COURSE STRUCTURE (R20)

Definition of Credit (C)

1 Hour Lecture (L) per week	1 Credit
1 Hour Tutorial (T) per week	1 Credit
1 Hour Practical (P) per week	0.5 Credit

Structure of B. Tech program Regulation R20

S.No.	Category	Code	Suggested Breakup of Credits by AICTE	Suggested Breakup of Credits by APSCHE	Breakup of Credits
1	Humanities and Social Sciences including Management courses	HS	12	10.5	10.5
2	Basic Science courses	BS	25	21	21
3	Engineering Science courses including workshop, drawing, basics of electrical/ mechanical/ computer etc	ES	24	24	25.5
4	Professional core courses	PC	48	51	49.5
5	Professional Elective courses relevant to chosen specialization/ branch	PE	18	15	15
6	Open subjects – Electives from other technical and /or emerging subjects	OE	18	12	12
7	Project work, seminar and internship in industry or elsewhere	PR	15	16.5	16.5
8	Mandatory Courses [Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Traditional Knowledge]	NC	Non-Credit	Non-Credit	0
9	Skill Oriented Courses	SC	--	10	10
Total			**160**	**160**	**160**

SEMESTER-WISE STRUCTURE OF CURRICULUM

SEMESTER-WISE STRUCTURE OF CURRICULUM

Course structure for eight semesters during four years of study is as follows

I Year I Semester (Semester-1)

S. No.	Category	Course Name	L	T	P	C
1	HS1101	Communicative English	3	0	0	3
2	BS1101	Mathematics-I	2	1	0	3
3	BS1102	Applied Physics	3	0	0	3
4	ES1101	Problem Solving using C	3	0	0	3
5	ES1102	Engineering Graphics	1	0	4	3
6	HS1101L	Communicative English Lab	0	0	3	1.5
7	BS1102L	Applied Physics & Virtual Lab	0	0	3	1.5
8	ES1101L	Problem Solving using C Lab	0	0	3	1.5
Total Credits						**19.5**

Category	Credits
Humanities and Social Science Courses	4.5
Basic Science Courses	7.5
Engineering Science Courses	7.5
Total Credits	**19.5**

I Year II Semester (Semester-2)

S. No.	Category	Course Name	L	T	P	C
1	BS1201	Mathematics-II	2	1	0	3
2	BS1202	Applied Chemistry	3	0	0	3
3	ES1201	Basic Electronic Devices and Circuits	2	1	0	3
4	ES1202	Problem Solving using Python	3	0	0	3
5	PC1201	Basic Circuit Analysis	2	1	0	3
6	BS1202L	Applied Chemistry Lab	0	0	3	1.5
7	ES1201L	Basic Electronic Devices and Circuits Lab	0	0	3	1.5
8	ES1202L	Problem Solving using Python Lab	0	0	3	1.5
9	MC1201	Indian Constitution	2	0	0	0
Total Credits						**19.5**

Category	Credits
Basic Science Courses	7.5
Professional Core Courses	3
Engineering Science Courses	9
Mandatory course (AICTE)	0
Total Credits	**19.5**

II Year I Semester (Semester-3)

S.No	Category	Course Title	L	T	P	C
1	BS2101	Mathematics-III	2	1	0	3
2	ES2101	Data Structures	3	0	0	3
3	PC2101	Electrical Machines –I	2	1	0	3
4	PC2102	Electrical Circuit Analysis	2	1	0	3
5	PC2103	Electromagnetic Fields	2	1	0	3
6	ES2101L	Data Structures Lab	0	0	3	1.5
7	PC2101L	Electrical machines –I Lab	0	0	3	1.5
8	PC2102L	Electrical Circuit Analysis Lab	0	0	3	1.5
9	SOC2101	Skill oriented course-1	1	0	2	2
10	MC2101	Essence of Indian Traditional Knowledge	2	0	0	0
Total Credits						**21.5**

Category	Credits
Basic Science Course	3
Engineering Science Courses	4.5
Professional Core Courses	12
Skill Oriented Course	2
Mandatory Course (AICTE)	0
Total Credits	**21.5**

II Year II Semester (Semester-4)

S.No	Category	Course Title	L	T	P	C
1	BS2201	Complex Variables and Statistical Methods	2	1	0	3
2	ES2201	Thermal and Hydro Prime Movers	3	0	0	3
3	PC2201	Power Systems-I	3	0	0	3
4	PC2202	Electrical Machines – II	2	1	0	3
5	PC2203	Control Systems	2	1	0	3
6	ES2201L	Thermal and Hydro Prime Movers Lab	0	0	3	1.5
7	PC2202L	Electrical Machines - II Lab	0	0	3	1.5
8	PC2204L	Control Systems Lab	0	0	3	1.5
9	SOC2201	Skill Oriented Course-2	1	0	2	2
10	MC2201	Environmental Science	2	0	0	0
Total Credits						**21.5**
		Internship/Community Service Project 2 Months (Mandatory) during summer vacation				
		Honors/Minor courses	3	0	2	4

Category	Credits
Basic Science Courses	3
Engineering Science Courses	4.5
Professional Core Courses	12
Skill Oriented Courses	2
Mandatory course (AICTE)	0
Total Credits	**21.5**

III Year I Semester (Semester-5)

S.No	Category	Course Title	L	T	P	C
1	HS3101	Engineering Economics and Management	3	0	0	3
2	PC3101	Power Systems – II	2	1	0	3
3	PC3102	Electrical Measurements and Instrumentation	3	0	0	3
4	PC3103	Power Electronics	3	0	0	3
5	OE3101	Open Elective-I	2	0	2	3
6	PC3102L	Electrical Measurements and Instrumentation Lab	0	0	3	1.5
7	PC3103L	Power Electronics Lab	0	0	3	1.5
8	SAC3101	Skill Advanced Course-1	1	0	2	2
9	INTERN3101	Summer Internship 2 Months (Mandatory) after second year (to be evaluated during V semester	0	0	0	1.5
					Total Credits	**21.5**
		Honors/Minor courses	3	0	2	4

Category	Credits
Humanities and Social Science Courses	3
Professional Core Courses	12
Open Elective Courses	3
Skill Advanced Course	2
Summer Internship	1.5
Total Credits	**21.5**

III Year II Semester (Semester-6)

S.No	Category	Course Title	L	T	P	C
1	HS3201	Universal Human Values-2	3	0	0	3
2	PC3201	Microprocessors & Microcontrollers	3	0	0	3
3	PC3202	Power Systems -III	2	1	0	3
4	PE3201	Professional Elective I 1. Digital Electronics 2. Special Electrical Machines 3. Advanced Control Systems 4. Solar and wind Energy Conversion Systems	2	0	2	3
5	PE3201	Professional Elective II 1. Power System Protection 2. Renewable Energy Sources 3. Advanced Control Systems 4. NPTEL/SWAYAM Duration: 12 Weeks minimum *course /subject title can't be repeated.	2	0	2	3
6	PC3201L	Microprocessors & Microcontrollers Lab	0	0	3	1.5
7	PC3202L	Power Systems Lab	0	0	3	1.5
8	PC3203L	Electrical Simulation Lab	0	0	3	1.5
9	SAC3201	Skill Advanced Course-2	1	0	2	2
Total Credits						**21.5**
		Industrial/Research Internship 2Months (Mandatory) during summer vacation				
		Honors/Minor courses	3	0	2	4

Category	Credits
Professional Core Courses	10.5
Humanities and Social Science Courses	3
Professional Electives Course	6
Skill Advanced Course	2
Total Credits	**21.5**

IV Year I Semester (Semester-7)

S.No	Category	Course Title	L	T	P	C
1	PE4101	Professional Elective III 1. Utilization of Electrical Energy 2. FACTS 3. High Voltage Engineering 4. Electrical Engineering Materials	2	0	2	3
2	PE4102	Professional Elective IV 1. Electric Drives 2. HVAC &DC Transmission 3. Power System Reliability 4. Reactive Power Compensation & Management	2	0	2	3
3	PE4103	Professional Elective V 1. Digital Control Systems 2. Energy Conservation & Auditing 3. Electric Power Quality 4. Electrical Machine Design	2	0	2	3
4	OE4101	Open Elective II	2	0	2	3
5	OE4102	Open Elective III	2	0	2	3
6	OE4103	Open Elective IV	2	0	2	3
7	SAC4101	Skill Advanced Course-3	1	0	2	2
8	MC4101	Entrepreneurial Skill Development	2	0	0	0
9	INTERN4101	Industrial/Research Internship 2 Months (Mandatory) after third year (to be evaluated during VII semester)	0	0	0	3
Total Credits						**23**
		Honors/Minor courses	3	0	2	4

Category	Credits
Professional Elective Courses	9
Open Elective Courses	9
Industrial/Research Internship (Mandatory)2months	3
Skill Advanced Course	2
Mandatory Course(AICTE)	0
Total Credits	**23**

IV Year II Semester (Semester-8)

S. No	Subject code	Course Name	L	T	P	C
1	PROJ4201	Major Project Project work, seminar, and internship in industry	0	0	0	12
		Internship (6 months)				
					Total Credits	**12**

Open Elective Courses

OE3101	OOPS Through JAVA	Advanced Python Programming	MEMS	Block-chain Technology
OE4101	Signals and Systems	Machine Learning	Electrical Machines Modelling and Analysis	VLSI
OE4102	Big Data Analytics	Linear IC Applications	Robotics	Embedded Systems
OE4103	Neural Networks & Fuzzy Logic	Cyber Security	Nano-Technology	Digital Signal Processing

Skill Oriented Course/Skill Advanced Courses

SOC2101	Fundaments of Internet of Things (IoT)	Industrial Safety, Codes and Standards	DC Drives	Python library tools
SOC2201	Fundaments of MATLAB and PSpice	Solar Panel installation	Sensors & Actuators for IoT	AC Drives
SAC3101	**Soft skills**	**Soft skills**	**Soft skills**	**Soft skills**
SAC3202	SGP (Low Voltage Switchgears)	PLC and SCADA	PSCAD	Process Instrumentation
SAC4101	Power Bi	Amazon Web Services	ETAP (Electrical Transient & Analysis Program)	HOMER (Hybrid optimization Model for Electrical Renewable)

List of Open Elective Subjects offered by EEE Branch

Open Elective-I

1.Non Conventional Energy Sources
2.Electrical Estimating and Costing
3.Principles of Electric Power Conversion

Open Elective-II

1.Programmable Logic Controller and Applications
2.Energy Storage Systems
3.Soft Computing Techniques

Open Elective-III

1.Electric Vehicles
2.Indian Electricity Act, 2003
3.Power Systems for Data Centres

Courses for Honors degree

POOL-1 (II-II)	**POOL-2 (III-I)**	**POOL-3 (III-II)**	**POOL-4 (IV-I)**
Analysis of Linear Systems	Energy Economics	Power System Optimization	Advanced Power Converters
Energy Storage Systems	Distribution System Engineering	Power System Protection	Hybrid Electrical Vehicle
Semiconductor Device Modeling	Sensors and Transducers	Advanced Power Systems	Modern Control Theory
Renewable Energy Sources	Process Control Engineering	Real Time Control of Power System	Power System Operation and Deregulation(PSOD)
MOOC-1*(NPTEL/SWAYAM) Duration:12Weeks minimum			
MOOC-2*(NPTEL/SWAYAM) Duration:12Weeks minimum			

*Course/subject title can't be repeated

General Minor Tracks

Department of Electrical and Electronics Engineering

S.No.	Course Name	L	T	P	C
1	Special Electrical Machines	3	0	2	4
2	Electrical Measurements and Instrumentation	3	0	2	4
3	M ATLAB for Engineering Applications	3	0	2	4
4	Generation of Electric Power	3	0	2	4
5	Energy audit	3	0	2	4
6	Non-conventional energy sources	3	0	2	4

Note:

i. A student can select four subjects from the above six subjects @3-0-2-4 credits per subject.
ii. Compulsory MOOC/NPTEL courses for 04 credits (02courses @02credits each)

VVIT Life skill courses

The following courses are admitted to be the **courses beyond curriculum** to improveindividuallifeskills.Thesecoursesandwillbedemonstratedintheclassrooma ndwillbehavinganinternalassessmentforsatisfactory.

S.No	Year and Semester	Course Name
1	I Year I Semester(Semester-1)	Quantitative Aptitude
2	I Year II Semester(Semester-2)	Verbal Ability
3	II Year I Semester(Semester-3)	Understanding Self for Effectiveness
4	II Year II Semester(Semester-4)	Design Thinking
5	III Year I Semester(Semester-5)	Stress and Coping Strategies
6	III Year II Semester(Semester-6)	Research Skills

SYLLABUS

I-Year-I Semester HS1101	COMMUNICATIVE ENGLISH (Common to CIV, EEE, MEC & ECE)	L	T	P	C
		3	0	0	3

Course objectives:

The main objectives are

1. Adopt activity-based teaching-learning methods to ensure that learners would be engaged in use of language both in the classroom and laboratory sessions.
2. Facilitate effective listening skills for better comprehension of academic lectures and English spoken by native speakers
3. Focus on appropriate reading strategies for comprehension of various academic texts and authentic materials
4. Help improve speaking skills through participation in activities such as role plays, discussions and structured talks/oral presentations
5. Impart effective strategies for good writing and demonstrate the same in summarizing, writing well organized essays, record and report useful information
6. Provide knowledge of grammatical structures and vocabulary and encourage their appropriate use in speech and writing

Unit – 1: **13 HOURS**

Detailed Study: A Proposal to Girdle the Earth (Excerpt) by Nellie Bly

Theme: Exploration

Listening: Identifying the topic, the context and specific pieces of information by listening to short audio texts and answering a series of questions.

Speaking: Asking and answering general questions on familiar topics such as home, family, work, studies and interests; introducing oneself and others. **Reading:** Skimming to get the main idea of a text; scanning to look for specific pieces of information.

Reading for Writing: Beginnings and endings of paragraphs - introducing the topic, summarizing the main idea and/or providing a transition to the next paragraph.

Grammar and Vocabulary: Content words and function words; word forms: verbs, nouns, adjectives and adverbs; nouns: countable and uncountable; singular and plural; basic sentence structures; simple question form - wh-questions; word order in sentences.

Non-Detailed Study:

1. "How to Fashion Your Own Brand of Success" by Howard Whitman

2. "How to Recognize Your Failure Symptoms" by Dorothea Brande

Unit-2: **13 HOURS**

Detailed Study: An excerpt from The District School as It Was by One Who Went to It by Warren Burton

Theme: On Campus

Listening: Answering a series of questions about main idea and supporting ideas after listening to audio texts.

Speaking: Discussion in pairs/ small groups on specific topics followed by short structured talks.

Reading: Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together.

Writing: Paragraph writing (specific topics) using suitable cohesive devices; mechanics of writing - punctuation, capital letters.

Grammar and Vocabulary: Cohesive devices - linkers, signposts and transition signals; use of articles and zero article; prepositions.
Non-detailed Study:
3. "How to Conquer the Ten Most Common Causes of Failure" by Louis Binstock
4. "How to Develop Your Strength to Seize Opportunities" by Maxwell Maltz

Unit-3: **13 HOURS**
Detailed Study: The Future of Work?
Theme: Working Together
Listening: Listening for global comprehension and summarizing what is listened to.
Speaking: Discussing specific topics in pairs or small groups and reporting what is discussed
Reading: Reading a text in detail by making basic inferences - recognizing and interpreting specific context clues; strategies to use text clues for comprehension.
Writing: Summarizing - identifying main idea/s and rephrasing what is read; avoiding redundancies and repetitions.
Grammar and Vocabulary: Verbs - tenses; subject-verb agreement; direct and indirect speech, reporting verbs for academic purposes.
Non-Detailed Study:
5. "How to Make the Most of Your Abilities" by Kenneth Hildebrand
6. "How to Raise Your Self-Esteem and Develop Self-confidence" by James W Newman

Unit-4: 13 HOURS
Detailed Study: H.G Wells and the Uncertainties of Progress by Peter J. Bowler
Theme: Fabric of Change
Listening: Making predictions while listening to conversations/ transactional dialogues without video; listening with video.
Speaking: Role-plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions.
Reading: Studying the use of graphic elements in texts to convey information, reveal trends/patterns/relationships, communicate processes or display complicated data.
Writing: Information transfer; describe, compare, contrast, identify significance/trends based on information provided in figures/charts/graphs/tables.
Grammar and Vocabulary: Quantifying expressions - adjectives and adverbs; comparing and contrasting; degrees of comparison; use of antonyms
Non-Detailed Study
7. "How to Win Your War against Negative Feelings" by Dr Maxwell Maltz
8. "How to Find the Courage to Take Risks" by Drs. Tom Rusk and Randy Read

Unit-5: 13 HOURS
Detailed Study: Leaves from the Mental Portfolio of a Eurasian by Sui Sin Far
Theme: Tools for Life
Listening: Identifying key terms, understanding concepts and answering a series of relevant questions that test comprehension.
Speaking: Formal oral presentations on topics from academic contexts - without the use of PPT slides.
Reading: Reading for comprehension.
Writing: Writing structured essays on specific topics using suitable claims and evidences
Grammar and Vocabulary: Editing short texts – identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject verb agreement)
Non-Detailed Study
9. "How to Become a Self-Motivator" by Charles T Jones

10. "How to Eliminate Your Bad Habits" by OgMandino

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

CO1	identify the context, topic, and pieces of specific information from social or transactional dialogues spoken by native speakers of English and formulate sentences using proper grammatical structures and correct word forms **(Describe, relate, tell, find L-3)**
CO2	speak clearly on a specific topic using suitable discourse markers in informal discussions **(Discuss, outline, explain, predict – L3)**
CO3	write summaries based on global comprehension of reading/listening texts **(Use, categorize, complete, solve L-3)**
CO4	produce a coherent paragraph interpreting a figure/graph/chart/table **(Identify, compare, explain, illustrate- L4)**
CO5	take notes while listening to a talk/lecture to answer questions **(explain, relate, outline, complete -L3)**

Text books:

1. English All Round: Communication Skills for Undergraduate Learners-Volume 1, Orient Black Swan, 2019
2. University of Success by OgMandino, Jaico, 2015.

Reference books:

1. Bailey, Stephen. Academic writing: A handbook for international students. Routledge, 2014.
2. Chase, Becky Tarver. Pathways: Listening, Speaking and Critical Thinking. Heinley ELT; 2nd Edition, 2018.
3. Skillful Level 2 Reading & Writing Student's Book Pack (B1) Macmillan Educational.
4. Hewings, Martin. Cambridge Academic English (B2). CUP, 2012.

AICTE Recommended Books

5. Meenakshi Raman and Sangeeta Sharma. Technical Communication. Oxford University Press, 2018.
6. Pushplata and Sanjay Kumar. Communication Skills, Oxford University Press, 2018.
7. Kulbushan Kumar. Effective Communication Skills. Khanna Publishing House, Delhi

Sample Web Resources

Grammar / Listening / Writing

1-language.com
http://www.5minuteenglish.com/
https://www.englishpractice.com/

Grammar/Vocabulary

English Language Learning Online
http://www.bbc.co.uk/learningenglish/
http://www.better-english.com/
http://www.nonstopenglish.com/
https://www.vocabulary.com/
BBC Vocabulary Games
Free Rice Vocabulary Game

Reading
https://www.usingenglish.com/comprehension/
https://www.englishclub.com/reading/short-stories.htm
https://www.english-online.at/
Listening
https://learningenglish.voanews.com/z/3613
http://www.englishmedialab.com/listening.html
Speaking
https://www.talkenglish.com/
BBC Learning English – Pronunciation tips
Merriam-Webster – Perfect pronunciation Exercises
All Skills
https://www.englishclub.com/
http://www.world-english.org/
http://learnenglish.britishcouncil.org/

Micro-Syllabus of Communicative English

Unit 1

Detailed Study: A Proposal to Girdle the Earth (Excerpt) by Nellie Bly
Theme: Exploration
Listening: Identifying the topic, the context and specific pieces of information by listening to short audio texts and answering a series of questions.
Speaking: Asking and answering general questions on familiar topics such as home, family, work, studies and interests; introducing oneself and others.
Reading: Skimming to get the main idea of a text; scanning to look for specific pieces of information.
Reading for Writing: Beginnings and endings of paragraphs - introducing the topic, summarizing the main idea and/or providing a transition to the next paragraph.
Grammar and Vocabulary: Content words and function words; word forms: verbs, nouns, adjectives and adverbs; nouns: countable and uncountable; singular and plural; basic sentence structures; simple question form - wh-questions; word order in sentences.
Non-Detailed Study:
1. "How to Fashion Your Own Brand of Success" by Howard Whitman
2. "How to Recognize Your Failure Symptoms" by Dorothea Brande

Unit	Module	Micro content
1a.Detailed Study	**Listening**	Identifying the topic, the context and specific pieces of information by listening to short audio texts and answering a series of questions.
	Speaking	Asking and answering general questions on familiar topics such as home, family, work, studies and interests; introducing oneself and others.
	Reading	Beginnings and endings of paragraphs - introducing the topic, summarizing the main idea and/or providing a transition to the next paragraph.

	Grammar and Vocabulary	Content words and function words; word forms: verbs, nouns, adjectives and adverbs; nouns: countable and uncountable; singular and plural; basic sentence structures; simple question form - wh-questions; word order in sentences.
1b.Non-Detailed Study	**“How to Fashion Your Own Brand of Success” by Howard Whitman**	Introduction to Whitman Summary of the Essay
	How to Recognize Your Failure Symptoms” by Dorothea Brande	Introduction to Dorothea Brande Summary of the Essay

Unit 2
Detailed Study: The District School As It Was by One Who Went to It by Warren Burton
Theme: On Campus
Listening: Answering a series of questions about main idea and supporting ideas after listening to audio texts.
Speaking: Discussion in pairs/ small groups on specific topics followed by short structured talks.
Reading: Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together.
Writing: Paragraph writing (specific topics) using suitable cohesive devices; mechanics of writing - punctuation, capital letters.
Grammar and Vocabulary: Cohesive devices - linkers, signposts and transition signals; use of articles and zero article; prepositions.
Non-detailed Study:
3. “How to Conquer the Ten Most Common Causes of Failure” by Louis Binstock
4. “How to Develop Your Strength to Seize Opportunities” by Maxwell Maltz

Unit	Module	Micro content
2a. Detailed Study	**Listening**	Answering a series of questions about main idea and supporting ideas after listening to audio texts.
	Speaking	Discussion in pairs/ small groups on specific topics followed by short structured talks.
	Reading	Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together.
	Writing	Paragraph writing (specific topics) using suitable cohesive devices; mechanics of writing - punctuation, capital letters.

