hrs.**	**COs**
	History or Origin of data science, Introduction to Variables and datatype in Data frames, recasting and joining of data frames, arithmetic, logic and matrix operation in R,Advanced programming in C(functions),control structures and data visualization in R basic graphics.	10	CO1
UNIT-II	**Linear algebra for data science**	**Hrs.**	**CO**
	Introduction to Linear algebra for data science,solving the linear equation, Algebraic view - vectors, matrices, product of matrix & vector, rank, null space, solution of over-determined set of equations and pseudo-inverse Geometric view - vectors, distance, projections, eigenvalue decomposition	7	CO2
UNIT-III	**Data science statistics**	**Hrs.**	**CO**
	Introduction to Statistical modelling, Random variables and probability mass/density functions, sample statistics which include descriptive statistics, notion of probability, distributions, mean, variance, covariance, covariance matrix, understanding univariate and multivariate normal distributions, introduction to hypothesis testing, confidence interval for estimates.	4	CO3
UNIT-IV	**Optimization of data science**	**Hrs.**	**CO**
	Introduction to Optimization of data science, Unconstrained Multivariate Optimization Gradient (Steepest) Descent(OR) Learning Rule, Multivariate Optimization With Equality Constraints, Multivariate Optimization With Inequality Constraints.	4	CO4
UNIT-V	**Data science problems and solution framework**	**Hrs.**	**CO**
	Solving Data Analysis Problems - A Guided Thought Process, Module : Predictive Modelling, Linear Regression, Model Assessment, Diagnostics to Improve Linear Model Fit, Simple Linear Regression Model Building, Simple Linear Regression Model Assessment, Multiple Linear Regression, Cross Validation, Multiple Linear Regression Modelling Building and Selection.	10	CO5
UNIT-VI	**Classification Of Logistics regression**	**Hrs.**	**CO**
	Classification of Logistic Regression, Performance Measures, Logistic Regression Implementation in R, K - Nearest Neighbors (kNN),K - Nearest Neighbors implementation in R,K - means Clustering - means implementation in R,Data Science for engineers - Summary	10	CO6

Text Books:

[T1] Chantal D. Larose & Daniel T. Larose, "Data Science Using Python and R", printed by wiley, ISBN:978-1-119-52681-0

[T2]Raghunathan Rengaswamy ,'Data science for Engineer',CRC press, ISBN 9780367754266

References:

[R1] Gilbert Stran," Introduction To Linear Algebra", Wellesley-Cambridge Press,Isbn-13 978-1733146630

[R2] Douglas Montgomery & George .C.Runner" Applied Statistics And Probability For Engineers,Fifth Edition Isbn–13 978-0-470-05304-1 Printed In The United States Of America,John Wiley And Sons.

E-References

[E1] https://nptel.ac.in/courses/106106179 (Data Science for Engineers)

EE414 : Professional Internship	
Teaching Scheme	**Examination Scheme**
Lectures: NA	**Oral Exam: 50 Marks**
	Term Work: 100 Marks
Credits: 6	**Total : 150 Marks**

Course Objectives

1. To get an opportunity to observe current technological developments relevant to the program.
2. To get the opportunity to learn, understand and sharpen the real time technical skills.
3. To get exposure to the industrial environment.

Course Outcomes (COs):

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

Course **Outcome (s)**		**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	**Understand** the current technological developments relevant to the program.	2	Understand
CO2	**Apply** technical skills to propose solutions to real-time problems.	3	Apply
CO3	**Acquire** professional competency in Electrical Engineering.	3	Apply

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	3	2	1	2	-	1	2	3	3	3	3
CO2	3	3	3	3	3	3	2	-	3	2	3	3	3	3
CO3	3	3	3	3	3	2	2	-	3	2	3	3	3	3

Course Contents

Guidelines for Internship

Minimum of Eight weeks to 6 months in an Industry in the area of Electrical Engineering.The Professional internship should give exposure to the practical aspects of the discipline. In addition, the student may also work on a specified task or project, which may be assigned to him/her. The outcome of the internship should be presented in the form of a report.

There are four different options available for the students to earn internship credit.