	Grammar and Vocabulary	Cohesive devices - linkers, signposts and transition signals; use of articles and zero article; prepositions.
2b. Non-Detailed Study	**"How to Conquer the Ten Most Common Causes of Failure" by Louis Binstock**	Introduction to Louis Binstock Summary of the Essay
	"How to Develop Your Strength to Seize Opportunities" by Maxwell Maltz	Introduction to Maxwell Maltz Summary of the Essay

Unit 3
Detailed Study: The Future of Work
Theme: Working Together
Listening: Listening for global comprehension and summarizing what is listened to.
Speaking: Discussing specific topics in pairs or small groups and reporting what is discussed
Reading: Reading a text in detail by making basic inferences - recognizing and interpreting specific context clues; strategies to use text clues for comprehension.
Writing: Summarizing - identifying main idea/s and rephrasing what is read; avoiding redundancies and repetitions.
Grammar and Vocabulary: Verbs - tenses; subject-verb agreement; direct and indirect speech, reporting verbs for academic purposes.
Non-Detailed Study:
5. "How to Make the Most of Your Abilities" by Kenneth Hildebrand
6. "How to Raise Your Self-Esteem and Develop Self-confidence" by James W Newman

Unit	Module	Micro content
3a. Detailed Study	**Listening**	Listening for global comprehension and summarizing what is listened to.
	Speaking	Discussing specific topics in pairs or small groups and reporting what is discussed
	Reading	Reading a text in detail by making basic inferences - recognizing and interpreting specific context clues; strategies to use text clues for comprehension.
	Writing	Summarizing - identifying main idea/s and rephrasing what is read; avoiding redundancies and repetitions.
	Grammar and Vocabulary	Verbs - tenses; subject-verb agreement; direct and indirect speech, reporting verbs for academic purposes.
3b. Non-Detailed	**"How to Make the Most**	Introduction to Kenneth Hildebrand

Study	**of Your Abilities" by Kenneth Hildebrand**	Summary of the Essay
	How to Raise Your Self-Esteem and Develop Self-confidence" by James W Newman	Introduction to James Newman Summary of the Essay

Unit 4
Detailed Study: H.G Wells and the Uncertainties of Progress by Peter J. Bowler
Theme: Fabric of Change
Listening: Making predictions while listening to conversations/ transactional dialogues without video; listening with video.
Speaking: Role-plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions.
Reading: Studying the use of graphic elements in texts to convey information, reveal trends/patterns/relationships, communicate processes or display complicated data.
Writing: Information transfer; describe, compare, contrast, identify significance/trends based on information provided in figures/charts/graphs/tables.
Grammar and Vocabulary: Quantifying expressions - adjectives and adverbs; comparing and contrasting; degrees of comparison; use of antonyms
Non-Detailed Study
7. "How to Win Your War Against Negative Feelings" by Dr Maxwell Maltz
8. "How to Find the Courage to Take Risks" by Drs. Tom Rust and Randy Read

Unit	Module	Micro content
4a. Detailed Study	**Listening**	Making predictions while listening to conversations/ transactional dialogues without video; listening with video.
	Speaking	Role plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions..
	Reading	Studying the use of graphic elements in texts to convey information, reveal trends/patterns/relationships, communicate processes or display complicated data.
	Writing	Information transfer; describe, compare, contrast, identify significance/trends based on information provided in figures/charts/graphs/tables.
	Grammar and Vocabulary	Quantifying expressions - adjectives and adverbs; comparing and contrasting; degrees of comparison; use of antonyms

<table>
<tr><td rowspan="2">4b. Non-Detailed Study</td><td>“How to Win Your War Against Negative Feelings” by Dr Maxwell Maltz</td><td>Introduction to Dr Maxwell Maltz
Summary of the Essay</td></tr>
<tr><td>“How to Find the Courage to Take Risks” by Drs Tom Rust and Randy Read</td><td>Introduction to Drs. Tom Rust and Randy Read
Summary of the Essay</td></tr>
<tr><td colspan="3"><u>Unit 5</u>
Detailed Study: Leaves from the Mental Portfolio of a Eurasian by Sui Sin Far
Theme: Tools for Life
Listening: Identifying key terms, understanding concepts and answering a series of relevant questions that test comprehension. Speaking: Formal oral presentations on topics from academic contexts - without the use of PPT slides.
Reading: Reading for comprehension. Writing: Writing structured essays on specific topics using suitable claims and evidences
Grammar and Vocabulary: Editing short texts – identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject verb agreement)
Non-Detailed Study
9. “How to Become a Self-Motivator” by Charles T Jones
10. “How to Eliminate Your Bad Habits” by OgMandino</td></tr>
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<tr><td>Speaking</td><td>Formal oral presentations on topics from academic contexts - without the use of PPT slides.</td></tr>
<tr><td>Reading</td><td>Reading for comprehension.</td></tr>
<tr><td>Writing</td><td>Writing structured essays on specific topics using suitable claims and evidences</td></tr>
<tr><td>Grammar and Vocabulary</td><td>Editing short texts – identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject verb agreement)</td></tr>
<tr><td rowspan="2">5b. Non-Detailed Study</td><td>“How to Become a Self-Motivator” by Charles T Jones</td><td>Introduction to Charles T Jones
Summary of the Essay</td></tr>
<tr><td>“How to Eliminate Your Bad Habits” by OgMandino</td><td>Introduction to OgMandino
Summary of the Essay</td></tr>
</table>

Course Outcomes

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

CO1. identify the context, topic, and pieces of specific information from social or transactional dialogues spoken by native speakers of English and formulate sentences using proper grammatical structures and correct word forms **(Describe, relate, tell, find L-3)**

CO2. speak clearly on a specific topic using suitable discourse markers in informal discussions **(Discuss, outline, explain, predict – L3)**

CO3. write summaries based on global comprehension of reading/listening texts **(Use, categorize, complete, solve L-3)**

CO4. produce a coherent paragraph interpreting a figure/graph/chart/table **(Identify, compare, explain, illustrate- L4)**

CO5. take notes while listening to a talk/lecture to answer questions **(explain, relate, outline, complete -L3)**

CO-PO MAPPING

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

I-Year-I Semester	Mathematics-I	L	T	P	C
BS1101		3	1	0	3

Preamble: This course illuminates the students in the concepts of calculus.

Course objectives:

The main objectives are

1. To enlighten the learners in the concept of differential equations and multivariable calculus.
2. To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real-world problems and their applications.

Unit–1: **13 HOURS**

Differential equations of first order and first degree

Linear differential equations-Bernoulli's equations - Exact equations and equations reducible to exact form.

Applications: Newton's Law of cooling – Law of natural growth and decay – Orthogonal trajectories – Electrical circuits.

Unit–2: **13 HOURS**

Linear differential equations of higher order

Non-homogeneous equations of higher order with constant coefficients – with non-homogeneous term of the type $e^{ax}, \sin ax, \cos ax$, polynomials in x^n , $e^{ax}V(x)$ and $x^nV(x)$ - Method of Variation of Parameters.

Applications: LCR circuit – Simple harmonic motion

Unit–3: **12 HOURS**

Mean value theorems

Mean value theorems (without proofs): Rolle's Theorem – Lagrange's mean value theorem – Cauchy's mean value theorem – Taylor's and Maclaurin's theorems with remainders.

Unit–4: **14 HOURS**

Partial differentiation

Introduction – Homogeneous function – Euler's theorem - Total derivative – Chain rule – Jacobian – Functional dependence – Taylor's and Mc Laurent's series expansion of functions of two variables.

Applications: Maxima and Minima of functions of two variables without constraints and Lagrange's method (with constraints).

Unit–5: **13 HOURS**

Multiple integrals

Double integrals (Cartesian and Polar) – Change of order of integration – Change of variables (Cartesian to Polar) –Triple integrals.

Applications: Areas by double integrals and Volumes by triple integrals.

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

CO1	solve the differential equations related to various engineering fields.
CO2	utilize mean value theorems to real life problems.
CO3	familiarize with functions of several variables which is useful in optimization.
CO4	apply double integration techniques in evaluating areas bounded by region.
CO5	learn important tools of calculus in higher dimensions. Students will become familiar with 2-dimensional and 3 – dimensional coordinate systems.

Text books:

1. **B.S. Grewal,** Higher Engineering Mathematics, 44th Edition, Khanna Publishers.
2. **B.V. Ramana,** Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

Reference books:

1. **H. K. Das,** Advanced Engineering Mathematics, 22nd Edition, S. Chand & Company Ltd.
2. **Erwin Kreyszig**, Advanced Engineering Mathematics, 10th Edition, Wiley-India.

Micro-Syllabus of MATHEMATICS – I (Calculus)

Unit-1: Differential equations of first order and first degree:
Linear differential equations-Bernoulli's equations - Exact equations and equations reducible to exact form.
Applications: Newton's Law of cooling – Law of natural growth and decay – Orthogonal trajectories – Electrical circuits.

Unit	Module	Micro content
1a. & 2a. Differential equations of first order and first degree	Linear differential equations	Solution of Linear differential equations in $'y'$
		Solution of Linear differential equations in $'x'$
		Initial value problem
	Non-Linear differential equations	Bernoulli's equations
		Equations reducible to Linear differential equations
	Exact differential equations	Solution of Exact differential equations
	Non-Exact differential equations	Equations reducible to Exact equations
		Integrating factor found by inspection
		Integrating factor of a Homogeneous equation
		Integrating factor for an equation of the type $f_1(xy)\,ydx + f_2(xy)\,xdy = 0$
		Integrating factor, if $\dfrac{\frac{\partial M}{\partial y} - \frac{\partial N}{\partial x}}{N}$ be a function of $'x'$
		Integrating factor, if $\dfrac{\frac{\partial N}{\partial x} - \frac{\partial M}{\partial y}}{M}$ be a function of 'y'

1b. & 2b. Applications	Application of differential equations of first order and first degree	Newton's Law of cooling
		Law of natural growth and decay
		Orthogonal trajectories
		Electrical circuits

Unit-2: Linear differential equations of higher order:
Non-homogeneous equations of higher order with constant coefficients – with non-homogeneous term of the type e^{ax}, $\sin ax$, $\cos ax$, polynomials in x^n , $e^{ax}V(x)$ and $x^n V(x)$ - Method of Variation of Parameters.
Applications: LCR circuit – Simple harmonic motion

Unit	**Module**	**Micro content**
3a. & 4a. Linear differential equations of higher order	Homogeneous equations of higher order with constant coefficients	Finding the Complementary function
	Non-homogeneous equations of higher order with constant coefficients	Particular integral of the type 'e^{ax}'
		Particular integral of the type 'sinax' (or) '$\cos ax$'
		Particular integral of the type x^n
		Particular integral of the type 'e^{ax} V(x)'
		Particular integral of the type 'x^nv(x)'
3b. & 4b. Applications	Applications of Non-homogeneous equations of higher order with constant coefficients	Method of variation of parameters
		LCR circuit
		Basic problems on simple harmonic motion

Unit-3: Mean value theorems:
Mean value theorems (without proofs): Rolle's theorem – Lagrange's mean value theorem – Cauchy's mean value theorem – Taylor's and Maclaurin's theorems with remainders.

Unit	**Module**	**Micro content**
5a. & 6a. Mean value theorems	Mean value theorems	Rolle's theorem
		Lagrange's mean value theorem
5b. & 6b. Mean value theorems	Mean value theorems	Cauchy's mean value theorem
		Taylor's expansions of $f(x)$
		Maclaurin's expansions of $f(x)$

Unit-4: Partial differentiation:
Introduction – Homogeneous function – Euler's theorem - Total derivative – Chain rule – Jacobians – Functional dependence – Taylor's and Mc Laurent's series expansion of functions of two variables.
Applications: Maxima and Minima of functions of two variables without constraints and Lagrange's method (with constraints).

Unit	**Module**	**Micro content**
7a. & 8a.	**Partial Differentiation**	Euler's theorem

Partial differentiation		Total derivative
		Chain rule
		Jacobians
7b. & 8b. Applications	**Applications of Partial Differentiation**	Taylor's and Mc Laurent's series expansion of functions of two variables
		Maxima and Minima of functions of two variables
		Lagrange's method of undetermined multipliers
Unit-5: Multiple integrals: Double integrals (Cartesian and Polar) – Change of order of integration – Change of variables (Cartesian to Polar) –Triple integrals. **Applications**: Areas by double integrals and Volumes by triple integrals.		
Unit	**Module**	**Micro content**
9a. & 10a. Multiple integrals	Evaluation of Double Integrals	Double integrals
		Change of order of integration
		Double integrals in Polar co-ordinates
		Change of variables
9b. & 10b. Applications	Evaluation of Triple Integrals	Triple integrals
	Applications of Multiple Integrals	Areas by double integrals
		Volumes by triple integrals

CO – PO MAPPING

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

I-Year-I Semester	APPLIED PHYSICS	L	T	P	C
BS1102		3	0	0	3

Course Objectives

Applied Physics curriculum which is re-oriented to the needs of Circuital branches of graduate engineering courses offered by Vasireddy Venkatadri Institute of Technology, which serves as a transit to understand the branch specific advanced topics. The course is designed to:

- Impart Knowledge ofPhysicalOpticsphenomena like Interference and Diffraction required to design instruments with higher resolution.
- Understand the physics of Semiconductors and their working mechanism for their utility in electronic devices.
- Impart the knowledge of materials with characteristic utility in appliances.

Unit-1 **Wave Optics:** **Interference:** PrincipleofSuperposition-Interferenceoflight – Conditionsfor sustainedInterference-Interferencein thin films (reflected geometry) - Newton's Rings (reflected geometry) **Diffraction:**Fraunhofer Diffraction:- Diffraction due to single slit (quantitative), double slit(qualitative), N –slits(qualitative) and circular aperture (qualitative) – Intensity distribution curves - Diffraction grating – Grating spectrum – missing order– resolving power – Rayleigh's criterion – Resolving powers of Microscope(qualitative), Telescope(qualitative) and grating (qualitative).
Unit-2 **LASERs and Holography** **LASERs:** Interaction of radiation with matter – Spontaneous and Stimulated emission of radiation – population inversion – Einstein's coefficients & Relation between them and their significance - Pumping Mechanisms - Ruby laser – Helium-Neon laser – Applications. **Holography:** Introduction – principle – differences between photography and holography – construction and reconstruction of hologram – applications of holograms
Unit-3 **Magnetism and Dielectrics** **Magnetism**: Introduction - Magnetic dipole moment - Magnetization-Magnetic susceptibility and permeability- Origin of permanent magnetic moment - Bohr magneton-Classification of magnetic materials: Dia, para & Ferro – Domain concept of Ferromagnetism - Hysteresis – soft and hard magnetic materials – applications of Ferromagnetic material. **Dielectrics:**Introduction- Dielectricpolarization-Dielectricpolarizability,SusceptibilityandDielectricconstant- Types of polarizations: Electronic and Ionic (Quantitative), Orientation Polarizations (Qualitative) - Lorentz Internal field-Claussius – Mossotti's equation- Frequency dependence of polarization - Applications of dielectrics.
Unit-4 **Quantum Mechanics** Introduction– matter waves – de Broglie's hypothesis – Davisson-Germer experiment – G.P.Thomson experiment – Heisenberg's Uncertainty Principle–Schrödinger time independent and time dependent wave equations – physical significance of Schrödinger wave function – Particle in a potential box (determination of energy).

Unit-5
Semiconductor Physics
Originofenergybands(qualitative) –Classificationofsolidsbasedonenergybands–Intrinsicsemiconductors-densityof charge carriers –Electricalconductivity-Fermi level –extrinsicsemiconductors-P-type&N-type – Densityofchargecarriers-DependenceofFermienergyoncarrierconcentrationandtemperature-Halleffect-Hallcoefficient-ApplicationsofHalleffect- Drift and Diffusion currents - Einstein's equation.

TEXT BOOKS

1. "Engineering Physics" by B. K. Pandey, S. Chaturvedi - Cengage Publications, 2012
2. "A Text book of Engineering Physics" by M.N. Avadhanulu, P.G.Kshirsagar - S.Chand, 2017.
3. "Engineering Physics" by D.K.Bhattacharya and Poonam Tandon, Oxford press (2015).
4. "Engineering Physics" by R.K Gaur. and S.L Gupta., - Dhanpat Rai publishers, 2012.

REFERENCE BOOKS

1. "Engineering Physics" by M.R.Srinivasan, New Age international publishers (2009).
2. "Optics" by AjoyGhatak, 6th Edition McGraw Hill Education, 2017.
3. "Solid State Physics" by A.J.Dekker, Mc Millan Publishers (2011).

Micro-Syllabus of Applied Physics

Unit-I: Wave Optics:
Interference: PrincipleofSuperposition-Interferenceoflight – ConditionsforsustainedInterference-Interferencein thin films (reflected geometry) - Newton's Rings (reflected geometry)
Diffraction: Fraunhofer Diffraction:- Diffraction due to single slit (quantitative), double slit(qualitative), N –slits(qualitative) and circular aperture (qualitative) – Intensity distribution curves - Diffraction grating – Grating spectrum – missing order– resolving power – Rayleigh's criterion – Resolving powers of Microscope(qualitative), Telescope(qualitative) and grating (qualitative).

Unit No	Module	Micro content
Ia. Interference	PrincipleofSuperposition&Interferenceoflight	Introduction to interference
		Principle of superposition
		Coherence
		ConditionsforsustainedInterference
	Interferencein thin films	Interference in thin films by reflection (cosine's law)
		Complementary nature
		Colours of thin film
	Newton's Rings	Newton's Rings(reflected geometry)
		Experimental arrangement & conditions for diameters
		Applications: determination of wavelength of monochromatic source and refractive index of the given transparent liquid.
Ib.Diffraction	Fraunhofer Diffraction	Differences between Fresnel's and Fraunhofer's

	- Diffraction due to single slit	diffraction
		Differences between interference and diffraction
		Fraunhofer diffraction due to single slit(quantitative)
		Fraunhofer diffraction due to circular aperture (qualitative)
	double slit (qualitative) & N – slits(qualitative)	Fraunhofer diffraction due to double slit (qualitative)
		Fraunhofer diffraction due to grating (N- slits) (qualitative)
		Intensity distribution curves
	Diffraction grating& Resolving powers	Grating spectrum, missing orders and maximum number of orders possible with a grating
		Rayleigh’s criterion for resolving power
		Resolving power of grating, Telescope and Microscope (qualitative)

Unit– II: LASERs and Holography

LASERs: Interaction of radiation with matter – Spontaneous and Stimulated emission of radiation – population inversion – Einstein’s coefficients & Relation between them and their significance - Pumping Mechanisms - Ruby laser – Helium-Neon laser – Applications.

Holography: Introduction – principle – differences between photography and holography – construction and reconstruction of hologram – applications of holograms

Unit No	Module	Micro content
IIa.LASERs	Interaction of radiation with matter	Introduction to LASERS
		Spontaneous emission
		Stimulated emission
	Einstein’s coefficients	Einstein'scoefficients
		Populationinversion
		Pumping mechanisms
	LASERS construction and working	Rubylaser
		Helium-Neon laser
		Applications of Lasers
IIb.Holography	Principle of holography	Introduction and Principle of holography
		Differences between photography and holography
	construction and reconstruction of hologram	Construction of hologram
		Reconstruction of hologram
		Applications of holography

Unit-III: Magnetism and Dielectrics

Magnetism: Introduction - Magnetic dipole moment - Magnetization-Magnetic susceptibility and permeability- Origin of permanent magnetic moment - Bohr magneton-Classification of magnetic materials: Dia, para & Ferro – Domain concept of Ferromagnetism - Hysteresis – soft and hard magnetic materials – applications of Ferromagnetic material.

Dielectrics: Introduction- Dielectricpolarization-Dielectricpolarizability,

SusceptibilityandDielectricconstant- Types of polarizations: Electronic and Ionic (Quantitative), Orientation Polarizations (Qualitative) - Lorentz Internal field-Claussius –Mossotti's equation- Frequency dependence of polarization - Applications of dielectrics.		
Unit No	**Module**	**Micro content**
IIIa. Magnetism	Introduction& Origin of permanent magnetic moment	Introduction to Magnetism, Definitions of Magnetic dipole moment, Magnetization, Magnetic susceptibility and Permeability
		Originofmagneticmoment
		Bohr magneton
	Classification of magnetic materials	Dia magnetic materials
		Para magnetic materials
		Ferro magnetic materials
	Domain concept of Ferromagnetism & Hysteresis	Domain concept of Ferromagnetism
		Hysteresis Curve (B-H Curve)
		Soft and hard magnetic materials classification based on HysteresisCurve
		Applications of magnetic materials
IIIb.Dielectrics	Introduction& definitions	Introduction to dielectrics
		Dielectric polarization, Dielectric polarizability, susceptibility
		Dielectric constant
	Types of polarizations	Electronic polarization (Quantitative)
		Ionic polarization (Quantitative)
		Orientational polarizations (Qualitative)
	Internal field& Claussius –Mossotti's equation	Lorentz Internalfieldsinsolids
		Clausius-Mossotti'sequation
		Frequency dependence of polarization
		Applications of Dielectrics
Unit– IV: Quantum Mechanics Introduction– matter waves – de Broglie's hypothesis – Davisson-Germer experiment – G.P.Thomson experiment – Heisenberg's Uncertainty Principle–Schrödinger time independent and time dependent wave equations – physical significance of Schrödinger wave function – Particle in a potential box (determination of energy).		
Unit No	**Module**	**Micro content**
IV. Quantum Mechanics	Introduction& de Broglie's hypothesis	Introduction to Matter waves
		de Broglie's hypothesis
		Properties of Matter waves
	Davisson-Germer experiment &G.P.Thomson experiment	Davisson and Germer's experiment
		G. P. Thomson experiment
		Heisenberg's uncertainty principle

	Schrödinger wave function & equations	Schrödinger's wave function and it's physical significance
		SchrodingerTimeIndependentwave equation
		SchrodingerTimeDependentwave equation
		Application to particle inonedimensionalbox

Unit– V: Semiconductor Physics

Originofenergybands(qualitative) -Classificationofsolidsbasedonenergybands–Intrinsicsemiconductors-densityof charge carriers –Electrical conductivity-Fermi level - extrinsic semiconductors-P-type&N-type-Densityofchargecarriers-DependenceofFermienergyoncarrierconcentrationandtemperature-Halleffect-Hallcoefficient-ApplicationsofHalleffect- Drift and Diffusion currents - Einstein's equation.

Unit No	Module	Micro content
V.Semiconductor Physics	Originofenergybands	Introduction to energy bands and Origin of energy bands in crystalline solids
		Classification of solids into conductors, semiconductors and insulators based on energy bands
	Intrinsic& extrinsicsemiconductors	Intrinsic semiconductor and Carrier Concentration
		Equation for Conductivity
		Extrinsic Semiconductors (p-type and n-type)and Carrier Concentration
	Drift and Diffusion &Hall effect	Drift and Diffusion in semiconductors
		Einstein's Equation
		Hall Effect and it's applications

Course Outcomes: *The students will be able to*

CO1. **Understand** the principles such as interference and diffraction to design and enhance the resolving power of various optical instruments.

CO2. **Learn** the basic concepts of LASER light Sources and Apply them to holography

CO3. **Study** the magnetic and dielectric materials to enhance the utility aspects of materials.

CO4. **Learn** the fundamental concepts of Quantum behaviour of matter.

CO5. **Identify** the type of semiconductors using Hall Effect.

CO PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										1
CO2	3	2										1
CO3	3	2										1
CO4	3	2										1
CO5	3	2										1

(Strong – 3; Moderate – 2; Weak – 1)

I-Year-I Semester ES1101	PROBLEM SOLVING USING C	L	T	P	C
		3	0	0	3

Course Objectives

1. To learn about the computer systems, computing environments, developing of a computer program and Structure of a C Program
2. To gain knowledge of the operators, selection, control statements and repetition in C
3. To learn about the design concepts of arrays, strings, enumerated structure and union types. To learn about their usage.
4. To assimilate about pointers, dynamic memory allocation and know the significance of Pre-processor.
5. To assimilate about File I/O and significance of functions

Unit-1 **Introduction to Computers:** Creating and running Programs, Computer Numbering System, Storing Integers, Storing Real Numbers **Introduction to the C Language:** Background, C Programs, Identifiers, Types, Variable, Constants, Input/output, Programming Examples, Scope, Storage Classes and Type Qualifiers. **Structure of a C Program:** Expressions Precedence and Associativity, Side Effects, Evaluating Expressions, Type Conversion Statements, Simple Programs, Command Line Arguments.
Unit-2 **Bitwise Operators:** Exact Size Integer Types, Logical Bitwise Operators, Shift Operators. **Selection & Making Decisions:** Logical Data and Operators, Two Way Selection, Multiway Selection, More Standard Functions **Repetition:** Concept of Loop, Pretest and Post-test Loops, Initialization and Updating, Event and Counter Controlled Loops, Loops in C, Other Statements Related to Looping, Looping Applications, Programming Examples
Unit-3 **Arrays:** Concepts, Using Array in C, Array Application, Two Dimensional Arrays, Multidimensional Arrays, Programming Example – Calculate Averages **Strings:** String Concepts, C String, String Input / Output Functions, Arrays of Strings, String Manipulation Functions String/ Data Conversion, A Programming Example – Morse Code **Enumerated, Structure, and Union:** The Type Definition (Type def), Enumerated Types, Structure, Unions, and Programming Application
Unit-4 **Pointers:** Introduction, Pointers to pointers, Compatibility, L value and R value **Pointer Applications:** Arrays, and Pointers, Pointer Arithmetic and Arrays, Memory Allocation Function, Array of Pointers, Programming Application,**rocessor Commands**: Processor Commands
Unit-5

Functions: Designing, Structured Programs, Function in C, User Defined Functions, Inter-Function Communication, Standard Functions, Passing Array to Functions, Passing Pointers to Functions, Recursion **Text Input / Output:** Files, Streams, Standard Library Input / Output Functions, Formatting Input / Output Functions, Character Input / Output Functions **Binary Input / Output:** Text versus Binary Streams, Standard Library, Functions for Files, Converting File Type.

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

CO1	**Understand** algorithms and basic terminology of C
CO2	**Solve** problems using control structures and modular approach
CO3	**Make** use of 1D and 2D arrays along with strings for linear data handling
CO4	**Determine** the use of pointers and structures
CO5	**Implement** various operations on data files.

TEXT BOOKS

1. Programming for Problem Solving, Behrouz A. Forouzan, Richard F.Gilberg, CENGAGE
2. The C Programming Language, Brian W.Kernighan, Dennis M. Ritchie, 2e, Pearson

REFERENCES

1. Computer Fundamentals and Programming, Sumithabha Das, Mc Graw Hill
2. Programming in C, Ashok N. Kamthane, AmitKamthane, Pearson
3. Computer Fundamentals and Programming in C, Pradip Dey, Manas Ghosh, OXFORD

Micro-Syllabus of Problem Solving in C

UNIT I **Introduction to Computers:** Creating and running Programs, Computer Numbering System, Storing Integers, Storing Real Numbers **Introduction to the C Language:** Background, C Programs, Identifiers, Types, Variable, Constants, Input/output, Programming Examples, Scope, Storage Classes and Type Qualifiers. **Structure of a C Program:** Expressions Precedence and Associativity, Side Effects, Evaluating Expressions, Type Conversion Statements, Simple Programs, Command Line Arguments.		
Unit	**Module**	**Micro content**
Introduction to Computers, C Language	Introduction to Computers	Creating and running Programs
		Computer Numbering System
		Storing Integers, Storing Real Numbers
	Introduction to C Language	C Tokens
		I/O Functions
		Scope and Storage classes
		Type Qualifiers
	Structure of a C	Expressions

	Program	Side effects in evaluation of expressions
		Precedence and Associativity
		Command Line Arguments

UNIT - II

Bitwise Operators: Exact Size Integer Types, Logical Bitwise Operators, Shift Operators.

Selection & Making Decisions: Logical Data and Operators, Two Way Selection, Multiway Selection, More Standard Functions

Repetition: Concept of Loop, Pretest and Post-test Loops, Initialization and Updating, Event and Counter Controlled Loops, Loops in C, Other Statements Related to Looping, Looping Applications, Programming Examples.

Unit	**Module**	**Micro content**
Control Statements	Bitwise Operators	Exact Size Integer Types
		Logical Bitwise Operators and Shift Operators
	Selection Statements	Two Way Selection
		Multi Way Selection
		More Standard Functions
	Iterative Statements	Counter Controlled Loops
		Logic Controlled Loops
		Other Statements related to looping
		Applications of looping and examples

UNIT III

Arrays: Concepts, Using Array in C, Array Application, Two Dimensional Arrays, Multidimensional Arrays, Programming Example – Calculate Averages

Strings: String Concepts, C String, String Input / Output Functions, Arrays of Strings, String Manipulation Functions String/ Data Conversion, A Programming Example – Morse Code

Enumerated, Structure, and Union: The Type Definition (Type def), Enumerated Types, Structure, Unions, and Programming Application

Unit	**Module**	**Micro content**
Derived and User Defined Data types	Arrays	One Dimensional Arrays : Theory and Practice Exercises
		Two Dimensional Arrays : Theory and Practice Exercises
		Introduction to Multi-Dimensional Arrays
		Some more Example Programs on Arrays
	Strings	Introduction to the concept of a String in C
		String I/O Functions
		Manipulation Functions on Strings
		String/Data Conversion
		Programming Example – Morse Code
	Structures, Unions and Enumeration	Introduction to the Concept of ‘typedef’
		Structures : Theory and Practice

		Unions : Theory and Practice
		Enumeration Data type

UNIT IV

Pointers: Introduction, Pointers to pointers, Compatibility, L value and R value

Pointer Applications: Arrays, and Pointers, Pointer Arithmetic and Arrays, Memory Allocation Function, Array of Pointers, Programming Application

Processor Commands: Processor Commands

Unit	**Module**	**Micro content**
Pointers and Processor Commands	Pointers	Introduction to Pointers
		Pointers to pointers
		Compatibility, L-value and R-value
	Applications of Pointers	Pointer Arithmetic
		Dynamic Memory Allocation
		Pointer to Arrays and Array of Pointers
	Processor Commands	Processor Commands

UNIT V

Functions: Designing, Structured Programs, Function in C, User Defined Functions, Inter-Function Communication, Standard Functions, Passing Array to Functions, Passing Pointers to Functions, Recursion

Text Input / Output: Files, Streams, Standard Library Input / Output Functions, Formatting Input / Output Functions, Character Input / Output Functions

Binary Input / Output: Text versus Binary Streams, Standard Library, Functions for Files, Converting File Type.

Unit	**Module**	**Micro content**
Functions and Files	User Defined Functions	Designing, Structured Programs, Function in C
		Inter-Function Communication, Standard Functions
		Passing Array to Functions
		Passing Pointers to Functions
		Recursion
	Text Input / Output	Files, Streams
		Standard Library Input / Output Functions
		Formatting Input / Output Functions
		Character Input / Output Functions
	Binary Input/ Output	Text versus Binary Streams
		Standard Library
		Functions for files
		Converting File Type

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

CO1	**Understand** algorithms and basic terminology of C
CO2	**Solve** problems using control structures and modular approach

CO3	**Make** use of 1D and 2D arrays along with strings for linear data handling
CO4	**Determine** the use of pointers and structures
CO5	**Implement** various operations on data files.

Correlation of Course Outcomes with Program Outcomes and Program Specific Outcomes (PO's& PSO's)														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	2	3	2	1	-	-	-	3	3	1	2	1	2
CO2	2	3	3	2	-	-	-	-	1	1	2	2	2	2
CO3	3	3	3	2	-	-	-	-	2	1	2	2	2	3
CO4	2	2	2	2	-	-	-	-	2	1	2	2	2	2
CO5	2	2	2	2	-	-	-	-	2	1	2	2	1	2

(Strong – 3; Moderate – 2; Weak – 1)

I-Year-I Semester ES1102	ENGINEERING GRAPHICS	L	T	P	C
		0	0	3	1.5

Course objectives:

The main objectives are

1. Expose the students to use Drafting packages for generating Engineering curves and conventions followed in Preparation of engineering drawings.
2. Make the students to understand the concepts of orthographic projections of Lines and Plane Surfaces.
3. To understand the concepts of orthographic projections of Regular Solids.
4. Develop the ability of understanding sectional views and Development of Solid Surfaces.
5. Enable them to use computer aided drafting packages for Conversion of Isometric view to Orthographic Projection and vice versa.

UNIT-I: INTRODUCTION TO AUTOCAD: 15 HOURS

Basic commands, Customization, ISO and ANSI standards for coordinate dimensioning, Annotations, layering, 2D drawings of various mechanical components, 2D drawings of various electrical and electronic circuits. Creation of engineering models- floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying colour coding according to building drawing practice; (Experiments should be Planned According to respective Core Branch Applications)

UNIT-II: THEORY OF PROJECTION: 12 HOURS

Principles of Orthographic Projections-Convention: Projections of Points, Projections of Lines inclined to both planes, Projections of planes inclined to one Plane & Projections of planes inclined to both Planes

UNIT III: PROJECTIONS OF REGULAR SOLIDS: 1 12 HOURS

Projections of Solids –with the axis perpendicular to one of the principal planes, with the axis Inclined to one of the principal planes, Projections of Solids –with the axis Inclined to Both the principal planes

UNIT IV: DEVELOPMENT OF SURFACES & SECTIONAL ORTHOGRAPHIC VIEWS 13 HOURS

Development of surfaces of Right Regular Solids – Prism, Pyramid, Cylinder and, Cone. Draw the sectional orthographic views of geometrical solids

UNIT V: ISOMETRIC PROJECTIONS 13 HOURS

Conversion of isometric views to orthographic views, drawing of isometric views - simple Solids, Conversion of orthographic views to isometric views of simple Drawings

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

CO1	Prepare engineering drawings as per BIS conventions Understand level, KL2}
CO2	Produce computer generated of orthographic projections of Lines and Plane surfaces using CAD software {Apply level, KL3}
CO3	Use the knowledge of orthographic projections of Solids to represent engineering information/concepts and present the same in the form of drawings {Apply level, KL3}
CO4	Use the knowledge of sectional views and Development of Solid Surfaces in Real time Applications {Apply level, KL3}
CO5	Develop isometric drawings of simple objects reading the orthographic projections of those objects {Analyze level, KL4}

Text books:

1. Engineering Drawing by N.D. Butt, Chariot Publications
2. Engineering Graphics with Autocad by Kulkarni D.M, PHI Publishers
3. Engineering Drawing + AutoCad – K Venugopal, V. Prabhu Raja, New Age
4. Engineering Drawing by Agarwal & Agarwal, Tata McGraw Hill Publishers

Reference books:

1. Engineering Drawing by K.L.Narayana& P. Kannaiah, Scitech Publishers
2. Engineering Graphics for Degree by K.C. John, PHI Publishers
3. Engineering Graphics by PI Varghese, McGrawHill Publishers
4. AutoCAD 2018 Training Guide (English, Paperback, Sagar Linkan) ISBN: 9789386551870, 938655187X RUPAPUBLICATIONS

CO-PO Mapping:

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

I-Year-I Semester HS1101L	COMMUNICATIVE ENGLISH LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

The main objective of the course is to adopt activity-based teaching-learning methods to ensure that learners would be engaged in use of language both in the classroom and laboratory sessions and appear confidently for competitive examinations for career development.

The specific objectives of the course are to

1. Facilitate effective listening skills for better comprehension of academic lectures and English spoken by native and non-native speakers
2. Focus on appropriate reading strategies for comprehension of various academic texts and authentic materials like newspapers, magazines, periodicals, journals, etc.
3. Help improve speaking skills through participation in activities such as role plays, discussions and structured talks/oral presentations
4. Impart effective strategies for good writing and demonstrate the same in summarizing, writing well organized essays, record and report useful information
5. Provide knowledge of grammatical structures and vocabulary and encourage their appropriate use in speech and writing

Course Outcomes

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

CO1: Prioritize information from reading texts after selecting relevant and useful points and paraphrase short academic texts using suitable strategies and conventions (L3)

CO2: Make formal structured presentations on academic topics using PPT slides with relevant graphical elements (L3)

CO3: Participate in group discussions using appropriate conventions and language strategies (L3)

CO4: Prepare a CV with a cover letter to seek internship/ job (L2)

CO5: Collaborate with a partner to make presentations and Project Reports (L2)

Detailed Syllabus

CALL based activity. English course books selected for classroom teaching will be used for practice in thecomputer-based language labs. Watching and listening to Video clips.

Listening Activity: Selected speeches of eminent personalities, audio texts, dialogues and discussions

Speaking: JAM, Oral Presentations, Group Discussions

Writing: Different types of reports

Project: Power point presentation of 5 min on a specific topic

Pair work, Role play, conversational practice and Individual speaking activities based on following essays from ***University of Success***.

1. “How to Get Yourself Organized” by Michael LeBeouf
2. “How to Turn Your Desires into Gold” by Napoleon Hill
3. “How to Look Like a Winner How to Increase Your Value” by OgMandino
4. “How to Swap a Losing Strategy” by Auren Uris and Jack Tarrant

5. “How to Bounce Back from Failure” by OgMandino
6. “How to Prevent Your Success from Turning into Ashes” by Allan Fromme
7. “How to Have a Happy Life” by Louis Binstock
8. “How to Keep the Flame of Success Shining Brightly” by Howard Whitman

Any ten Supplementary Language Activities from ***UN Global Goals***document

1. “Developing children’s understanding of the Global Goals” by Carol Read
2. “End poverty in all its forms everywhere” by SylwiaZabor-Zakowska
3. “End hunger, achieve food security and improved nutrition and promote sustainable agriculture” by Linda Ruas
4. ‘Ensure healthy lives and promote well-being for all at all ages” by Carmen Flores
5. “Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all” by Daniel Xerri
6. “Achieve gender equality and empower all women and girls” by Jemma Prior and Tessa Woodward
7. “Ensure availability and sustainable management of water and sanitation for all” by Wei KeongToo
8. “Ensure access to affordable, reliable, sustainable and modern energy for all” by Phil Wade
9. “Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all” by Nik Peachey
10. “Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation” by MaluSciamarelli
11. “Reduce inequality within and among countries” by Alan Maley
12. “Make cities and human settlements inclusive, safe, resilient and sustainable” by David Brennan
13. “Ensure sustainable consumption and production patterns” by Laszlo Katona and Nora Tartsay
14. “Take urgent action to combat climate change and its impacts” by Maria Theologidou
15. “Conserve and sustainably use the oceans, seas and marine resources for sustainable development” by Jill Hadfield and Charlie Hadfield
16. “Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss” by ChrysaPapalazarou
17. “Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels” by Rebeca Duriga
18. “Strengthen the means of implementation and revitalise the global partnership for sustainable development” by Jennifer Verschoor and Anna Maria Menezes
19. “Content and the Sustainable Development Goals: going beyond language learning” by AdrianTennant
20. “Using extensive reading creatively to raise awareness of issues of equality and justice” by SueLeather

21. “Storytelling for a better world” by David Heathfield
22. “Using the Sustainable Development Goals in the EAP classroom” by Averil Bolster and PeterLevrai

Text Books

1. Alan Maley and Nik Peachy. *Integrating global issues in the creative English Classroom: Withreference to the United Nations Sustainable Development Goals.* British Council Teaching English, 2018 (Public Domain UN Document)

2. *University of Success* by OgMandino, Jaico, 2015 (Reprint).

Reference Books

1. Bailey, Stephen. *Academic writing: A handbook for international students*. Routledge, 2014.
2. Chase, Becky Tarver. *Pathways: Listening, Speaking and Critical Thinking.* Heinley ELT; 2ndEdition, 2018.
3. Skillful Level 2 Reading & Writing Student's Book Pack (B1) Macmillan Educational.
4. Hewings, Martin. *Cambridge Academic English (B2)*. CUP, 2012.
5. Chaturvedi, P. D. and ChaturvediMukesh. *The Art and Science of Business Communication:Skills, Concepts, Cases and Applications.* 4Ed. Pearson, 2017.

AICTE Recommended Books

1. Meenakshi Raman and Sangeeta Sharma. *Technical Communication.* Oxford University Press,2018.
2. Pushplata and Sanjay Kumar. *Communication Skills*, Oxford University Press, 2018.
3. Kulbushan Kumar. *Effective Communication Skills.* Khanna Publishing House, Delhi

Sample Web Resources

Grammar / Listening / Writing 1-language.com http://www.5minuteenglish.com/ https://www.englishpractice.com/ Grammar/Vocabulary English Language Learning Online http://www.bbc.co.uk/learningenglish/ http://www.better-english.com/ http://www.nonstopenglish.com/ https://www.vocabulary.com/ BBC Vocabulary Games Free Rice Vocabulary Game	Reading https://www.usingenglish.com/comprehension/ https://www.englishclub.com/reading/short stories.htm https://www.english-online.at/ Listening https://learningenglish.voanews.com/z/3613 http://www.englishmedialab.com/listening.html Speaking https://www.talkenglish.com/ BBC Learning English – Pronunciation tips Merriam-Webster – Perfect pronunciation Exercises
All Skills https://www.englishclub.com/ http://www.world-english.org/	

CO-PO MAPPING

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

I-Year-I Semester BS1102L	APPLIED PHYSICS LAB	L	T	P	C
		0	0	3	1.5

Course Objectives: The Applied Physics Lab is designed to

- **Understand** the concepts of interference and diffraction and their applications.
- **Apply** the concept of LASER in the determination of wavelength.
- **Recognize** the importance of energy gap in the study of conductivity and Hall Effect.
- **Illustrate** the magnetic and dielectric materials applications.
- **Apply** the principles of semiconductors in various electronic devices.

LIST OF EXPERIMENTS(Any 10 of the following listed 15 experiments)

1. Determination of wavelength of a source-Diffraction Grating-Normal incidence.
2. Newton's rings – Radius of Curvature of Plano - Convex Lens.
3. Determination of thickness of a spacer using wedge film and parallel interference fringes.
4. Magnetic field along the axis of a current carrying coil – Stewart and Gee's apparatus.
5. Energy Band gap of a Semiconductor p - n junction.
6. Characteristics of Thermistor – Temperature Coefficients
7. Determination of dielectric constant by charging and discharging method
8. Variation of dielectric constant with temperature
9. Study the variation of B versus H by magnetizing the magnetic material (B-H curve).
10. LASER - Determination of wavelength by plane diffraction grating
11. Determination of resistivity of semiconductor by Four probe method.
12. Determine the radius of gyration using compound pendulum
13. Rigidity modulus of material by wire-dynamic method (torsional pendulum)
14. Dispersive power of diffraction grating.
15. Determination of Hall voltage and Hall coefficients of a given semiconductor using Hall Effect.

Course Outcomes: The students will be able to:

CO1. Operate optical instruments like microscope and spectrometer

CO2. Determine thickness of a paper with the concept of interference

CO3. Estimate the wavelength of differentcolours using diffraction grating and resolving power

CO4. Plot the intensity of the magnetic field of circular coil carrying current with distance

CO5. Calculate the band gap of a given semiconductor

CO POMapping

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

(Strong – 3; Moderate – 2; Weak – 1)

I-Year-I Semester ES1101L	PROBLEM SOLVING USING C LAB	L	T	P	C
		0	0	3	1.5

Course Objectives

1. Apply the principles of C language in problem solving.
2. To design flowcharts, algorithms and knowing how to debug programs.
3. To design & develop of C programs using arrays, strings pointers & functions.
4. To review the file operations, pre-processor commands.

Exercise 1

1. Write a C program to print a block F using hash (#), where the F has a height of six characters and width of five and four characters.
2. Write a C program to compute the perimeter and area of a rectangle with a height of 7 inches and width of 5 inches.
3. Write a C program to display multiple variables.

Exercise 2

1. Write a C program to calculate the distance between the two points.
2. Write a C program that accepts 4 integers p, q, r, s from the user where r and s are positive and p is even. If q is greater than r and s is greater than p and if the sum of r and s is greater than the sum of p and q print "Correct values", otherwise print "Wrong values".

Exercise 3

1. Write a C program to convert a string to a long integer.
2. Write a program in C which is a Menu-Driven Program to compute the area of the various geometrical shape.
3. Write a C program to calculate the factorial of a given number.

Exercise 4

1 .Write a program in C to display the n terms of even natural number and their sum.
2. Write a program in C to display the n terms of harmonic series and their sum.
1 + 1/2 + 1/3 + 1/4 + 1/5 ... 1/n terms.
3. Write a C program to check whether a given number is an Armstrong number or not.

Exercise 5

1. Write a program in C to print all unique elements in an array.
2. Write a program in C to separate odd and even integers in separate arrays.
3. Write a program in C to sort elements of array in ascending order.

Exercise 6

1. Write a program in C for multiplication of two square Matrices.
2. Write a program in C to find transpose of a given matrix.

Exercise 7

1. Write a program in C to search an element in a row wise and column wise sorted matrix.
2. Write a program in C to print individual characters of string in reverse order.

Exercise 8

1. Write a program in C to compare two strings without using string library functions.
2. Write a program in C to copy one string to another string.

Exercise 9

1. Write a C Program to Store Information Using Structures with Dynamically Memory Allocation
2. Write a program in C to demonstrate how to handle the pointers in the program.

Exercise 10

1. Write a program in C to demonstrate the use of & (address of) and *(value at address) operator.
2. Write a program in C to add two numbers using pointers.

Exercise 11

1. Write a program in C to add numbers using call by reference.
2. Write a program in C to find the largest element using Dynamic Memory Allocation.

Exercise 12

1. Write a program in C to swap elements using call by reference.
2. Write a program in C to count the number of vowels and consonants in a string using a pointer.

Exercise 13

1. Write a program in C to show how a function returning pointer.
2. Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using malloc( ) function.

Exercise 14

1. Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using calloc( ) function. Understand & write the difference.
2. Write a program in C to convert decimal number to binary number using the function.