1. **SAP:** Students shall register for SAP certification course under the **SAP** Academy Centre of the Department. After registration, Students shall attend the 200 hours training under the module provided by **SAP** Academy. Students shall attend the internship provided under the specific module. Credits shall be awarded to the students on successful completion of Global Certification examination conducted by **SAP India**.
2. **Data Science:** Any industry related Project or Task allotted by Renowned Organisation.

3. **Industrial Internship:** Credits shall be awarded to the students on successful completion of Industrial Internship for 2-6 month.
Guidelines:
Two guides shall supervise the internship project work, one from the department and another one from industry.
Industry shall submit the month-wise satisfactory attendance of the students to the institute/department
Students must regularly use a daily diary, which is to cultivate the habit of documenting.
The presentation is a way to evaluate student performance, so students must be ready as institute guides, and internal and external examiners evaluate them.
Students must submit a comprehensive report to the department before presentation.
Steps to apply for internship
Students shall ask for permission letters from Department office/office of Training & Placement cell of the college in consultation of guide (Institute) to allot Minimum 8 to 12 weeks during internship periods.
Students on joining Training at the concerned Industry must submit the permission letter from the office of Training & Placement cell of the college.
Students must regularly use a diary to record the details and submit attendance in the internship report.
Students shall obtain a Training Certificate from industry.
Students shall submit a training report after completion of internship to guide.
Evaluation process for internship
Students must submit training reports and training certificates from industry after completion of internship to guide.
Guide will assess performance of student through presentation, which is evaluated by institute guide and external examiner from institute itself.

EE415: PROJECT STAGE II

Teaching Scheme	**Examination Scheme**
Practical: 04 Hrs./Week	**Oral: 50 Marks**
Credits: 02 Credits	**Total: 50 Marks**

Prerequisite Course:

1. Mini Project, Seminar

Course Objectives

1. The student should be made to learn methodology to select a good project and able to work in a team leading to development of hardware/software product.
2. Prepare a good technical report.
3. Gain Motivation to present the ideas behind the project with clarity.

Course Outcomes (COs):

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

	Course Outcome (s)	**Bloom's Taxonomy**	
		Level	**Descriptor**
CO1	Identify, formulate, design, interpret, analyze and provide solutions to complex engineering and societal issues by applying knowledge gained on basics of science and Engineering	**3**	Apply
CO2	Choose, conduct and demonstrate a sound technical knowledge of their selected project topics in the field of power components, protection, high voltage, electronics, process automation, power electronics and drives, instrumentation and control, allied engineering by exploring suitable engineering and IT tools.	**5**	Evaluate
CO3	Formulate and propose new learning algorithms to solve engineering and societal problems of moderate complexity through multidisciplinary projects understanding commitment towards sustainable development.	**6**	Create
CO4	Demonstrate, prepare reports, communicate and work in a team as a member/leader by adhering to ethical responsibilities.	**2**	Understand

Mapping of Course Outcomes to Program Outcomes (POs) & Program Specific Outcomes (PSOs):

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	3	-	-	-	-	-	-	-	-	3	3
CO2	-	-	-	-	3	3	-	-	-	-	-	-	3	3
CO3	-	-	-	-	-	-	3	-	3	-	-	-	3	3
CO4	-	-	-	-	-	-	-	3	3	3	3	3	3	3

Project Stage II

The aim of the project work is to deepen comprehension of principles by applying them to a new problem which may be the design /fabrication of any power component / circuit / sensor / Activator / Controller, a research investigation, a computer or management project or a design problem.

The progress of the project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners constituted by the Head of the Department based on oral presentation and the project report.

Guidelines to students:

1. Continue with the same group and identify opportunities for self-learning and upgrading skills.
2. Actively participate in all the activities related to the project.
3. Document the project in the form of a hard-bound report at the end and submit it to the department.
4. Attempt to make a prototype, working model, and demonstration of the project to display during the final presentation.
5. Participate in project competitions, paper presentations, etc.
6. Maintain an institutional culture of authentic collaboration, self-motivation, peer learning, and personal responsibility.
7. Maintain a notebook to keep records of all the meetings, discussions, notes, etc. This is to be done by the individual student and submitted at the end to the supervisor or guide.
8. Some parameters, will be evaluated and assessed at a group level and some at an individual level.
9. Format for project report is given in project stage I guidelines.