Exercise 15

1. Write a program in C to check whether a number is a prime number or not using the function.
2. Write a program in C to get the largest element of an array using the function.

Exercise 16

1. Write a program in C to append multiple lines at the end of a text file.
2. Write a program in C to copy a file in another name.
3. Write a program in C to remove a file from the disk.

Course Outcomes: By the end of the Lab, the student able to

CO1. **Comprehend** the various concepts of a C language

CO2. **Develop** algorithms and flowcharts

CO3. **Design** and development of C problem solving skills.

CO4. **Acquire** modular programming skills.

CO – PO Mapping

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

(Strong – 3; Moderate – 2; Weak – 1)

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I-Year-II Semester BS1201	MATHEMATICS-II	L	T	P	C
		3	1	0	3

Course objectives:

The main objectives are

1. To elucidate the different numerical methods to solve nonlinear algebraic equations
2. To disseminate the use of different numerical techniques for carrying out numerical integration
3. To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real-world problems and their applications

UNIT-1: Iterative methods	**11 HOURS**
Introduction–Bisection method–Method of false position–Iteration method–Newton-Raphson method (one variable)–Jacobi and Gauss-Seidel methods for solving system of equations.	
UNIT-2: Interpolation	**14 HOURS**
Introduction–Errors in polynomial interpolation–Finite differences–Forward differences–Backward differences–Central differences –Relations between operators–Newton's forward and backward formulae for interpolation–Gauss's forward and backward formulae for Interpolation – Interpolation with unequal intervals–Lagrange's interpolation formula–Newton's divide difference formula.	
UNIT-3: Numerical integration and solution of ordinary difference equations	**12 HOURS**
Trapezoidal rule–Simpson's 1/3rd and 3/8th rule–Solution of ordinary differential equations by Taylor's series–Picard's method of successive approximations–Euler's method–Modified Euler's method–Runge-Kutta method (second and fourth order).	
UNIT–4: Laplace Transforms:	**14 HOURS**
Laplace transforms of standard functions – Shifting theorems – Transforms of derivatives and integrals – Unit step function – Dirac's delta function –Periodic function - Inverse Laplace transforms – Convolution theorem (without proof) Applications: Evaluation of integrals using Laplace transforms - Solving ordinary differential equations (Initial value problems) using Laplace transforms.	
UNIT 5: Fourier series and Fourier Transforms:	**14 HOURS**
Fourier series: Introduction – Periodic functions – Fourier series of periodic function – Dirichlet's conditions – Even and odd functions – Change of interval – Half-range sine and cosine series. Fourier Transforms: Fourier integral theorem (without proof) - Fourier sine and cosine integrals – Sine and cosine transforms – Properties – Inverse transforms – Finite Fourier transforms.	

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

CO1	Evaluate approximate in the roots of polynomial and transcendental equations by different algorithms (EVALUATE)
CO2	Solve system of linear algebraic equations using Gauss Jacobi, Gauss Seidel and apply Newton's forward and backward interpolation and Lagrange's formulae for equal and unequal intervals (SOLVE,APPLY, FIND)

CO3	Apply different algorithms for approximating the solutions of ordinary differential equations to its analytical computations and also by Laplace the transforms for solving differential equations (SOLVE,APPLY, FIND)
CO4	Find or compute the Fourier series of periodic signals (SOLVE, APPLY, FIND, ANALYSE)
CO5	Know and be able to apply integral expressions for the forwards and inverse Fourier transform to range of non-periodic waveforms (SOLVE, APPLY, FIND)

Text books:
3. **B.S. Grewal,** Higher Engineering Mathematics, 44th Edition, Khanna Publishers
Reference books:
1. **B.V. Ramana,** Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education. 2. **H.K.Das,** Advanced Engineering Mathematics, 22nd Edition, S. Chand & Company Ltd. 3. **Erwin Kreyszig**, Advanced Engineering Mathematics, 10th Edition, Wiley-India.

Micro-Syllabus of MATHEMATICS-II

UNIT-1: Iterative methods: Introduction–Bisection method–Method of false position–Iteration method–Newton-Raphson method (one variable)–Jacobi and Gauss-Seidel methods for solving system of equations.

Unit	Module	Micro content
1a. Solving given polynomial	Numerical solution of algebraic and transcendental polynomials	Bisection method
		Method of false position
		Iteration method
		Newton-Raphson’s method
1b. Solving linear system	Solving linear system	Jacobi’s method
		Gauss-seidel method

UNIT-2: Interpolation: Introduction–Errors in polynomial interpolation–Finite differences–Forward differences–Backward differences–Central differences –Relations between operators–Newton’s forward and backward formulae for interpolation–Gauss’s forward and backward formulae for
Interpolation – Interpolation with unequal intervals–Lagrange’s interpolation formula–Newton’s divide difference formula.

Unit	Module	Micro content
2a. Equal-Spaced difference tables	Finite difference tables	Forward, backward & central difference tables
		Errors in polynomials
	Finding functional values for given data	Newton’s forward and backward difference interpolation formula
		Gauss forward and backward difference interpolation formula
2b.	Unequal spaced data &	Lagrange’s interpolation formula

Unequal spaced data & relation between various operators	relation between various operators	Relation between various operators (Shift, forward, backward, central, average & differential operators)

UNIT-3: Numerical integration and solution of ordinary difference equations:
Trapezoidal rule–Simpson's 1/3rd and 3/8th rule–Solution of ordinary differential equations by Taylor's series–Picard's method of successive approximations–Euler's method–Modified Euler's method–Runge-Kutta method (second and fourth order).

Unit	Module	Micro content
3a. Numerical integration	Numerical Integration	Trapezoidal rule
		Simpson's 1/3rd rule
		Simpson's 3/8th
3b. Numerical solution of ordinary differential equations for single variable	Numerical solution of ordinary differential equations for single variable	Taylors series method
		Picard's method
		Euler's method
		Modified Euler's method

UNIT – 4: Laplace Transforms: Laplace transforms of standard functions – Shifting theorems – Transforms of derivatives and integrals – Unit step function – Dirac's delta function –Periodic function - Inverse Laplace transforms – Convolution theorem (without proof)
Applications: Evaluation of integrals using Laplace transforms - Solving ordinary differential equations (Initial value problems) using Laplace transforms.

Unit	Module	Micro content
4a Laplace Transforms	Laplace transforms and theorem	Shifting theorems
		Derivatives and integrals
		Multiplication and division
4b. Inverse Laplace transforms and Applications	Periodic functions &Inverse Laplace Transforms	Periodic functions
		Dirac delta functions
		Evaluation integrals using Laplace Transforms
		Solving differential equations using Laplace transforms

UNIT 5: Fourier series and Fourier Transforms: Fourier series: Introduction – Periodic functions – Fourier series of periodic function – Dirichlet's conditions – Even and odd functions – Change of interval – Half-range sine and cosine series. Fourier Transforms: Fourier integral theorem (without proof) - Fourier sine and cosine integrals – Sine and cosine transforms – Properties – Inverse transforms – Finite Fourier transforms.		
Unit	**Module**	**Micro content**
5a. **Fourier Series**	Fourier Series	Periodic functions
		Dirichlet's conditions
		Even and odd function's
		Change of interval
		Half range sine and cosine series
5b. **Fourier Transforms**	Fourier Transforms	Fourier Sine and Cosine integral
		Properties of Fourier Transforms
		Fourier and Inverse Fourier Transforms
		Fourier cosine and Inverse Fourier cosine Transforms
		Fourier sine and Inverse Fourier sine Transforms
		Finite Fourier Transforms
		Inverse Finite Fourier Transforms

CO-PO Mapping

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

I-Year-II Semester BS1202	APPLIED CHEMISTRY	L	T	P	C
		3	0	0	3

Knowledge of basic concepts of chemistry for Engineering students will help them as professional engineers later in design and material selection as well as utilizing the available resources.

Course Objectives

1. Significance of various types of plastic materials in household appliances and composites (FRP) in aerospace and automotive industries.
2. Understand the basic concepts of electrochemistry, which are useful to construct the electrochemical cells, batteries and fuel cells.
   Illustrate the theories and mechanism of corrosion and its prevention.
3. Importance of advanced materials and their engineering applications.
4. Make use of molecular machines in supramolecular chemistry and need of green chemistry.
5. Design and construction of advanced instrumental techniques and recall their importance.

Unit-1
POLYMER TECHNOLOGY
***Polymerisation**:* Introduction-Methods of polymerisation-(emulsion and suspension)-Physical and mechanical properties.
***Plastics**:* Compounding-Fabrication (compression, injection, blown film, extrusion)-Preparation, properties and applications of PVC, ploycarbonates and Bakelite-Mention some examples of plastic materials used in electronic gadgets, recycling of e-plastic waste.
***Elastomers**:* Natural rubber-Drawbacks-Vulcanization-Preparation-Properties and applications of synthetic rubbers (Buna S, thiokol and polyurethanes)
Composite Materials: Fiber reinforced plastics-CFRP and GFRP
Conducting polymers: Polyacetylene, doped conducting polymers -p-type and n-type doping.
Bio degradable polymers: Biopolymers and biomedical polymers

Unit-2
ELECTROCHEMICAL CELLS AND CORROSION
Single electrode potential-Electrochemical series and uses of series-Standard hydrogen electrode, calomel electrode, concentration cell, construction of glass electrode, Batteries: Dry cell, Ni-Cd cells, Ni-Metal hydride cells, Li-ion battery, Zinc air cells, Fuel cells-H_2 –O_2, CH_3OH-O_2, phosphoric acid, molten carbonate.
***Corrosion**:* Definition-theories of corrosion (chemical and electrochemical)-galvanic corrosion, differential aeration corrosion, stress corrosion, water-line corrosion- passivity of metals-galvanic series-factors influencing rate of corrosion-corrosion control: (proper designing, cathodic protection)-protective coatings: cathodic and anodic coatings, electroplating, electroless plating (nickel), paints (constituents and its functions).

Unit-3
MATERIAL CHEMISTRY
Non-elemental semiconducting materails: Stoichiometric, controlled valency & chalcogen photo/semiconductors-preparation of semiconductors (distillation, zone refining, Czochralski

crystal pulling technique) – Semiconductor devices (p-n junction diode as rectifier, junction transistor) ***Nano materials:*** Introduction, sol-gel method, characterization by BET, SEM and TEM methods, applications of graphene-carbon nanotubes and fullerenes: Types, preparation of carbon nanomaterials by carbon-arc, laser abalation methods. ***Liquid crystals:*** Introduction-types-applications. ***Superconductors***: Meissner effect, type- I and type- II superconductors, characteristics and applications.
Unit-4 **ADVANCED CONCEPTS AND GREEEN CHEMISTRY** ***Molecular switches and machines***: Introduction to supramolecular chemistry, characteristics of molecular motors and machines. Rotaxanes and Catenanes as artificial molecular machines. Protypes linear motions in Rotaxanes, and acid-base controlled molecular shuttle, a molecular elevator, an autonomous light –powered molecular motors, natural molecular motors and machine. ***Green chemistry:*** Principles of green chemistry, green synthesis – aqueous phase, microwave assisted chemical reactions and phase transfer catalysis (PTC).
Unit-5 **SPECTROSCOPIC TECHNIQUES & NON-CONVENTIONAL ENERGY SOURCES** ***Spectroscopic Techniques:*** Electromagneticspectrum-types of molecular spectra and their absorption criteria. ***UV***-visible spectroscopy (electronic spectroscopy), Frank-Condon principle, Beer-Lambert's law and its limitations, chromophores and auxochromes – *applications of UV visible spectroscopy. ***IR*** spectroscopy – functional group and finger print region – molecular vibrations – stretching and bending vibrations – *applications of IR. ***NMR*** (Nuclear magnetic resonance): Working principle and instrumentation of NMR – chemical shift(δ) – *applications of NMR. (*only general applications – without any spectroscopic problems regarding quantitative and qualitative analysis.) ***Non-conventional energy sources***: Design, working, schematic diagram, advantages and disadvantages of photovoltaic cell, organic photo-voltaic, hydropower, geothermal power, tidal, ocean thermal energy conversion (OTEC) – open cycle OTEC, closed cycle OTEC and hybrid cycle OTEC.

REFERENCE BOOKS

1. A text book of Engineering Chemistry by S.S. Dara, S. S. Umare; S. Chand & Co., Ltd., Latest Edition.
2. Engineering Chemistry by Shashi Chawla; Dhanpat Rai Publicating Co., Latest Edition.

TEXT BOOKS

1. Engineering Chemistry by Jain & Jain; Dhanpat Rai Publicating Co., Latest Edition
2. Engineering Chemistry by Shikha Agarwal; Cambridge University Press, 2019 Edition.
3. Engineering Chemistry by Prasanth Rath, B. Ramadevi, Ch. Venkata Ramana Reddy, Subendu Chakravarthy; Cengage Publications, 2019 Edition.

Micro-Syllabus of Applied Chemistry

UNIT-I: POLYMER TECHNOLOGY 14 HRS

Polymerisation*:*Introduction-Methods of polymerisation-(emulsion and suspension)-Physical and mechanical properties.

Plastics*:* Compounding-Fabrication (compression, injection, blown film, extrusion)-Preparation, properties and applications of PVC, ploycarbonates and Bakelite-Mention some examples of plastic materials used in electronic gadgets, recycling of e-plastic waste.

Elastomers*:* Natural rubber-Drawbacks-Vulcanization-Preparation-Properties and applications of synthetic rubbers (Buna S, thiokol and polyurethanes)

Composite Materials: Fiber reinforced plastics-CFRP and GFRP.

Conducting polymers: Polyacetylene, doped conducting polymers- p-type and n-type doping.

Bio degradable polymers: Biopolymers and biomedical polymers.

Unit	**Module**	**Micro content**
Polymerization	Introduction, Methods of Polymerization And Properties of Polymers	Introduction - Polymer, monomer, functionality and polymerization. Methods of polymerisation - Emulsion and suspension Physical and mechanical properties of polymers.
Plastics	Compounding of plastics, fabrication of polymer articles, preparation, properties and applications of some polymers, e-plastic and disposal of e-plastic waste.	Compounding of plastics Fabrication of polymer articles – compression, injection, blowing, extrusion Preparation, properties and applications of PVC, ploycarbonates and Bakelite Mention some examples of plastic materials used in electronic gadgets, recycling of e-plastic waste.
Elastomers	Natural Rubber, vulcanization, synthetic rubbers	Natural rubber – Drawbacks – Vulcanization Preparation – Properties and applications of synthetic rubbers – Buna S, thiokol and polyurethane rubbers.
Composite materials	Fiber reinforced plastics	Fiber Reinforced Plastics (FRP) – CFRP and GFRP.
Conducting polymers	Polyacetylene polymer, p-type and n-type doping	Polyacetylene, doped conducting polymers- p-type and n-type doping.
Biodegradable polymers	Biopolymers and biomedical polymers	Biopolymers and biomedical polymers – polylactic acid polyglycolic acid polymers

UNIT-II: ELECTROCHEMICAL CELLS AND CORROSION
12 HRS

Single electrode potential - Electrochemical series and uses of series - Standard hydrogen electrode, calomel electrode, concentration cell, construction of glass electrode, Batteries: Dry cell, Ni-Cd cells, Ni-Metal hydride cells, Li-ion battery, Zinc air cells, Fuel cells-H_2 –O_2, CH_3OH-O_2, phosphoric acid, molten carbonate.

Corrosion: Definition - theories of corrosion (chemical and electrochemical)-galvanic corrosion, differential aeration corrosion, stress corrosion, water-line corrosion- passivity of metals-galvanic series-factors influencing rate of corrosion-corrosion control: (proper designing, cathodic protection)-protective coatings: cathodic and anodic coatings, electroplating, electroless plating (nickel), paints (constituents and its functions).

Unit	**Module**	**Micro content**
Introduction	Single electrode potential	Oxidation potential
		Reduction potential
Concentration cells	Electrode concentration cell and electrolyte concentration cell	Electrode concentration cell and electrolyte concentration cell
Electro chemical series	Electro chemical series	Definition – Electro chemical series
		Significances of Electro chemical series
		Differences between Electro chemical series and galvanic series
Reference electrodes	Standard Hydrogen Electrode	Working Principle and Construction of a – Standard Hydrogen Electrode – Calomel Electrode – Glass Electrode
	Calomel Electrode	
	Glass Electrode	
Corrosion	Introduction	Definition – Corrosion
	Theories of Corrosion	Chemical Theory of Corrosion / Dry Corrosion Electro Chemical Theory of Corrosion / Wet Corrosion
	Types of Corrosion	Galvanic corrosion, Differential aeration corrosion, Stress corrosion, Water-line corrosion
	Passivity of metals	Passivity, Examples for passive metals
Factors affecting rate of Corrosion	(a) Nature of metal	*(a) Nature of metal:* (i) Position of metal in the Galvanic series (ii) Purity of metal (iii) Relative surface area of anodic and cathodic metal (iv) Nature of oxide film (v) Physical state of metal (vi) Solubility and volatility of corrosion products
	(b) Nature of environment	*(b) Nature of environment:* (i) Temperature (ii) Humidity (iii) pH of the medium (iv) Establishment of oxygen concentration cell (v) Impurities of the atmosphere (vi) Polarization of electrodes

Corrosion control methods	Cathodic protection	Sacrificial anodic protection, impressed cathodic current
	|Cathodic and Anodic coatings	Galvanizing and Tinning
	Electroplating	Electroplating with example
	Electroless plating	Nickel Electroless plating
	Paints	Constituents of paints and its functions

UNIT-III: MATERIAL CHEMISTRY **12 HRS**

Non-elemental semiconducting materails: Stoichiometric, controlled valency & chalcogen photo / semiconductors - Preparation of semiconductors (distillation, zone refining, Czochralski crystal pulling technique) – Semiconductor devices (p-n junction diode as rectifier, junction transistor)

Nano materials*:* Introduction, sol-gel method, characterization by BET, SEM and TEM methods, applications of graphene-carbon nanotubes and fullerenes: Types, preparation of carbon nanomaterials by carbon-arc, laser abalation methods.

Liquid crystals*:* Introduction – types-applications.

Superconductors: Meissner effect, type- I and type- II superconductors, characteristics and applications.

Unit	**Module**	**Micro content**
Non elemental semiconducting materials	Non elemental semiconductors	Stoichiometric, controlled valency & chalcogen photo / semiconductors
	Preparation, purification and fabrication of semiconductors	Preperation – Distillation, zone refining, Czochralski crystal pulling technique
	Applications of semiconducting devices	p-n junction diode as rectifier, junction transistor
Nano materials	Introduction, sol-gel method, characterization of nano materials	Introduction to Nano materials, Sol-gel method, characterization by BET, SEM and TEM methods,
	Applications of graphene	Carbon nanotubes and fullerenes. Types,
	Preparation of carbon nanomaterials	Carbon-arc, laser abalation methods.
Liquid crystals	Introduction, Types, Applications	Introduction,Thermotropic and Lyotropic liquid crystals, nematic and smectic liquid crystals, Applications of liquid crystals
Superconductors	Introduction, Characteristics and Applications	Introiduction, Meissner effect, type-I and type-II superconductors,characteristics and applications.

UNIT-IV: ADVANCED CONCEPTS AND GREEEN CHEMISTRY **10 HRS**

Molecular motors/ machines: Introduction to supramolecular chemistry, characteristics of molecular motors. Rotaxanes and Catenanes as artificial molecular machines. molecular shuttle, a molecular elevator, an autonomous light –powered molecular motors.

Green chemistry: Principles of green chemistry, green synthesis – aqueous phase, microwave assisted chemical reactions and phase transfer catalysis (PTC).

Unit	Module	Micro content
Molecular motors/ machines	Introduction to supramolecular chemistry Moleculatr Motors.	Introduction to supramolecular chemistry, characteristics of molecular motors.
	Natural Molecular Motors and Artificial Molecular Motors	Natural Molecular Motors, Artificial Molecular Machines: Rotaxanes and Catenanes. Molecular shuttle, a molecular elevator, an autonomous light –powered molecular motors
Green chemistry	Principles of Green Chemistry Green Synthetic Methods	12 Principles of green chemistry, green synthesis – aqueous phase, microwave assisted chemical reactions and phase transfer catalysis (PTC).

UNIT-V: SPECTROSCOPIC TECHNIQUES & NON-CONVENTIONAL ENERGY SOURCES 12 HRS

Spectroscopic Techniques:Electromagneticspectrum-types of molecular spectra and their absorption criteria.

UV-visible spectroscopy (electronic spectroscopy), Frank-Condon principle, Beer-Lambert's law and its limitations, chromophores and auxochromes – *applications of UV visible spectroscopy.

IR spectroscopy – functional group and finger print region – molecular vibrations – stretching and bending vibrations – *applications of IR.

NMR (Nuclear magnetic resonance): Working principle and instrumentation of NMR – chemical shift(δ) – *applications of NMR.

(*only general applications – without any spectroscopic problems regarding quantitative and qualitative analysis.)

Non-conventional energy sources: Design, working, schematic diagram, advantages and disadvantages of photovoltaic cell, organic photo-voltaic, hydropower, geothermal power, tidal, ocean thermal energy conversion (OTEC) – open cycle OTEC, closed cycle OTEC and hybrid cycle OTEC.

Unit	Module	Micro content
Spectroscopic Techniques	Introduction to Electromagneticspectrum	Electromagneticspectrum-types of molecular spectra and their absorption criteria.
UV	UV Visible Spectroscopy Applications	UV – Visible spectroscopy (electronic spectroscopy), Frank-Condon principle, Beer-Lambert's law and its limitations, chromophores and auxochromes – *applications of UV visible spectroscopy.

IR	IR Spectroscopy, Applications	***IR*** spectroscopy – functional group and finger print region – molecular vibrations – stretching and bending vibrations – *applications of IR.
NMR	NMR Spectroscopy, Applications	***NMR*** (Nuclear magnetic resonance): Working principle and instrumentation of NMR – chemical shift(δ) – *applications of NMR. **(Note:** *only general applications – without any spectroscopic problems regarding quantitative and qualitative analysis.)
Non-conventional energy sources	Photovoltaic cells, Organic Photovoltaic cells, hydropower, geo thermal power, tidal and ocean thermal energy conversion	Design, working, schematic diagram, advantages and disadvantages of photovoltaic cell, organic photo-voltaic cell, hydropower, geothermal power, tidal, ocean thermal energy conversion (OTEC) – open cycle OTEC, closed cycle OTEC and hybrid cycle OTEC.

Course Outcomes: At the end of the course, the students will be able to

CO1. **explain** the preparation, properties and applications of thermoplastics, thermosettings, elastomers and conducting polymers.

CO2. **know** the importance of various materials and their uses in the construction of batteries and fuel cells.

CO3. **know** the applications of advanced materials in various industries.

CO4. **apply** the principles of supramolecular chemistry in the applications of molecular machines, need of green chemistry.

CO5. **explain** the principles of spectrometry such as UV, IR, and NMR.

CO PO MAPPING

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

(Strong – 3; Moderate – 2; Weak – 1)

I-Year-II Semester PC1201	BASIC CIRCUIT ANALYSIS	L	T	P	C
		3	1	0	3

Course objectives

- To study the concepts of network elements and network reduction techniques.
- To understand the behavior of RLC networks for sinusoidal excitations.
- To study the performance of different circuits and to understand the concept of resonance.
- To understand the applications of network theorems.
- To study the concept of magnetic coupled circuits.

Unit-1 **Introduction to Electrical Circuits** Passive components and their V-I relations. Sources (dependent and independent, Ideal and Practical) -Kirchhoff's laws, Network reduction techniques, source transformation techniques, Nodal analysis and Mesh analysis with DC excitation.
Unit-2 **Single Phase A.C Systems** RMS, average value, form factor and Peak factor for Periodic waveforms, Concept of phase, phase angle and phase difference, 'j' operator, waveforms and phasor diagrams for lagging and leading networks. Concept of Impedance and admittance- steady state analysis of R, L and C circuits with sinusoidal excitation, real, reactive power, apparent power and power triangle.
Unit-3 **Analysis of AC Networks** Nodal and Mesh analysis with AC excitation, resonance and anti-resonance, selectivity, band width and Quality factor, voltage and current magnification factor, locus diagrams.
Unit-4 **Network theorems (DC & AC Excitations)** Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem, Reciprocity theorem, Millman's theorem, Compensation theorem and Telligen's theorem.
Unit-5 **Magnetic Circuit** MMF, flux, reluctance, flux density, field intensity and its relations. Analogy between electrical and magnetic circuits. Faraday's laws of electromagnetic induction, Concept of self and mutual inductance, Dot convention, coefficient of coupling and composite magnetic circuit.

Text Books

1. "Fundamentals of Electric Circuits "Charles K.Alexander, Mathew N.O.Sadiku, Tata McGraw-Hill.

2. Engineering Circuit Analysis by William Hayt and Jack E.Kemmerley,Mc Graw Hill Company,6th edition

3. Network Analysis: Van Valkenburg; Prentice-Hall of India Private Ltd.

4. 3000 Solved Problems in Electrical Circuit by Schaum's solved problem series Tata McGraw- Hill.

Reference Books

1. Circuits & Networks Analysis & Synthesis by A. Sudhakar and Shyammohan S Palli, Tata McGraw- Hill.
2. Network Analysis by N.C.Jagan, C.Lakshmi Narayana BS publications 2nd edition
3. Circuit Theory by A.ChakrabartiDanapat Rai & Co publisher.

e- Resources & other digital material:

1. https://www.youtube.com/watch?v=8gMuLr_0-TI&t=7s
2. https://www.youtube.com/watch?v=pO9qgzzRWaA&t=337s
3. https://www.youtube.com/watch?v=HcgDoL9YtMM&t=15s
4. https://www.youtube.com/watch?v=MdPLQFFeQ30&t=74s
5. https://www.youtube.com/watch?v=Q-qKhjXYFPQ

Micro-Syllabus of Basic Circuit Analysis

Unit No.	Unit	Module	Micro-Content
Unit: 1 Introduction to Electrical Circuits Passive components and their V-I relations. Sources (dependent and independent, Ideal and Practical) -Kirchhoff's laws, Network reduction techniques, source transformation techniques, Nodal analysis and Mesh analysis with DC excitation.			
I	**1a, 1b.**	**Introduction to Electrical Circuits**	1. Types of Network elements
			2. V- I relations
			3. Types of sources and source transformation technique
			4. Kirchhoff 's Laws, numerical problems
			5. Series, parallel connection of elements, star and delta transformation, numerical problems
	2a,2b	Network reduction techniques	6. Nodal Analysis with DC excitation, numerical problems (both dependant and Independent sources) 7. Mesh Analysis with DC excitation, numerical problems(both dependant and Independent sources)
UNIT 2: Single Phase A.C Systems RMS, average value, form factor and Peak factor for Periodic waveforms, Concept of phase, phase angle and phase difference, 'j' operator, waveforms and phasor diagrams for lagging and leading networks. Concept of Impedance and admittance- steady state analysis of R, L and C circuits with sinusoidal excitation, real, reactive power, apparent power and power triangle.			

II	**3a,3b**	Introduction to Single phase ac systems	1. Introduction to single phase AC quantities different forms of representing periodic quantities
			2. Basic definitions and Calculation of Average, RMS, peak and form factor using Integration method- numerical problems
			3. Concept of phase, phase angle, phasor representation, phasor relation between quantities and j operator significance.
	4a,4b	Steady state analysis of RLC circuits with AC excitation	4. Steady state analysis with AC excitation - Concept of impedence, admittance in RLC series and parallel networks - numerical problems
			5. Basic terms and definitions- real, reactive power, apparent power and power triangle.- numerical problems
Unit 3: Analysis of AC Networks Nodal and Mesh analysis with AC excitation, resonance and anti-resonance, selectivity, band width and Quality factor, voltage and current magnification factor, locus diagrams.			
III	**5a,5b**	Analysis of circuit with AC excitation and resonance	1. Nodal analysis with AC excitation - numerical problems (Independent sources only)
			2. Mesh analysis with AC excitation - numerical problems (Independent sources only)
	6a,6b	Locus Diagrams of RLC networks	3. Concept of resonance and anti-resonance
			4. Definition and derivations of selectivity, band width and Quality factor, voltage and current magnification factor- numerical problems
			5. RL and RC locus diagrams with individual parameter variation- simple numerical problems
Unit 4: Network theorems (DC & AC Excitations) Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem, Reciprocity theorem, Millman's theorem, Compensation theorem and Telligen's theorem.			
IV	**7a,7b**	Analysis of electric circuits using network theorems	1. Thevenin's theorem
			2. Superposition theorem
			3. Norton's theorem
			4. Maximum Power Transfer theorem

	8a,8b	Analysis of electric circuits using network theorems	5. Reciprocity theorem
			6. Millman's theorem
			7. Compensation theorem
			6. Telligen'stheorem - All theorems with both DC and excitations - numerical problems

Unit 5: Magnetic Circuits
MMF, flux, reluctance, flux density, field intensity and its relations. Analogy between electrical and magnetic circuits. Faraday's laws of electromagnetic induction, Concept of self and mutual inductance, Dot convention, coefficient of coupling and composite magnetic circuit.

V	**9a,9b**	Introduction and analysis of magnetic circuits	1. Basic Terms and definitions related to magnetic circuits- MMF, flux, reluctance, flux density, field intensity and its relations
			2. Analogy between electrical and magnetic circuits
			3. Types of Magnetic Circuits- series, parallel and composite circuits- numerical problems
	10a,10b	Calculation of Inductance of magnetic circuits	4. Faraday's laws of electromagnetic induction
			5. Concept of self , mutual inductance and coefficient of coupling - numerical problems
			6. Dot convention- numerical problems

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

CO1	Various electrical networks in presence of active and passive elements. **{Apply level, KL3}**
CO2	Any R, L, C network with sinusoidal excitation.. **{Apply level, KL3&Analyse level, KL4}**
CO3	Any R, L, C network with variation of any one of the parameters i.e R, L, C. and f.**{Apply level, KL3&Analyse level, KL4}**
CO4	Electrical networks by using principles of network theorems.**{Apply level, KL3}**
CO5	Any magnetic circuit with various dot conventions. **{Apply level, KL3}**

CO-PO MAPPING

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	3	2	2									
2	3	2	2	1		1						1
3	3	2	3	1								
4	3	2	1	1								

5	2	2	2	1		1						1
Average	2.8	2	2	1		1						1

(Strong – 3; Moderate – 2; Weak – 1)

I-Year-II Semester	BASICELECTRONIC DEVICES &CIRCUITS	L	T	P	C
ES1201		3	0	0	3

Course objectives:

1. To Understand the Diode operation and switching characteristics,
2. To understand the implementation of various diode applications
3. To Understand the Operation of BJT, FET, MOSFET metal semiconductor rectifying and ohmic contacts.
4. To learn the various biasing methods and small-signal models of Transistors
5. To learn the feedback topology of amplifier and applications of transistors.

Unit-1
Junction Diode Characteristics
P-N Junction Diode Qualitative Theory of P-N Junction, P-N Junction as a Diode, Diode Equation(Qualitative), Volt-Ampere Characteristics, Temperature dependence of VI characteristic, Ideal versus Practical – Resistance levels (Static and Dynamic), Transition and Diffusion Capacitances, Diode Equivalent Circuits, Load Line Analysis, Breakdown Mechanisms in Semiconductor Diodes.

Special Diodes, Zener Diode Characteristics, Principle of Operation LED and Photo Diode.

Unit-2
Diode Applications
Rectifiers: Half wave rectifier, ripple factor, full wave rectifier, Harmonic components in a rectifier circuit Rectifier with Filters(Qualitative Treatment only): Inductor filter, Capacitor filter, Qualitative Treatment of L - section filter, Pi - section filter, Multiple L and pi -section and filter, and comparison of various filter circuits in terms of ripple factors

Voltage Regulators: Simple circuit of a regulator using zener diode.

Unit-3
Transistor Characteristics
Bi-polar Junction Transistors(BJT): Formation of N-P-N and P-N-P transistors, Transistor current components, Operation of BJT, BJT characteristics (CE, CB configurations), Early effect, Current equations, Relation between Alpha and Beta, typical transistor junction voltage values and Limits of Operation, Transistor as an amplifier. (6 Hrs)

Junction Field Effect Transistors (JFET): Junction Field Effect Transistor (JFET) structure, Drain and Transfer Characteristics, Significance of Pinch-Off Voltage, JFET as an amplifier and switch, Comparison of BJT and JFET.

Unit-4
Transistor Amplifiers
Biasing and Stabilisation: Need for Proper Biasing, Q-point stability, Fixed and Voltage Divider biasing for BJT, Emitter Degeneration, Design of Self Biasing circuit, Thermal Stability considerations. Fixed, Voltage Divider biasing for JFET.

Small Signal Low frequency analysis of BJT and FET amplifiers: Small signal low frequency h-

parameter model of BJT. Approximate model, Analysis of BJT amplifiers using Approximate model for CB,CC and CE configurations, Analysis of JFET Amplifiers, Analysis of CS, CD Amplifiers. (06 Hrs)
Unit-5 **Feedback Amplifiers** Negative Feedback Amplifiers: Concept of feedback, Classification of feedback amplifiers, General characteristics of negative feedback amplifiers, Effect of Feedback on input and output characteristics, Voltage series, voltage shunt, current series, and current shunt feedback amplifiers with discrete components and their analysis (05 Hrs) Oscillators: Condition for oscillations. RC-phase shift oscillators with Transistor and FET, Hartley and Colpitts oscillators, Wein bridge oscillator, Crystal oscillators, Frequency and amplitude stability of oscillators.
Advanced Topics in this Subject: The historical background of MOS devices and their fabrication will be briefly reviewed, as well as the basic MOS structure for accumulation, depletion and inversion. Advanced issues such as work function, trapped charge, interface traps, non-equilibrium operation and re-equilibration processes will be covered.

Text books

1. Jacob Millman and Halkias , ‘ Integrated Electronics’, Tata-Mcgraw Hill International.
2. Donald A. Neaman,”Semiconductor Physics and Devices”, Times Mirror High Education Group, Chicago.

Reference books

1. Robert L.Boylestead and Louis Nashelsky,”Electronic Devices and Circuit Theory”,Pearson Education.
2. Adel S. Sedra and Kenneth C. Smith, “ Microelectronic Circuits”, Oxford University Press.
3. D. Chattopadhyay and P.C. Rakshit Electronics: Fundamentals and Applications

e- Resources & other digital material

1. https://nptel.ac.in/courses/117/102/117102061/
2. https://nptel.ac.in/courses/117/106/117106091/
3. https://nptel.ac.in/courses/108/107/108107142/

Micro-Syllabus of Basic Electronic Devices & Circuits

Unit No.	Topic Name	Micro-Topics
I	**Junction Diode Characteristics**	1. Formation of PN junction and space charge Region 2. Open Circuited P-N Junction a. Electrical representation b. Energy Band diagram and Fermi energy level c. Barrier Potential and Electrical symbols

		3. Forward and reverse bias characteristics 4. Diode current equation 5. Diode resistance 6. Temperature Effect on V-I Characteristics 7. Illustrative examples 8. Transition and Diffusion Capacitances of Diode
	Special Diodes	9. Reverse Breakdown mechanisms 10. Operation of Zener Diode 11. Working of LED, Photodiode.
II	**Diode Applications**	1. Working of Diode as a switch 2. Components of Power Supply 3. Working of HWR,FWCR and FWBR 4. Characteristics of Rectifiers a. RMS Output b. DC output c. Ripple Factor d. Efficiency e. PIV f. Percentage Regulation g. TUF 4. Illustrative Examples 5. Need for filtering ac content 6. Working of FWR with series inductor filter and capacitor filter 7. L-section and Pi-section filters 8. Design of Shunt Voltage Regulator with Zener Diode 9. Worked out examples
III	**Bipolar Junction Transistor**	1. Construction of BJT 2. Transistor configurations and modes of operation 3. Operation of Bipolar Transistor 4. Transistor Current components and transportation factors a. Emitter Injection Efficiency b. Base Tansporation factor 5. Large Signal Current gain 6. Early Effect and Circuit symbols 7. Input and Output Characteristics of CB,CE configurations 8. Transistor as an Amplifier and switch
	Junction Field Effect Transistor	8. Structures of N and P channel JFETs 9. Drain and Transfer Characteristics 10. Pinch of Voltage(V_p) 11. Interpretation of Shockley’s Equation,

IV	**Transistor Biasing**	1. Define Q-Point and DC load line 2. Proper Selection of Q-point 3. Stability of Q-point and Definition of Stability factors 4. Basics of Fixed biasing Circuit 5. Voltage divider biasing circuit 6. Analysis of Self-bias circuit 7. Design of self bias circuit 8. Thermal Stability considerations 9. Worked out examples 10. Fixed Biasing in JFET 11. Voltage Divider Biasing of JFET 12. Worked out examples on FET biasing
	Small Signal Low frequency analysis of BJT and FET amplifiers	1. BJT low frequency and small signal equivalent models and definitions h-parameter model 2. Temperature dependence of h-parameters and determination of h-parameters from characteristics 3. General analysis of CE,CC and CB amplifiers and comparison 4. Procedure to analyze practical amplifiers 5. CS amplifier analysis 6. Analysis of CD amplifier
V	**Feedback Amplifiers**	1. Concept of feedback 2. Block Diagram, Concept of negative and positive feedback 3. Characteristics of Negative feedback Amplifiers 4. Voltage Series feedback Amplifier (Block diagram and practical circuit analysis) 5. Current series feedback Amplifier (Block diagram and practical circuit analysis) 6. Voltage shunt feedback Amplifier (Block diagram and practical circuit analysis) 7. Current shunt feedback Amplifier (Block diagram and practical circuit analysis)
	Oscillators	1. Barkhausen Criterion, Classification of Oscillators 2. General form of LC oscillator 3. Hartley and Colpitts Oscillators 4. RC phase shift oscillator with Transistor and FET 5. Wein Bridge Oscillator 6. Crystal Oscillator 7. Frequency Stability of Oscillators

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

CO1: Develop through basic knowledge on the behaviour and the characteristics of semiconductor junction. **(Understand)**

CO2: Demonstratethe usage of diodes in various applications **(Apply)**

CO3: Acquire knowledge on the operations of BJT, FET, and MOSFET. **(Understand)**

CO4: Learn the art of biasing of BJTs and FETs, small signal low frequency models of BJTs and FETS in amplifier analysis **(Apply, Analyze)**

CO5: Learn the feedback topology of amplifier and applications of transistors **(Apply, Analyze)**

CO-PO MAPPING

Mapping	P01	P02	P03	P04	P05	P06	P07	P08	P09	P010	P011	P012	PS01	PSO2
C01		3												2
C02	2	2												2
C03		3												3
C04		3												2
C05	2		2											2

(Strong – 3; Moderate – 2; Weak – 1)

I-Year-II Semester ES1202	PROBLEM SOLVING USING PYTHON	L	T	P	C
		3	0	0	3

Course Objectives

- To learn about Python programming language syntax, semantics, and the runtime environment
- To be familiarized with universal computer programming concepts like data types, containers
- To be familiarized with general computer programming concepts like conditional execution, loops & functions
- To be familiarized with general coding techniques and object-oriented programming

Unit-1 **Introduction:** Introduction to Python, Program Development Cycle, Input, Processing, and Output, Displaying Output with the Print Function, Comments, Variables, Reading Input from the Keyboard, Performing Calculations, Operators. Type conversions, Expressions, More about Data Output. **Data Types, and Expression:** Strings Assignment, and Comment, Numeric Data Types and Character Sets, Using functions and Modules. **Decision Structures and Boolean Logic:** if, if-else, if-elif-else Statements, Nested Decision Structures, Comparing Strings, Logical Operators, Boolean Variables. Repetition Structures: Introduction, while loop, for loop, Calculating a Running Total, Input Validation Loops, Nested Loops.
Unit-2 **Control Statement:** Definite iteration for Loop Formatting Text for output, Selection if and if else Statement Conditional Iteration, While Loop **Strings and Text Files:** Accessing Character and Substring in Strings, Data Encryption, Strings and Number Systems, String Methods Text Files.
Unit-3 **List and Dictionaries:** Lists, Defining Simple Functions, Dictionaries **Design with Function:** Functions as Abstraction Mechanisms, Problem Solving with Top Down Design, Design with Recursive Functions, Case Study Gathering Information from a File System, Managing a Program's Namespace, Higher Order Function. **Modules:** Modules, Standard Modules, Packages.
Unit-4 **File Operations:** Reading config files in python, Writing log files in python, Understanding read functions, read(), readline() and readlines(), Understanding write functions, write() and writelines(), Manipulating file pointer using seek, Programming using file operations **Object Oriented Programming:** Concept of class, object and instances, Constructor, class attributes and destructors, Real time use of class in live projects, Inheritance , overlapping and overloading operators, Adding and retrieving dynamic attributes of classes, Programming using Oops support **Design with Classes:** Objects and Classes, Data modeling Examples, Case Study An ATM, Structuring Classes with Inheritance and Polymorphism
Unit-5 **Errors and Exceptions:** Syntax Errors, Exceptions, Handling Exceptions, Raising Exceptions, User-defined Exceptions, Defining Clean-up Actions, Redefined Clean-up Actions.

Graphical User Interfaces: The Behavior of Terminal Based Programs and GUI -Based, Programs, Coding Simple GUI-Based Programs, Other Useful GUI Resources.
Programming: Introduction to Programming Concepts with Scratch.

TEXT BOOKS:

1. Fundamentals of Python First Programs, Kenneth. A. Lambert, Cengage.
2. Python Programming: A Modern Approach, VamsiKurama, Pearson.

REFERENCES:

1. Introduction to Python Programming, Gowrishankar.S, Veena A, CRC Press.
2. Introduction to Programming Using Python, Y. Daniel Liang, Pearson.

Micro-Syllabus of Problem-Solving usingPython

UNIT I

Introduction: Introduction to Python, Program Development Cycle, Input, Processing, and Output, Displaying Output with the Print Function, Comments, Variables, Reading Input from the Keyboard, Performing Calculations, Operators. Type conversions, Expressions, More about Data Output.
Data Types, and Expression: Strings Assignment, and Comment, Numeric Data Types and Character Sets, Using functions and Modules.
Decision Structures and Boolean Logic: if, if-else, if-elif-else Statements, Nested Decision Structures, Comparing Strings, Logical Operators, Boolean Variables. Repetition Structures: Introduction, while loop, for loop, Calculating a Running Total, Input Validation Loops, Nested Loops.

Unit	Module	Micro content
Introduction to Python Language	Introduction Data Types and Expressions	Program Development Cycle, I/O Functions
		Comments, Variables, Operators
		Reading From Keyboard, Type Conversions
		Numeric Data types.
		Strings and Character set.
		String Functions
		Comments
	Decision Structures and Boolean Logic	Conditional Statements
		Nested Conditional Statements
		Looping Techniques
		Nested Loops

UNIT – II

Control Statement: Definite iteration for Loop Formatting Text for output, Selection if and if else Statement Conditional Iteration, While Loop
Strings and Text Files: Accessing Character and Substring in Strings, Data Encryption, Strings and Number Systems, String Methods Text Files.

Unit	Module	Micro content
Control Statements	Control Statements	For loop formatting text for output
		Selection if and if else statement
		Conditional iteration, While loop
	String and Text Files	Character and substring in strings
		Data Encryption
		Strings and Number Systems, String methods Text Files.

UNIT III

List and Dictionaries: Lists, Defining Simple Functions, Dictionaries

Design with Function: Functions as Abstraction Mechanisms, Problem Solving with Top Down Design, Design with Recursive Functions, Case Study Gathering Information from a File System, Managing a Program's Namespace, Higher Order Function.

Modules: Modules, Standard Modules, Packages.

Unit	Module	Micro content
Data Structures, Functions and Modules	List and Dictionaries	Lists
		Functions of Lists
		Dictionaries
		Functions of Dictionaries
	Design with Function Modules	Functions and there usage in python
		Recursive Functions
		Managing a Programs Namespace
		Gathering Info from a File System
		Higher Order Function
		Standard Modules
		Packages and their usage.

UNIT IV

File Operations: Reading config files in python, Writing log files in python, Understanding read functions, read(), readline() and readlines(), Understanding write functions, write() and writelines(), Manipulating file pointer using seek, Programming using file operations

Object Oriented Programming: Concept of class, object and instances, Constructor, class attributes and destructors, Real time use of class in live projects, Inheritance , overlapping and overloading operators, Adding and retrieving dynamic attributes of classes, Programming using Oops support

Design with Classes: Objects and Classes, Data modeling Examples, Case Study An ATM, Structuring Classes with Inheritance and Polymorphism

Unit	Module	Micro content
File Operations, Object Oriented Programming	File Operations	Reading and Writing Files in python using read and write functions
		File operations using seek and other operations

	Object Oriented Programming Design With Classes	Class, Object, constructor and destructor, OOP Principles.
		Objects and Classes, Data modeling Examples
		Adding and retrieving dynamic attributes of classes

UNIT V

Errors and Exceptions: Syntax Errors, Exceptions, Handling Exceptions, Raising Exceptions, User-defined Exceptions, Defining Clean-up Actions, Redefined Clean-up Actions.

Graphical User Interfaces: The Behavior of Terminal Based Programs and GUI -Based, Programs, Coding Simple GUI-Based Programs, Other Useful GUI Resources.

Programming: Introduction to Programming Concepts with Scratch.

Unit	Module	Micro content
Errors and Exceptions, GUI and Programming	Errors and Exceptions	Syntax Errors, Exceptions, Handling Exceptions
		Raising Exceptions, User-defined Exceptions
		Defining Clean-up Actions
		Redefined Clean-up Actions
	GUI Programming	Terminal Based Programs and GUI – Based
		Simple GUI-Based Programs and other useful GUI Resources
		Introduction to Programming
		Scratch Programming

Course Outcomes: After completing this course, Students will be able to-

CO1: Develop essential programming skills in computer programming concepts like data types, containers

CO2: Solve coding tasks related to conditions, loops and String processing

CO3: Experiment with various Data structures in interpreted Language and to build modules and packages for real software needs.

CO4: Implement Files and object oriented principles in Python

CO5: Identify solutions using GUI in Python.

CO – PO MAPPING

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

[1-Slight (low), 2-Moderate (Medium), 3-Substantial (High)]

I-Year-II Semester BS1202L	APPLIED CHEMISTRY LAB	L	T	P	C
		0	0	3	1.5

Introduction to chemistry laboratory – Molarity, Normality, Primary, Secondary standard solutions, Volumetric titrations quantitative analysis .

Course Objectives

1. To furnish the students with a solid foundation in Chemistry Laboratory required to solve the Engineering problems.
2. To expose the students in practical aspects of the theoritical concepts like pH, hardness of water etc.
3. To guide the students on how to handle the instruments like UV-visible spectrophotometer, potentiometer and conductometer.

List of Experiments: (Students should do any 10 experiments listed below)

1. Determination of HCl using standard Na_2CO_3 solution.
2. Determination of alkalinity of a sample containing Na_2CO_3 and NaOH.
3. Determination of Mn (II) using standard oxalic acid solution.
4. Determination of ferrous iron using standard $K_2Cr_2O_7$ solution.
5. Determination of Copper (II) using standard EDTA solution.
6. Determination of temporary and permanent hardness of water using standard EDTA solution.
7. Determination of Iron (III) by colorimetric method.
8. Determination of the concentration of acetic acid using sodium hydroxide (pH-metric method).
9. Determination of concentration of strong acid vs strong base (by conductometric method).
10. Determination of strong acid vs strong base (by potentiometric method).
11. Determination of Mg^{+2} present in an antacid.
12. Determination of $CaCO_3$ presence in an egg shell.
13. Estimation of vitamin- C.
14. Determination of phosphoric content in soft drinks.
15. Adsorption of acetic acid by charcoal.
16. Prepatation of nylon-6, 6 and Bakelite (demonstration only)

Reference Books:

A Text Book of Quantitative Analysis, Arthur J. Vogel.

Course Outcomes: At the end of the course, the students will be able

CO1. To estimate the amount of metal ions present in different solutions (L4 & L3)

CO2. To analyze the quality parameters of water (L4)

CO3. To determine the strength of different solutions by using different instrumentation techniques (L3)

CO-PO MAPPING

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

(Strong – 3; Moderate – 2; Weak – 1)

I-Year-II Semester ES1201L	BASIC ELECTRONIC DEVICES & CIRCUITS LAB	L	T	P	C
		0	0	3	1.5

Course Objectives

1. To study basic electronic components
2. To observe characteristics of electronic devices

Learning Outcomes: At the end of the course the students can able to

1. Measure voltage, frequency and phase of any waveform using CRO.
2. Generate sine, square and triangular waveforms with required frequency and amplitude using function generator.
3. Analyze the characteristics of different electronic devices such as diodes, transistors etc.
4. Analyze and design simple circuits like rectifiers, power supplies and amplifiers etc.,

Electronic Workshop Practice:

1. Identification, Specifications and Testing of active devices, Diodes, BJTs, JFETs, LEDs, LCDs, SCR, UJT.
2. Soldering Practice- Simple circuits using active and passive components.
3. Study and operation of Ammeters, Voltmeters, Transformers, Analog and Digital Millimeter, Function
4. Regulated Power Supply and CRO.

List of Experiments(Any 10 of the following experiments are to be conducted)

1. P.N Junction Diode Characteristics
    - Part A: Germanium Diode (Forward bias& Reverse bias)
    - Part B: Silicon Diode (Forward Bias only)
2. Zener Diode Characteristics
    - Part A: V-I Characteristic
    - Part B: Zener Diode as Voltage Regulator
3. Rectifiers (without and with c-filter)
    - Part A: Half-wave Rectifier
    - Part B : Full-wave Rectifier
4. BJT Characteristics (CE Configuration)
    - Part A: Input Characteristics
    - Part B: output Characteristics
5. FET Characteristics
    - Part A: Drain Characteristics
    - Part B: Transfer Characteristics
6. SCR Characteristics
7. UJT Characteristics
8. Transistor Biasing

9. CRO Operation and its Measurement
10. BJT-CE Amplifier
11. Emitter Follower –CC Amplifier
12. Design any oscillator and measure frequency (RC PHASE SHIFT, WEIN BRIDGE, HARTLEY, and COLPITT'S)
13.Design of variable DC power supply (application).

CO PO MAPPING

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

(Strong – 3; Moderate – 2; Weak – 1)

I-Year-II Semester ES1202L	PROBLEM SOLVING USING PYTHON LAB	L	T	P	C
		0	0	3	1.5

Course Objectives

- To acquire programming skills in core Python.
- To acquire Object Oriented Skills in Python
- To develop the skill of designing Graphical user Interfaces in Python
- To develop the ability to write database applications in Python

List of Problems

1. Write a program that asks the user for a weight in kilograms and converts it to pounds. There are 2.2 pounds in a kilogram.
2. Write a program that asks the user to enter three numbers (use three separate input statements). Create variables called total and average that hold the sum and average of the three numbers and print out the values of total and average.
3. Write a program that uses a *for* loop to print the numbers 8, 11, 14, 17, 20, . . . , 83, 86, 89.
4. Write a program that asks the user for their name and how many times to print it. The program should print out the user's name the specified number of times.
5. Use a *for* loop to print a triangle like the one below. Allow the user to specify how high the triangle should be.
   *
   **
   ***
   ****
6. Generate a random number between 1 and 10. Ask the user to guess the number and print a message based on whether they get it right or not.
7. Write a program that asks the user for two numbers and prints *Close* if the numbers are within .001 of each other and Not close otherwise.
8. Write a program that asks the user to enter a word and prints out whether that word contains any vowels.
9. Write a program that asks the user to enter two strings of the same length. The program should then check to see if the strings are of the same length. If they are not, the program should print an appropriate message and exit. If they are of the same length, the program should alternate the characters of the two strings. For example, if the user enters *abcde* and *ABCDE* the program should print out *AaBbCcDdEe*.Write a program that asks the user for a large integer and inserts commas into it according to the standard American convention for commas in large numbers. For instance, if the user enters 1000000, the output should be 1,000,000.
10. In algebraic expressions, the symbol for multiplication is often left out, as in 3x+4y or 3(x+5). Computers prefer those expressions to include the multiplication symbol, like

3*x+4*y or 3*(x+5). Write a program that asks the user for an algebraic expression and then inserts multiplication symbols where appropriate.

11. Write a program that generates a list of 20 random numbers between 1 and 100.
    a) Print the list.
    b) Print the average of the elements in the list.
    c) Print the largest and smallest values in the list.
    d) Print the second largest and second smallest entries in the list
    e) Print how many even numbers are in the list.
12. Write a program that asks the user for an integer and creates a list that consists of the factors of that integer.
13. Write a program that generates 100 random integers that are either 0 or 1. Then find the longest run of zeros, the largest number of zeros in a row. For instance, the longest run of zeros in [1,0,1,1,0,0,0,0,1,0,0] is 4.
14. Write a program that removes any repeated items from a list so that each item appears at most once. For instance, the list [1,1,2,3,4,3,0,0] would become [1,2,3,4,0].
15. Write a program that asks the user to enter a length in feet. The program should then give the user the option to convert from feet into inches, yards, miles, millimeters, centimeters, meters, or kilometers. Say if the user enters a 1, then the program converts to inches, if they enter a 2, then the program converts to yards, etc. While this can be done with if statements,it is much shorter with lists and it is also easier to add new conversions if you use lists.
16. Write a function called *sum_digits* that is given an integer num and returns the sum of the digits of num.
17. Write a function called *first_diff* that is given two strings and returns the first location in which the strings differ. If the strings are identical, it should return -1.
18. Write a function called *number_of_factors* that takes an integer and returns how many factors the number has.
19. Write a function called *is_sorted* that is given a list and returns True if the list is sorted and False otherwise
20. Write a function called root that is given a number x and an integer n and returns $x^{1/n}$. In the function definition, set the default value of n to 2.
21. Write a function called primes that is given a number n and returns a list of the first n primes. Let the default value of n be 100.
22. Write a function called merge that takes two already sorted lists of possibly different lengths, and merges them into a single sorted list.
    a) Do this using the sort method. b) Do this without using the sort method.
23. Write a program that asks the user for a word and finds all the smaller words that can be made from the letters of that word. The number of occurrences of a letter in a smaller word can't exceed the number of occurrences of the letter in the user's word.
24. Write a program that reads a file consisting of email addresses, each on its own line. Your program should print out a string consisting of those email addresses separated by semicolons.

25. Write a program that reads a list of temperatures from a file called *temps.txt*, converts those temperatures to Fahrenheit, and writes the results to a file called ftemps.txt.
26. Write a class called Product. The class should have fields called name, amount, and price, holding the product's name, the number of items of that product in stock, and the regular price of the product. There should be a method *get_price* that receives the number of items to be bought and returns a the cost of buying that many items, where the regular price is charged for orders of less than 10 items, a 10% discount is applied for orders of between 10 and 99 items, and a 20% discount is applied for orders of 100 or more items. There should also be a method called *make_purchase* that receives the number of items to be bought and decreases amount by that much.
27. Write a class called Time whose only field is a time in seconds. It should have a method called *convert_to_minutes* that returns a string of minutes and seconds formatted as in the following example: if seconds is 230, the method should return '5:50'. It should also have a method called *convert_to_hours* that returns a string of hours, minutes, and seconds formatted analogously to the previous method.
28. Write a class called Converter. The user will pass a length and a unit when declaring an object from the class—for example, c = Converter(9,'inches'). The possible units are inches, feet, yards, miles, kilometers, meters, centimeters, and millimeters. For each of these units there should be a method that returns the length converted into those units. For example, using the Converter object created above, the user could call c.feet() and should get 0.75 as the result.
29. Write a Python class to implement pow(x, n).
30. Write a Python class to reverse a string word by word.
31. Write a program that opens a file dialog that allows you to select a text file. The program then displays the contents of the file in a textbox.
32. Write a program to demonstrate Try/except/else.
33. Write a program to demonstrate try/finally and with/as.

Course Outcomes: After completing this course, Students will be able to-

CO1: Comprehend how software easily to build right out of the box.

CO2: Demonstrates the use of an interpreted language for problem solving through control statements including loops and conditionals.

CO3: Practice with data structures for quick programming solutions.

CO4: Demonstrates software building for real needs by breaking out code into reusable functions and modules.

CO5: Comprehend the software reliability through exception handling.

CO – PO MAPPING:

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

[1-Slight (low), 2-Moderate (Medium), 3-Substantial (High)]

I-Year-II Semester MC1201	CONSTITUTIONOF INDIAN	L T P C 2 0 0 0

Course objectives:

The main objectives are

1. To Enable the student to understand the importance of constitution
2. To understand the structure of executive, legislature and judiciary
3. To understand philosophy of fundamental rights and duties
4. To understand the autonomous nature of constitutional bodies like Supreme Court and high court controller and auditor general of India and election commission of India.
5. To understand the central and state relation financial and administrative.

UNIT-I

Introduction to Indian Constitution: Constitution' meaning of the term, Indian Constitution - Sources and constitutional history, Features - Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

UNIT-II

Union Government and its Administration Structure of the Indian Union: Federalism, Centre-State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha, The Supreme Court and High Court: Powers and Functions;

UNIT-III

State Government and its Administration Governor - Role and Position - CM and Council of ministers, State Secretariat: Organisation, Structure and Functions

UNIT-IV

Local Administration - District's Administration Head - Role and Importance, Municipalities - Mayor and role of Elected Representative - CEO of Municipal Corporation Panchayati: Functions PRI: Zila Panchayat, Elected officials and their roles, CEO Zila Panchayat: Block level Organizational Hierarchy - (Different departments), Village level - Role of Elected and Appointed officials - Importance of grass root democracy

UNIT-V

Election Commission: Election Commission- Role of Chief Election Commissioner and Election Commissionerate State Election Commission: Functions of Commissions for the welfare of SC/ST/OBC and women

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

CO1	Know the sources, features and principles of Indian Constitution.
CO2	Learn about Union Government, State government and its administration.
CO3	Get acquainted with Local administration and Pachayati Raj.
CO4	Be aware of basic concepts and developments of Human Rights.
CO5	Gain knowledge on roles and functioning of Election Commission

Reference books:

1. Durga Das Basu, Introduction to the Constitution of India, Prentice – Hall of India Pvt. Ltd.. New Delhi
2. Subash Kashyap, Indian Constitution, National Book Trust
3. J.A. Siwach, Dynamics of Indian Government & Politics
4. D.C. Gupta, Indian Government and Politics
5. H.M.Sreevai, Constitutional Law of India, 4th edition in 3 volumes (Universal Law Publication)
6. J.C. Johari, Indian Government and Politics Hans
7. J. Raj Indian Government and Politics
8. M.V. Pylee, Indian Constitution Durga Das Basu, Human Rights in Constitutional Law, Prentice – Hall of India Pvt. Ltd.. New Delhi
9. Noorani, A.G., (South Asia Human Rights Documentation Centre), Challenges to Civil Right), Challenges to Civil Rights Guarantees in India, Oxford University Press 2012

CO-PO Mapping:

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

****

II-Year-I Semester	Mathematics-III	L	T	P	C
BS2101		3	1	0	3

Pre-Requisites:

1. Basics of Matrix Algebra
2. Partial Differentiation
3. Multiple Integrals
4. Ordinary Differential Equations

Course Objectives: To learn

1. The concept of rank of a matrix which is used to know the consistency of system of linear equations and also to find the eigenvectors of a given matrix.
2. Cayley-Hamilton theorem to find the inverse and power of a matrix and determine the nature of the quadratic form.
3. The gradient of a scalar function, divergence and curl of a vector function
4. To evaluate line, surface and volume integrals and construct relation between line, surface and volume integrals using vector integral theorems.
5. To familiarize the techniques in solutions of partial differential equations.

Syllabus

Unit No	Contents	Mapped CO
I	**Solving system of linear equations, Eigen values and Eigenvectors: (12 hrs)** Rank of a matrix by Echelon form and normal form–solving system of homogeneous and non-homogeneous linear equations–Gauss elimination, Gauss Jordan for solving system of equations- Eigen values and Eigen vectors and their properties.	CO1
II	**Cayley-Hamilton theorem and quadratic forms: (12 hrs)** Cayley-Hamilton theorem (without proof)–Finding inverse and power of a matrix by Cayley-Hamilton theorem–Reduction to Diagonal form–Quadratic forms and nature of the quadratic forms–Reduction of quadratic form to canonical forms by orthogonal transformation. **Application:** Free vibration of two mass systems.	CO2
III	**Vector Differentiation:(10 hrs)** Scalar and Vector point functions-Vector Differential operator- Gradient – Directional derivatives – Divergence – Curl – Laplacian second order operator- Vector identities- Scalar Potential.	CO3
IV	**Vector Integration: (12 hrs)** Line integral – Work done – Circulation- Surface integral- Volume integral **Vector integral theorems (without proof):** Green’s theorem in a plane- Stoke’s theorem- Gauss Divergence theorem.	CO4

V	**Solutions of Partial differential Equations: (14 hrs)** Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solutions of first order linear (Lagrange) equation and nonlinear (standard types) equations. **Second order PDE:** Solutions of linear partial differential equations with constant coefficients – RHS term of the type e^{ax+by}, $\sin(ax+by)$, $\cos(ax+by)$, $x^m y^n$.	**CO5**
Content Beyond the Syllabus: Unit-I:Finding the current in electrical circuits Unit-III&IV: Cylindrical coordinates and Spherical coordinates Unit-V:Charpit's method.		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO 1	**Analyze** the solution of the system of linear equations and to find the Eigenvalues and Eigen vectors of a matrix. (L4)
CO 2	**Apply** Cayley-Hamilton theorem to determine inverse and power of a matrix and **identify** the nature of the quadratic form (L3)
CO 3	**Interpret** the physical meaning of different operators such as gradient, curl and divergence. (L5)
CO 4	**Determine** line, surface and volume integrals. **Apply** Green's, Stoke's and Gauss divergence theorems to calculate line, surface and volume integrals. (L5& L3)
CO 5	**Identify** the solution methods for partial differential equation that model physical processes. (L3)

Text books:

1. **B.S. Grewal,** Higher Engineering Mathematics, 44th Edition, Khanna Publishers.
2. **B.V. Ramana,** Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

Reference books

1. **Erwin Kreyszig,** Advanced Engineering Mathematics, 10th Edition, Wiley-India.
2. **H. K. Das,** Advanced Engineering Mathematics, 22nd Edition,S. Chand & Company Ltd.
3. **David Poole**, Linear Algebra- A modern introduction, 4th edition, Cengage.
4. **Peter O' Neil**, Advanced Engineering Mathematics, Cengage
5. **Srimantha Pal, S C Bhunia**, Engineering Mathematics, Oxford University Press.

e- Resources & other digital material

1. https://www.youtube.com/watch?v=LJ-LoJhbBA4&list=PLbMVogVj5nJQ2vsW_hmyvVfO4GYWaaPp7
(For Unit-I, Mod1 :1-7 lectures, Mod 6: 25th lecture, Mod 6: 26th lecture&For Unit-II Mod 7: 25th -27th lectures)
2. https://www.youtube.com/watch?v=9MCjyQSRmR8&list=PLFW6lRTa1g80fZ1giRbqbe_X

	dXPdkkyqY&ab_channel=NPTEL-NOCIITMNPTEL-NOCIITM (For Unit-I 1-17 lectures)
3.	https://www.youtube.com/watch?v=ksS_yOK1vtk&list=PLbRMhDVUMngfIrZCNOyPZwHUU1pP66vQW&ab_channel=IITKharagpurJuly2018IITKharagpurJuly2018 (For Unit-III 33-52 lectures, For Unit-IV 53-56 lectures)
4.	http://www.infocobuild.com/education/audio-video-courses/mathematics/Mathematics-III-IIT-Roorkee/lecture-16.html (For Unit-V lectures: 30-32)
5.	https://www.youtube.com/watch?v=PDUHeFyq6sA&list=PLoVRJrAl0FT0oYJJQbchL1hiAUjlJ4y4O&index=42&ab_channel=AKTUDigitalEducationAKTUDigitalEducation (For Unit-V lectures: 41-44)

Micro-Syllabus

<table>
<tr><td colspan="3">Unit-1:Solving system of linear equations, Eigen values and Eigen Vectors : (12 hrs)
Rank of a matrix by Echelon form and normal form–solving system of homogeneous and non-homogeneous linear equations–Gauss elimination, Gauss Jordan for solving system of equations-Eigen values and Eigen vectors and their properties.</td></tr>
<tr><td>Unit No</td><td>Module</td><td>Micro content</td></tr>
<tr><td rowspan="7">1a.Rank of a matrix &Solving system of linear equations</td><td rowspan="3">Rank of a matrix</td><td>Echelon form</td></tr>
<tr><td>Normal form</td></tr>
<tr><td>Normal form by reducing it into PAQ form</td></tr>
<tr><td rowspan="4">Solutions to the system of linear equations</td><td>Homogeneous Linear system</td></tr>
<tr><td>Non homogeneous linear system</td></tr>
<tr><td>Gauss elimination method</td></tr>
<tr><td>Gauss Jordan method</td></tr>
<tr><td rowspan="2">1b. Eigen values and Eigen vectors of a matrix &Properties</td><td>Eigen values and Eigen vectors of a matrix</td><td>Eigen Values and Eigen vectors</td></tr>
<tr><td>Properties</td><td>Properties of Eigen values and Eigen vectors</td></tr>
<tr><td colspan="3">Unit-2:Cayley-Hamilton theorem and quadratic forms: ((12 hrs)
Cayley-Hamilton theorem (without proof)–Finding inverse and power of a matrix by Cayley-Hamilton theorem–Reduction to Diagonal form–Quadratic forms and nature of the quadratic forms–Reduction of quadratic form to canonical forms by orthogonal transformation.
Application: Free vibration of two mass systems.</td></tr>
<tr><td>Unit No</td><td>Module</td><td>Micro content</td></tr>
<tr><td rowspan="2">2.a. Cayley-Hamilton theorem &</td><td rowspan="2">Cayley-Hamilton theorem</td><td>Verification of Cayley-Hamilton theorem</td></tr>
<tr><td>Find the inverse of a matrix using Cayley-</td></tr>
</table>

<table>
<tr><td rowspan="3">Applications</td><td rowspan="2"></td><td>Hamilton theorem</td></tr>
<tr><td>Find the higher powers of a matrix using Cayley-Hamilton theorem</td></tr>
<tr><td>Free vibration of two mass systems</td><td>Find the natural frequencies and normal modes using Free vibration of two mass systems</td></tr>
<tr><td rowspan="2">2.b. Diagonalization of a matrix & Reduction of the quadratic forms into canonical form</td><td rowspan="2">Diagonalization of a matrix, Rank, index, nature, signature, nature of the Quadratic forms</td><td>Diagonalization of a matrix</td></tr>
<tr><td>Reduction of the quadratic forms into canonical form by orthogonal transformation</td></tr>
<tr><td colspan="3">Unit-3: Vector Differentiation: (10 hrs)
Scalar and Vector point functions-Vector Differential operator- Gradient – Directional derivatives – Divergence – Curl – Laplacian second order operator- Vector identities- Scalar Potential.</td></tr>
<tr><td>Unit No</td><td>Module</td><td>Micro content</td></tr>
<tr><td rowspan="5">3.a. Del applied to scalar and vector point functions</td><td rowspan="5">Gradient,Divergence andCurl</td><td>Unit normal vector</td></tr>
<tr><td>Angle between the two surfaces</td></tr>
<tr><td>Directional derivatives</td></tr>
<tr><td>Divergence of a vector-Solenoidal</td></tr>
<tr><td>Curl of a vector-Irrotational</td></tr>
<tr><td rowspan="3">3. b. Scalar potential, Del applied twice to point functions.</td><td rowspan="3">Scalar potential functions, Laplacian operators, Vector identities</td><td>Scalar potential function</td></tr>
<tr><td>Problems on Laplacian operator</td></tr>
<tr><td>Vector identities</td></tr>
<tr><td colspan="3">Unit-4: Vector Integration: (12 hrs)
Line integral – Work done – Circulation- Surface integral- Volume integral
Vector integral theorems (without proof): Green’s theorem in a plane- Stoke’s theorem- Gauss Divergence theorem.</td></tr>
<tr><td>Unit No</td><td>Module</td><td>Micro content</td></tr>
<tr><td rowspan="3">4a. Integration of vectors</td><td rowspan="3">Line, surface and volume integrals</td><td>Work done by the force</td></tr>
<tr><td>Surface integral</td></tr>
<tr><td>Volume integral</td></tr>
<tr><td rowspan="3">4b. Vector integral theorems</td><td rowspan="3">Relations between line, surface and volume integrals.</td><td>Green’s theorem in the plane</td></tr>
<tr><td>Stoke’s theorem</td></tr>
<tr><td>Gauss divergence theorem</td></tr>
<tr><td colspan="3">Unit-5:Solutions of Partial differential Equations:(14 hrs)
Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solutions of first order linear (Lagrange) equation and nonlinear (standard types) equations.
Second order PDE: Solutions of linear partial differential equations with constant coefficients –</td></tr>
</table>

RHS term of the type e^{ax+by}, $\sin(ax+by)$, $\cos(ax+by)$, $x^m y^n$.		
Unit No	**Module**	**Micro content**
5 a. Formation of a partial differential equations and Solutions to the partial differential equations of first order	Formation of partial differential equations	Formation of partial differential equations by eliminating the arbitrary constants
		Formation of partial differential equations by eliminating the arbitrary functions
	Linear (Lagrange's) partial differential equations	Method of grouping
		Method of multipliers
	Non-linear partial differential equations	$f(p,q)=0$
		$f(z,p,q)=0$
		$f(x,p)=g(y,q)$
		$z=px+qy+f(p,q)$
5.b. Second order partial differential equations	Homogeneous partial differential equations of second order with constant coefficients	Finding the Complementary function
		Particular integral of the type 'e^{ax+by}'
		Particular integral of the type '$\sin(ax+by)$ *or* $\cos(ax+by)$'
		Particular integral of the type '$x^m y^n$'
	Non-homogeneous partial differential equations of second order with constant coefficients	Finding the Complementary function
		Particular integral of the type 'e^{ax+by}'
		Particular integral of the type '$\sin(ax+by)$ *or* $\cos(ax+by)$'
		Particular integral of the type '$x^m y^n$'

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Analyze** the solution of the system of linear equations and to find the Eigenvalues and Eigen vectors of a matrix. (L4)
CO2	**Apply** Cayley-Hamilton theorem to determine inverse and power of a matrix and **identify** the nature of the quadratic form (L3)
CO3	**Interpret** the physical meaning of different operators such as gradient, curl and divergence. (L5)
CO4	**Determine** line, surface and volume integrals. **Apply** Green's, Stoke's and Gauss divergence theorems to calculate line, surface and volume integrals. (L5& L3)
CO5	**Identify** the solution methods for partial differential equation that model physical processes. (L3)
Text books:	

1. **B.S. Grewal,** Higher Engineering Mathematics, 44th Edition, Khanna Publishers. 2. **B.V. Ramana,** Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.
Reference books
1. **Erwin Kreyszig,** Advanced Engineering Mathematics, 10th Edition, Wiley-India. 2. **H. K. Das,** Advanced Engineering Mathematics, 22ndEdition,S. Chand & Company Ltd. 3. **David Poole**, Linear Algebra- A modern introduction, 4th edition, Cengage. 4. **Peter O' Neil**, Advanced Engineering Mathematics, Cengage 5. **Srimantha Pal, S C Bhunia**, Engineering Mathematics, Oxford University Press.
e- Resources & other digital material
1. https://www.youtube.com/watch?v=LJ-LoJhbBA4&list=PLbMVogVj5nJQ2vsW_hmyvVfO4GYWaaPp7 2. (For Unit-I, Mod1 :1-7 lectures, Mod 6: 25th lecture, Mod 6: 26thlecture&For Unit-II Mod 7: 25th -27th lectures)
3. https://www.youtube.com/watch?v=9MCjyQSRmR8&list=PLFW6lRTa1g80fZ1giRbqbe_XdXPdkkyqY&ab_channel=NPTEL-NOCIITMNPTEL-NOCIITM 4. (For Unit-I 1-17 lectures)
5. https://www.youtube.com/watch?v=ksS_yOK1vtk&list=PLbRMhDVUMngfIrZCNOyPZwHUU1pP66vQW&ab_channel=IITKharagpurJuly2018IITKharagpurJuly2018 6. (For Unit-III 33-52 lectures, For Unit-IV 53-56 lectures)
7. http://www.infocobuild.com/education/audio-video-courses/mathematics/Mathematics-III-IIT-Roorkee/lecture-16.html 8. (For Unit-V lectures: 30-32)
9. https://www.youtube.com/watch?v=PDUHeFyq6sA&list=PLoVRJrAl0FT0oYJJQbchL1hiAUjlJ4y4O&index=42&ab_channel=AKTUDigitalEducationAKTUDigitalEducation (For Unit-V lectures: 41-44)

CO-PO Mapping :

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

II- Year I- Semester	Name of the Course	L	T	P	C
	Data Structures	3	0	0	3

Prerequisites: Programming in C.

Course Objectives:

- To make students learn the basic concepts of Data Structures and Algorithms.
- To solve problems using data structures such as linear lists, stacks, queues.
- To explore advanced data structures such as balanced search trees.
- To be familiar with Graphs and their applications.
- To analyze various sorting techniques.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Linear Lists (12 hrs)** Introduction to Data Structures, Definition, Need & Types of Data Structures **Algorithms:** Introduction, Time complexity and Space complexity, Performance and Analysis **Linear lists (Arrays) –** Introduction, Operations, Searching. **Sorting -** Insertion Sort, Quick Sort, Merge Sort and Radix Sort.	**CO1**
II	**Stack & Queue (10 hrs)** **Stacks**: Introduction, Operations, implementation, Applications. **Queues**: Introduction, Operations, implementation, Applications, Circular Queue	**CO2**
III	**Linked Lists (10 hrs)** **Single Linked List**: Introduction, Representation, Operations, Applications. **Circular Lists:** Introduction, Representation, Operations. **Double linked lists –** Representation, operations.	**CO3**
IV	**TREES (8 hrs)** **Trees**: Introduction, Terminology, Representation of Trees **Binary Trees**: Properties, Representations, Traversals, Types of Trees **Binary Search Trees:** Definition, Operations.	**CO4**
V	**GRAPHS (12 hrs)** **Graphs:** Introduction, Definition, Representation, Degree of vertex, Types of graphs, Elementary Graph Operations, Graph Traversals – Depth First Search, Breadth First Search, Spanning trees-Prim's algorithm, Krushkal's algorithm	**CO5**

Course Outcomes

Upon successful completion of the course, the student will be able to	
CO1	**Implement** various operations on linear lists. (L2)
CO2	**Apply** data structure strategies like stacks and queues for exploring complex data structures. (L3)
CO3	**Identify** performance and trade-offs of static and dynamic data structures. (L3)
CO4	**Incorporate** data structures into the applications such as binary trees, binary search trees. (L3)
CO5	**Identify** appropriate data structure algorithms for graphs. (L3)

Learning Resources

Text Books:

1. Data structures, Algorithms and Applications in C, S. Sahni, University Press (India) Pvt. Ltd, 2nd edition, Universities Press, Pvt. Ltd.
2. Data structures and Algorithm Analysis in C, Mark Allen Weiss, Pearson Education. Ltd, Second Edition.
3. Data Structures, Schaum's Outline, Seymour Lipschutz, Kindle Edition

Reference Books

1. Introduction to Algorithms, by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, MIT Press.
2. Classical Data Structures, Second Edition, Debasis Samanta, PHI

e- Resources & other digital material

Data Structures Visualizations : https://www.cs.usfca.edu/~galles/visualization/Algorithms.html
Code Archery Youtube Channel:
https://www.youtube.com/playlist?list=PLrKBFf87Cy9CNZpzi3poq8BFWc0h4f0vL

MICRO SYLLABUS

Unit 1:Linear Lists (12 hrs)
Introduction to Data Structures, Definition, Need & Types of Data Structures
Algorithms: Introduction, Time complexity and Space complexity, Performance and Analysis

Unit No	Module	Micro content
1.a.		Introduction to Data Structures
		Definition
		Need & Types of Data Structures
	Algorithms:	Introduction
		Time complexity and Space complexity, Performance and Analysis, Asymptotic Notations - Big Oh(O), Small Oh(o) and Theta Notation (θ), necessary examples
	Linear lists (Arrays)	Introduction, Operations, Searching.

1.b	**Sorting -**	Insertion Sort, Quick Sort, Merge Sort and Radix Sort.

Unit-2:Stack & Queue (10 hrs)
Stacks: Introduction, Operations, implementation, Applications.
Queues: Introduction, Operations, implementation, Applications, Circular Queue.

Unit No	Module	Micro content
2.a.	**Stacks**:	Introduction, Operations – push, pop, underflow, overflow, peek and implementation, Applications – Infix to Postfix Conversion, Postfix evaluation.
2.a.	**Queues**:	Introduction, Operations – enqueue, dequeue, underflow, overflow and implementation, Applications – Circular Queue (operations), FIFO, Hot Potato Problem Simulation.

Unit-3:**Linked Lists (10 hrs)**
Single Linked List: Introduction, Representation, Operations, Applications.
Circular Lists: Introduction, Representation, Operations.
Double linked lists – Representation, operations.

Unit No	Module	Micro content
3.a.	**Single Linked List**:	Introduction, Differences between arrays & linked lists. Representation, Operations – insert, delete, concat, count and search, Applications – Polynomial representation, addition, multiplication.
3.b.	**Circular Lists:**	Introduction, Representation and implementation.
	Double linked lists	Representation, Operations – insert, delete and search.

Unit-4: TREES (8 hrs)
Trees: Introduction, Terminology, Representation of Trees
Binary Trees: Properties, Representations, Traversals, Types of Trees
Binary Search Trees: Definition, Operations.

Unit No	Module	Micro content
4.a.	**Trees**:	Introduction, Terminology, Representation of Trees
	Binary Trees:	Properties, Representations, Traversal – Inorder Traversal, Preorder Traversal, Postorder Traversal (Recursive and Non Recursive) Types of trees – complete binary tree, Full binary tree, Thread Binary Trees, Expression Tree.

4.b	**Binary Search Trees:**	Definition, Operations – insertion, deletion and find min, find max, count, leaf and Searching.

Unit-5: GRAPHS (12 hrs)

Graphs: Introduction, Definition, Representation, Degree of vertex, Types of graphs, Elementary Graph Operations, Graph Traversals – Depth First Search, Breadth First Search, Spanning trees-Prim's algorithm, Krushkal's algorithm..

Unit No	Module	Micro content
5.a.	**Graphs:**	Introduction to graphs, Definition, Types of graphs, Degree of vertex.
		Representation - Adjacency matrix &Adjacency list.
5.b		Elementary Graph Operations – Add Vertex, Add Edge, Delete Vertex, Delete Edge, Find Vertex and Find Edge.
		Graph Traversals – Depth First Search, Breadth First Search
		Spanning trees-Prim's algorithm, Kruskal's algorithm.

Course Outcomes

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

CO1	**Implement** various operations on linear lists. (L2)
CO2	**Apply** data structure strategies like stacks and queues for exploring complex data structures. (L3)
CO3	**Identify** performance and trade-offs of static and dynamic data structures. (L3)
CO4	**Incorporate** data structures into the applications such as binary trees, binary search trees. (L3)
CO5	**Identify** appropriate data structure algorithms for graphs. (L3)

Learning Resources

Text Books:

1. Data structures, Algorithms and Applications in C, S. Sahni, University Press (India) Pvt. Ltd, 2nd edition, Universities Press, Pvt. Ltd.

2. Data structures and Algorithm Analysis in C, Mark Allen Weiss, Pearson Education. Ltd, Second Edition.

3. Data Structures, Schaum’s Outline, Seymour Lipschutz, Kindle Edition

Reference Books

1. Introduction to Algorithms, by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, MIT Press.

2. Classical Data Structures, Second Edition, Debasis Samanta, PHI
e- Resources & other digital material
Data Structures Visualizations : https://www.cs.usfca.edu/~galles/visualization/Algorithms.html Code Archery Youtube Channel: https://www.youtube.com/playlist?list=PLrKBFf87Cy9CNZpzi3poq8BFWc0h4f0vL

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSPO1	PSPO2
CO-1	2	2	1	-	-	-	-	-	-	-	-	-	1	1
CO-2	1	2	2	-	-	-	-	-	-	-	-	-	2	1
CO-3	1	-	2	2	-	-	-	-	-	-	-	-	2	1
CO-4	2	-	2	1	-	-	-	-	-	-	-	-	1	1
CO-5	-	2	1	2	-	-	-	-	-	-	-	-	1	1

II-Year-I Semester PC2101	Electrical Machines-1	L	T	P	C
		3	0	0	3

PRE-REQUISITES: 1) Basic Circuit Analysis

Course objectives: The student should be able to

1. To understand the unifying principles of energy conversion and DC Generator.
2. To Understand the significance of Back EMF and Production of Torque in DC Motor.
3. To learn the characteristics, performance, methods of speed control and testing methods of DC motors.
4. To predetermine the performance of single phase transformers with equivalent circuit models.
5. To understand the parallel operation of transformers and three-phase totwo phase Conversion.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Electromechanical Energy Conversion and introduction to DC machines (13 hrs)** **Electromechanical Energy Conversion (06 hrs)** Principles of electromechanical energy conversion – singly excited system – concept of Co-Energy- force and torque derivation- multi excited system (qualitative treatment). **Construction and principle of operation of DC machine(07 hrs)** EMF equation for generator – Classification of DC machines based on excitation – OCC of DCShunt generator- Determination of Critical resistance and critical speed- Armature reaction and Commutation -Numerical problems.	**CO1**
II	**Performance of D.C. Machines (10 hrs)** Torque and back-EMF equation of dc motor– characteristics of shunt, series and compound motors - losses and efficiency- applications of dc motors- Numerical problems.	**CO2**
III	**Starting, Speed Control and Testing of D.C. Machines (15 hrs)** **Starting, Speed Control of D.C. Machines (05 hrs)** Necessity of starter –3 point and 4 point starters – Speed control of Shunt motor by armature voltage and field control. **Testing of D.CMachines(10 hrs)**	**CO3**

	Testing methods - Swinburne's Test – Hopkinson'sTest -Brake Test on Shunt Motor–Load test on shunt generator- Numerical problems.	
IV	**Single-phase Transformers (06 hrs)** Principle of operation- Constructional details - EMF equation - operation on no load and on load - phasor diagrams. **Equivalent Circuit and Performance (08 hrs)** Equivalent circuit –Voltage regulation – losses and efficiency – effect of variation of frequency and supply voltage on losses – All day efficiency- Numerical problems.	**CO4**
V	**Transformers Testing and Three Phase Transformers (12 hrs)** **Single phase Transformer Testing(08 hrs)** Tests on single phase transformers – open circuit and short circuit tests – Sumpner's test - Separation of losses – parallel operation with equal voltage ratios- Auto Transformer- comparison with two winding transformers-Numerical problems. **Three Phase Transformers(04hrs)** Poly phase connections - Y/Y, Y/Δ, Δ/Y, Δ/Δ and open Δ-Scott connection.	**CO5**

Content Beyond the Syllabus:

1. Internal and External characteristics of DC Shunt Generator.
2. Load Test on DC Series Generator.
3. Parallel operation conditions, advantages and with un equal voltage ratios.
4. Simplified Equivalent Circuit of Single Phase Transformer.

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the concepts of energy conversion and principle operation of DC Generator. **(Remember and Understand)**
CO2	**Examine** the significance of Back EMF and Production of Torque in DC Motor. (**Apply**)
CO3	**Analyze** the speed control methods and performance of DC Machine. (**Analyze**).
CO4	**Quantify** the performance of single phase transformers. (**Evaluate**)
CO5	Empathies parallel operation of transformers and three-Phase to two- phase Conversion. (**Understand, Apply and Analyze**).

Learning Resources
Text books:
1. Theory & Performance of Electrical Machines by J.B.Guptha. S.K.Kataria& Sons. 2. Electrical Machines – P.S. Bhimbra, Khanna Publishers.
Reference books:
1. Electrical Machines by D. P.Kothari, I .J .Nagarth, Mc Graw Hill Publications, 4th edition. 2. Electrical Machinery by AbijithChakrabarthi and Sudhipta Debnath, Mc Graw Hill education 2015. 3. Electrical Machinery Fundamentals by Stephen J Chapman McGraw Hill education 2010. 4. Electric Machinery by A.E. Fitzgerald, Charleskingsley, Stephen D.Umans, TMH.
e- Resources & other digital material
1. https://nptel.ac.in/courses/108/105/108105017
2. https://nptel.ac.in/courses/103/102/108102146
3. www.nptelvideos.in/2012/11/electrical-machines-i.html
4. https://www.electrical4u.com/losses-in-dc-machine

Micro-Syllabus

Unit 1:Electromechanical Energy Conversion and introduction to DC machines (13 hrs)
Electromechanical Energy Conversion (06 hrs)
Principles of electromechanical energy conversion – singly excited system – concept of Co-Energy-force and torque derivation- multi excited system (qualitative treatment).
Construction and principle of operation of DC machine(07 hrs)
EMF equation for generator – Classification of DC machines based on excitation – OCC of DC Shunt generator- Determination of Critical resistance and critical speed- Armature reaction and Commutation -Numerical problems.

Unit No	Module	Micro content
1.a or 2.a Electromechanical Energy Conversion	Principles of electromechanical energy conversion	Principles of energy conversion
		Block diagram representations
		Power flow diagrams for dc machine
	singly excited system	Definition of single excited system
		Representation with figure.
		Co-energy concept in linear system
		Derivation of force and torque in non linear and linear systems.

	Multi excited system	Definition and representation of multi excited system.
1.b or 2.b Construction and principle of operation of DC machine	DC generator And classification	Principle operation of single loop dc generator
		Construction of dc generator and Emf equation derivation-numerical problems.
		Types of dc generators- based on excitation-separately excited –self excited-shunt-series-compound(long and short shunt cumulative and differential)-Numerical problems on self excited (only on shunt and series). – OCC characteristics of DC shunt generator by experimental procedure- Determination of Critical resistance and critical speed from OCC- Armature reaction and commutation.

Unit-2:Performance of D.C. Machines (10 hrs)

Torque and back-EMF equation of dc motor– characteristics of shunt, series and compound motors - losses and efficiency- applications of dc motors- Numerical problems.

Unit No	Module	Micro content
3.a or 4.a Performance of D.C. Machines	Torque and back-EMF equation of dc motor	Motor principle operation-significance of back EMF-Derivation of Torque –Numerical problems on torque
3.b or 4.b Performance calculation of D.C. Machines	Characteristics, losses and efficiency	Characteristics of shunt, series and compound motors –applications of dc motors.
		Power flow diagrams of generator and motor-losses and efficiency -Numerical problems.

Unit-3: **Starting, Speed Control and Testing of D.C. Machines (15 hrs)**

Starting, Speed Control of D.C. Machines (05 hrs)

Necessity of starter –3 point and 4 point starters – Speed control of Shunt motor by armature voltage and field control.

Testing of D.C. Machines(10 hrs)

Testing methods - Swinburne's Test – Hopkinson's Test -Brake Test on Shunt Motor–Load test on shunt generator- Numerical problems.

Unit No	Module	Micro content

5.a or 6.aStarting, Speed Control of D.C. Machines	Starters	Necessity of starter – Starting by 3 point and 4 point starters construction and operation (**only elementary treatment**)
	Speed control of Shunt motor	armature voltage and field control methods for shunt motor
5.b or 6.b Testing of D.C. Machines	Testing of D.C. Machines	brake test, Swinburne's method – principle of regenerative or Hopkinson's method - Load test on dc shunt generator procedure-Numerical problem on brake test, Swinburne's test.

Unit-4: Single-phase Transformers (06 hrs)

Principle of operation- Constructional details - EMF equation - operation on no load and on load - Phasor diagrams.

Equivalent Circuit and Performance (08 hrs)

Equivalent circuit –Voltage regulation – losses and efficiency – effect of variation of frequency and supply voltage on losses – All day efficiency-Numerical problems.

Unit No	Module	Micro content
7.a or 7.b Single-phase Transformers	Principle of operation	Principle of operation -Types (core, shell types) and constructional details.
		E.M.F equation –Numerical problems.
	Operation of single phase Transformer	Operation on no load and on load – lagging, leading and unity power factors loads - phasor diagrams of transformers –Numerical problems.
8.a or 8.b Equivalent Circuit & Performance:	Equivalent circuit& Voltage regulation	Equivalent circuit –secondary is referred to primary and vice versa-Numerical problems on equivalent circuit parameters- derivation of voltage regulation for lagging and leading loads.
	Performance	Losses and efficiency – Numerical problems- effect of variation of frequency and supply voltage on losses – All day efficiency-Numerical problems.

Unit-5: Transformers Testing and Three Phase Transformers (12 hrs)

Single phase Transformer Testing(08 hrs)

Tests on single phase transformers – open circuit and short circuit tests – Sumpner's test -separation of losses – parallel operation with equal voltage ratios- Auto Transformer-comparison with two winding transformers-Numerical problems.

Three Phase Transformers (04 hrs) Poly phase connections - Y/Y, Y/Δ, Δ/Y, Δ/Δ and open Δ-Scott connection.		
Unit No	**Module**	**Micro content**
9.a or 10.aTransformers Testing and auto transformer	Tests on single phase transformers	Open circuit and short circuit tests -Sumpner's test - separation of losses test-
		Conditions for parallel operation-Parallel operation with equal voltage ratios derivation-Numerical problem.
9.b or 10.b Three Phase Transformers		Auto transformer operation(**only Elementary treatment**)– comparison with two winding transformer.
	Three Phase Transformers	Poly phase connections - Y/Y, Y/Δ, Δ/Y, Δ/Δ and open Δ-Scott connection (only elementary treatment).

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

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the concepts of energy conversion and principle operation of DC Generator. **(Remember and Understand)**
CO2	**Examine** the significance of Back EMF and Production of Torque in DC Motor. (**Apply**)
CO3	**Analyze** the speed control methods and performance of DC Machine. (**Analyze**).
CO4	**Quantify** the performance of single phase transformers. (**Evaluate**)
CO5	Empathies parallel operation of transformers and three-Phase to two- phase Conversion. (**Understand, Apply and Analyze**).

Learning Resources
Text books:
1. Theory & Performance of Electrical Machines by J.B.Guptha. S.K.Kataria& Sons. 2. Electrical Machines – P.S. Bhimbra, Khanna Publishers.
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e- Resources & other digital material
1.https://nptel.ac.in/courses/108/105/108105017
2.https://nptel.ac.in/courses/103/102/108102146
3.www.nptelvideos.in/2012/11/electrical-machines-i.html
4. https://www.electrical4u.com/losses-in-dc-machine

CO-PO Mapping :

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	2	2		2								2		1
CO2	2	2		-								-		-
CO3	2	2		-								2		1
CO4	2	2		2								2		1
CO5	1	1		2								-		-

II-Year-I Semester	Electrical Circuit Analysis	L	T	P	C
PC2102		3	1	0	3

Prerequisites: Basic Circuit Analysis,
Integrations,
Laplace transforms and
Differential equations

Course Objectives: The student should be able to

1. To study the concepts of balanced and unbalanced three-phase systems.
2. To study the transient behaviour of electrical circuits with DC excitation
3. To study the transient behaviour of electrical circuits with AC excitation.
4. To study the analysis of two port network.
5. To understand the concept of Network synthesis.

Syllabus

Unit No	Contents	Mapped CO
I	**Three Phase Systems(10hrs)** Types of three phase systems - Phase sequence- relation between line and phase voltages and currents - analysis of balanced three phase systems - Analysis of three phase unbalanced systems: Loop method – Milliman's method	CO1
II	**Transient Analysis in DC circuits(11hrs)** Transient response of R-L, R-C, R-L-C circuits for DC excitation, Solution using differential equations and Laplace transforms	CO2
III	**Transient Analysis in AC circuits(11hrs)** Transient response of R-L, R-C, R-L-C circuits for pulse and AC excitations, Solution using differential equations and Laplace transforms.	CO3
IV	**Two port Networks(10hrs)** Two port network parameters – Z, Y, ABCD and Hybrid parameters and their relations, Cascaded networks	CO4
V	**Network Synthesis(10hrs)** Positive real function - basic synthesis procedure - LC immittance functions - RC impedance functions and RL admittance function - RL impedance function and RC admittance function - Foster and Cauer methods	CO5

Course Outcomes

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

CO1	Various three phase balanced and unbalanced systems **{Apply level, KL3}**
CO2	Transient response of electrical networks for DC excitation. **{Apply level,**

	KL3&Analyse level, KL4}
CO3	Transient response of electrical networks for AC excitations**{Apply level, KL3&Analyse level, KL4}**
CO4	Two port network parameters **{Apply level, KL3}**
CO5	Equivalent electrical network for a given transfer function. **{Apply level, KL3}**

Learning Resources

Text books:

1. Circuits & Networks Analysis & Synthesis by A. Sudhakar and Shyammohan S Palli, Tata McGraw- Hill.
2. Circuit Theory by A.ChakrabartiDanapat Rai & Co publisher.

Reference books

1. Fundamentals of Electric Circuits" Charles K.Alexander, Mathew N.O.Sadiku, Tata McGraw-Hill.
2. Engineering Circuit Analysis by William Hayt and Jack E.Kemmerley,Mc Graw Hill Company,6th edition
3. Network synthesis: Van Valkenburg; Prentice-Hall of India Private Ltd
4. 3000 Solved Problems in Electrical Circuit by Schaum's solved problem series Tata McGraw- Hill.
5. Network Analysis by N.C.Jagan, C.Lakshmi Narayana BS publications 2nd edition

e- Resources & other digital material

1. https://www.youtube.com/watch?v=MHwM1C1zUz4
2. https://www.youtube.com/watch?v=xaeob9lTXS0
3. https://www.youtube.com/watch?v=GasWAllvvD8&list=PL16EE39765482C57F
4. https://www.youtube.com/watch?v=2D_eGLGcUXQ&list=PL16EE39765482C57F&index=5
5. https://www.youtube.com/watch?v=UltkCsoh6Bw&list=PL16EE39765482C57F&index=7

Micro-Syllabus

Unit-1:Threephasecircuits(10hrs)

Phasesequence-staranddeltaconnection-relationbetweenlineandphasevoltagesandcurrents-analysisofbalancedthreephase circuits-Analysisofthreephase unbalancedcircuits: Loopmethod –Star-Deltatransformationtechnique

Unit No	Module	Micro content
1a.Three phasecircuitConnections	Phasesequence-staranddeltaconnection	Threephasesystemintroduction
		Advantagesofthreephaseoversinglephase
		Phasesequence
		Staranddeltaconnections
		ThreephaseBalancedandunbalancedsystem

	Relationbetweenlineand phase voltagesand currents for bothstar and Deltaconnectednetworks	Relationbetweenphaseandlinevolt agescurrentsstar-star
		Relationbetweenphaseandlinevoltagesc urrents star-Delta
		Relationbetweenphaseandlinevolt agescurrentsdelta-star
		Relationbetweenphaseandlinevolt agescurrentsdelta-delta
1b. Analysis of threephase balancedandunbalan cedcircuits	Determinationoflineandphas eparametersof both balanced andunbalancedsystems	Relationbetweenphaseandlinevolt agescurrentsstar-star-Numericalproblems
		Relationbetweenphaseandlinevolt agescurrentsstar-Delta-Numericalproblems
		Relationbetweenphaseandlinevolt agescurrentsdelta-star-Numericalproblems
		Relationbetweenphaseandlinevolt agescurrentsdelta-delta-Numericalproblems
		Analysisofunbalancedsystem-Loopmethod
		Millman’smethod

Unit-2:TransientAnalysisinDCcircuits(11hrs)

TransientresponseofR-L,R-C,R-L-CcircuitsforDCexcitations,Solutionusingdifferentialequations andLaplacetransforms.

Unit No	Module	Microcontent
2a. Transientresponse ofR-L,R-C,R-L-C circuitsforDCexcit ations	Transientresponseof R-L	Responseof sourcefreeRLcircuit
		ResponseofsourceRLcircuitwithDCexci tation
	Transient response of R-C	ResponseofsourcefreeRCcircuit
		ResponseofsourceRCcircuitwithDCexci tation
	Transient response of R-L-C	Responseof sourcefreeRLCcircuit
		ResponseofsourceRLCcircuitwithDC excitation

2b.Transientresponse of R-L,R-C, R-L-C circuitsforDCexcitations-numericalproblems	Determination ofTransient response of R-L,R-C,R-L-CcircuitsforDCexcitations	Related numerical problem of R-L, R-C and R-L-CcircuitsusingLaplaceordifferentialequationmethod
Unit-3:TransientAnalysisinACcircuits(11hrs) TransientresponseofR-L,R-C,R-L-CcircuitsforACexcitations,Solutionusingdifferentialequations andLaplacetransforms.		
Unit	**Module**	**Microcontent**
3a.Transientresponse of R-L,R-C, R-L-C circuitsforDCexcitations	TransientresponseofR-L	Responseof sourcefreeRLcircuit
		ResponseofsourceRLcircuitwithACexcitation
	TransientresponseofR-C	ResponseofsourcefreeRCcircuit
		ResponseofsourceRCcircuitwithACexcitation
	TransientresponseofR-L-C	Responseof sourcefreeRLCcircuit
		Response of source RLC circuit with ACexcitation
3b. Transient responseofR-L,R-C,R-L-C circuits for DCexcitations-numericalproblems	Determination ofTransientresponseofR-L,R-C,R-L-C circuits for DCexcitations	RelatednumericalproblemofR-L,R-CandR-L-C circuitsusinglaplace ordifferentialequationmethod
Unit-4:TwoPortNetworks(10hrs) Twoportnetworkparameters–Z,Y,ABCDandHybridparametersandtheirrelations,Cascadednetworks.		
Unit No	**Module**	**Microcontent**
4a. Twoportnetworkparameters	Determination ofnetworkparameters	MathematicalanalysisofZand ABCDparameters
		DeterminationofZandABCDparameters-numericalproblems
		Relation between Z and ABCD parameters
4b.		Mathematical analysis of Y and Hybrid parameters

Twoportnetworkparameters	Determination ofnetworkparameters	Determination of Y and Hybrid parameters- numerical problems
		Relation between Y and Hybrid parameters
		Analysis of Cascaded networks

Unit-5:Networksynthesis(10hrs)

Positiverealfunction-basicsynthesisprocedure-LCimmittancefunctions-RCimpedancefunctionsandRLadmittancefunction -RLimpedancefunctionandRCadmittancefunction-FosterandCauermethods.

Unit No	**Module**	**Microcontent**
5a. Networksynthesis	LCandRLNetworkSynthesis	SynthesisofLCImmitancenetworkusingFosterandCauer methods
		SynthesisofRLImpedencenetworkusing Foster andCauermethods
		SynthesisofRLadmittancenetworkusingFosterandCauer methods
5b.Networksynthesis	RC NetworkSynthesis	SynthesisofRCImpedencenetworkusingFosterandCauer methods
		SynthesisofRCadmittancenetworkusingFosterandCauer methods

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

CO1	Various three phase balanced and unbalanced systems **{Apply level, KL3}**
CO2	Transient response of electrical networks for DC excitation. **{Apply level, KL3&Analyse level, KL4}**
CO3	Transient response of electrical networks for AC excitations**{Apply level, KL3&Analyse level, KL4}**
CO4	Two port network parameters **{Apply level, KL3}**
CO5	Equivalent electrical network for a given transfer function. **{Apply level, KL3}**

Text books:

1. Circuits & Networks Analysis & Synthesis by A. Sudhakar and Shyammohan S Palli, Tata McGraw- Hill.
2. Circuit Theory by A.ChakrabartiDanapat Rai & Co publisher.

Reference books

1. Fundamentals of Electric Circuits” Charles K.Alexander, Mathew N.O.Sadiku, Tata

McGraw-Hill.
2. Engineering Circuit Analysis by William Hayt and Jack E.Kemmerley,Mc Graw Hill Company,6th edition
3. Network synthesis: Van Valkenburg; Prentice-Hall of India Private Ltd
4. 3000 Solved Problems in Electrical Circuit by Schaum's solved problem series Tata McGraw- Hill.
5. Network Analysis by N.C.Jagan, C.Lakshmi Narayana BS publications 2nd edition

CO-PO Mapping:

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

II-Year-I Semester PC2102	Electromagnetic Fields	L	T	P	C
		3	1	0	3

PRE-REQUISITES: Co-Ordinate systems, Differential equations, Integration, vector algebra

Course Objectives: The student should be able to

1. Study the electric field and potentials due to different configurations of static charge and Maxwell's first equation
2. Study the behavior of conductors and dielectrics, evaluation of capacitance for different configurations.
3. Study the Biot Savart's Law, Ampere Circuital Law and applications
4. Study the Lorentz force equation
5. Understand the concept inductance and time varying fields

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Unit-1: Electrostatic Fields (16 hrs)** Coulomb's Law, Electric Field Intensity (EFI),EFI due to a line, surface and volume charge, Work done in moving a point charge in an electrostatic field, Electric Potential, Properties of potential function, Potential gradient, Gauss's law, Application of Gauss's Law, Maxwell's first law, Laplace's and Poison's equations, Solution of Laplace's equation in one variable.	**CO1**
II	**Unit-2: Dielectrics and Capacitance (12 hrs)** Electric dipole, Dipole moment, Potential and EFI due to an electric dipole, Torque on an Electric dipole in an electric field, Behavior of conductors in an electric field, Electric field inside a dielectric material, Polarization, Dielectric – Conductor and Dielectric – Dielectric boundary conditions, Capacitance, Capacitance of parallel plate and spherical and co-axial capacitors with composite dielectrics, Energy stored and energy density in a static electric field, Current density, Conduction and Convection current densities, Ohm's law in point form – Equation of continuity.	**CO2**
III	**Unit-3: Static magnetic fields (12 hrs)** Biot-Savart's law, Magnetic field intensity (MFI), MFI due to a straight current carrying filament, MFI due to circular, rectangular, square and solenoid current Carrying wire, Maxwell's second Equation, Ampere's circuital law and its applications, MFI due to an infinite sheet of current and a long current carrying	**CO3**

	filament, Differential form of Ampere's circuital law (Maxwell's third equation).	
IV	**Unit-4: Force in Magnetic fields (12 hrs)** Magnetic force on Moving charges in a Magnetic field, Lorentz force equation, Force on a current element in a magnetic field, Force on a straight and a long current carrying conductor in a magnetic field, Force between two straight long and parallel current carrying conductors, Magnetic dipole and dipole moment, A differential current loop as a magnetic dipole, Torque on a current loop placed in a magnetic field.	**CO4**
V	**Unit-5: Electromagnetic Induction(12 hrs)** **Inductance:** Self and Mutual inductance, Determination of self-inductance of a solenoid and toroid, Mutual inductance between a straight long wire and a square loop wire in the same plane, Energy stored and density in a magnetic field. **Time varying fields:** Faraday's laws of electromagnetic induction, Integral and point forms, Maxwell's fourth equation, statically and dynamically induced EMFs, Modification of Maxwell's equations for time varying fields, Displacement current, Poynting theorem and Poynting vector.	**CO5**
Content Beyond the syllabus: • Co-ordinate systems rectangular, cylindrical and spherical systems • Uniqueness theorem for the solution of Laplace equation		

Course Outcomes Upon successful completion of the course		**POs, PSOs**	**KL**
CO1	The student will be able to calculate the electric field and potentials using Gauss's law and Laplace equation **(Remember, Understand, and Apply)**	PO3, PSO2	1,3
CO2	The student will be able to evaluate capacitance for different configurations **(Understand, Apply, Analyze and valuate)**	PO1, PSO2	2,3
CO3	The student will be able to find magnetic field intensity of different configurations using Biot-Savart's law and Ampere's law (**Apply, Analyze, valuate, and create)**	PO1, PSO2	1,2
CO4	The student will be able to calculate magnetic forces and torque produced by currents in magnetic fields **(Understand, Apply, and Analyze)**	PO2, PSO2	2,3
CO5	The student will be able to quantify inductance and evaluation	PO2, PSO2	1,2

	of induced EMF in time varying fields **(Apply, Analyze and create)**		

Learning Resources
Text books:
1. "Elements of Electro Magnetics" by Matthew N.O.Sadiku, 7th edition, Oxford Publications **2.** "Engineering Electro Magnetics" by William H. Hayt& John. A. Buck, 7thEditon Mc. Graw-Hill Companies,.2006.
Reference books:
1. "Electro Magnetic Fields" by Dr.Y.Mallikarjuna Reddy, 2nd edition , Universities Press. **2.** "Introduction to Electro Dynamics" by D J Griffiths, 2nd edition, PHI Pvt. Ltd. **3.** "Electro Magnetics" by J. D Kraus , 4th edition ,Mc Graw-Hill Inc. 1992. **4.** "Electro Magnetic Theory" by U.A. Bakshi and A.V.Bakshi, Technical Publications
e- Resources & other digital material
1. https://www.sciencedirect.com/topics/medicine-and-dentistry/electromagnetic-field
2. https://phys.libretexts.org/
3. https://nptel.ac.in/courses/108/106/108106073/
4. https://nptel.ac.in/courses/117/103/117103065/
5. https://nptel.ac.in/courses/108/104/108104087/
6. https://nptel.ac.in/courses/115/101/115101005/

Micro-Syllabus

Unit-1: Electrostatic Fields

Coulomb's Law ,Electric Field Intensity (EFI) ,EFI due to a line, surface and volume charge, Work done in moving a point charge in an electrostatic field, Electric Potential , Properties of potential function, Potential gradient, Gauss's law, Application of Gauss's Law, Maxwell's first law, Laplace's and Poison's equations, Solution of Laplace's equation in one variable.

Unit	**Module**	**Micro content**
1. Electrostatic Fields	Coulomb's Law	Statement, explanation, Force due to number of charges Problems – Finding force between two point charges, charges located at the corners of a triangle and square
	Electric Field Intensity (EFI)	Definition, expression and $\vec{E}$ due to number of charges
	EFI due to a line, surface and volume charge	$\vec{E}$ due to finite length of line charge, infinite line charge, circular ring, circular disc, infinite sheet

	Work done in moving a point charge in an electrostatic field	W = $- Q \int_A^B \vec{E}.\overrightarrow{d}$
	Electric Potential	Definition and potential due to point charge, line charge of finite length and circular disc.
	Properties of potential function	Properties only
	Potential gradient	Derivation for E = - grad(V)
	Gauss's law	Electric flux, flux density, relation between $\vec{D}$ and $\vec{E}$, statement and proof for Gauss law
	Application of Gauss's Law	To find $\vec{E}$ due to infinite line, sheet, co-axial cables, concentric spherical shells and spheres
	Maxwell's first law, div (D) =ρv	Divergence theorem, proof for div (D) $=\rho_v$
	Laplace's and Poison's equations	Statements and proofs.
	Solution of Laplace's equation in one variable	Applications to find potential, flux density or field intensity due to concentric spheres, coaxial cables and coaxial cones

Unit-2: Dielectrics and Capacitance:

Electric dipole, Dipole moment, Potential and EFI due to an electric dipole, Torque on an Electric dipole in an electric field, Behavior of conductors in an electric field, Electric field inside a dielectric material, Polarization, Dielectric – Conductor and Dielectric – Dielectric boundary conditions, Capacitance, Capacitance of parallel plate and spherical and co-axial capacitors with composite dielectrics, Energy stored and energy density in a static electric field, Current density, Conduction and Convection current densities, Ohm's law in point form – Equation of continuity.

Unit	**Module**	**Micro content**
2. (A). Dielectrics	Electric dipole	Definition, representation, difference between physical and pure dipoles
	Dipole moment	Definition and expression
	Potential and EFI due to an electric dipole	Derivations and problems
	Torque on an Electric dipole in an electric field	Derivations and problems
	Behavior of conductors in an electric field	Explanation with properties
	Polarization	Definition and expression
	Electric field inside a dielectric material	Derivation

	Dielectric – Conductor and Dielectric – Dielectric boundary conditions	Derivations and problems
2. (B). Capacitance	Capacitance, Capacitance of parallel plate capacitor with composite dielectrics	Definition, expression, derivations and problems
	Capacitance of spherical and co-axial capacitors	Derivations
	Energy stored and energy density in a static electric field	Definitions and derivations
	Current density, Conduction and Convection current densities,	Definitions
	Ohm's law in point form	Proof
	Equation of continuity	Statement and proof

Unit-3: Static magnetic fields:

Biot-Savart's law, Magnetic field intensity (MFI), MFI due to a straight current carrying filament, MFI due to circular, rectangular, square and solenoid current Carrying wire, Maxwell's second Equation, Ampere's circuital law and its applications, MFI due to an infinite sheet of current and a long current carrying filament, Differential form of Ampere's circuital law (Maxwell's third equation).

Unit	**Module**	**Micro content**
3. Static Magnetic fields	Magnetic field intensity (MFI)	Concepts and definitions
	Biot-Savart's law	Statement and proof
	MFI due to a straight current carrying filament	For finite and infinite length filaments-derivation and problems
	MFI due to circular, square and solenoid current Carrying wire	Derivations, numericals and MFI due to Polygon of n sides.
	Maxwell's second Equation, div(B)=0	Statement and proof
	Ampere's circuital law	Statement and proof – Integral form
	Ampere's law applications, MFI due to an infinite sheet of current and a long current carrying filament	Derivation and numerical examples, MFI due to solenoid, toroid
	Differential form of Ampere's circuital law (Maxwell's third equation, Curl (H) =Jc,)	Statement and proof, Numerical examples

Unit-4: Force in Magnetic fields:

Magnetic force on Moving charges in a Magnetic field, Lorentz force equation, Force on a current element in a magnetic field, Force on a straight and a long current carrying conductor in a magnetic field, Force between two straight long and parallel current carrying conductors, Magnetic dipole and dipole moment, A differential current loop as a magnetic dipole, Torque on a current loop placed in a magnetic field.

Unit	Module	Micro content
4. Force in Magnetic fields	Magnetic force on moving charges in a Magnetic field	Concepts and derivation
	Lorentz force equation	Derivation and numericals
	Force on a current element in a magnetic field	Derivation and numericals
	Force on a straight and a long current carrying conductor in a magnetic field	Derivation and numericals
	Force between two straight long and parallel current carrying conductors	Derivation and nature of force and numericals
	Magnetic dipole and dipole moment	Definitions expressions
	A differential current loop as a magnetic dipole	Explanation
	Torque on a current loop placed in a magnetic field.	Derivation and numericals

Unit-5: Electromagnetic Induction

Inductance: Self and Mutual inductance, Determination of self-inductance of a solenoid and toroid, Mutual inductance between a straight long wire and a square loop wire in the same plane, Energy stored and density in a magnetic field.

Time varying fields: Faraday's laws of electromagnetic induction, Integral and point forms, Maxwell's fourth equation, Statically and dynamically induced EMFs, Modification of Maxwell's equations for time varying fields, Displacement current, Poynting theorem and Poynting vector.

Unit	Module	Micro content
5. (A). Inductance	Self and Mutual inductance	Definitions and expressions, Coefficient of coupling
	Determination of self-inductance of a solenoid and toroid	Derivations and problems
	Mutual inductance between a straight long wire and a square loop wire in the same plane	Derivation
	Energy stored and density in a magnetic field.	Definitions, derivations and problems
5. (B). Time	Faraday's laws of electromagnetic induction	Statement

varying fields	Integral and point forms, Maxwell's fourth equation	Derivations - Curl (E) = - ∂B/∂t
	Statically and dynamically induced EMFs	Expressions, derivations and problems
	Modification of Maxwell's equations for time varying fields	Modified Ampere's law, time and frequency varying fields
	Displacement current	Definition, significance and problems
	Poynting Theorem and Poynting vector	Statement and proof only

Course Outcomes: Upon successful completion of the course

CO1	The student will be able to calculate the electric field and potentials using Gauss's law and Laplace equation **(Remember, Understand, and Apply)**
CO2	The student will be able to evaluate capacitance for different configurations **(Understand, Apply, Analyze and valuate)**
CO3	The student will be able to find magnetic field intensity of different configurations using Biot-Savart's law and Ampere's law (**Apply, Analyze, valuate, and create)**
CO4	The student will be able to calculate magnetic forces and torque produced by currents in magnetic fields **(Understand, Apply, and Analyze)**
CO5	The student will be able to quantify inductance and evaluation of induced EMF in time varying fields **(Apply, Analyze and create)**

Learning Resources
Text books:
1. "Elements of Electro Magnetics" by Matthew N.O.Sadiku, Oxford Publications, 7th edition **2.** "Engineering Electro Magnetics" by William H. Hayt& John. A. Buck Mc. Graw-Hill Companies, 7th Editon.2006.
Reference books:
1. "Electro Magnetic Fields" by Dr.Y.Mallikarjuna Reddy, Universities Press. 2nd edition 2. "Introduction to Electro Dynamics" by D J Griffiths, PHI Pvt. Ltd, 2nd edition. 3. "Electro Magnetics" by J. D Kraus Mc Graw-Hill Inc. 4th edition 1992. 4. "Electro Magnetic Theory" by U.A. Bakshi and A.V.Bakshi, Technical Publications
e- Resources & other digital material
1. https://www.sciencedirect.com/topics/medicine-and-dentistry/electromagnetic-field

2.	https://phys.libretexts.org/
3.	https://nptel.ac.in/courses/108/106/108106073/
4.	https://nptel.ac.in/courses/117/103/117103065/
5.	https://nptel.ac.in/courses/108/104/108104087/
6.	https://nptel.ac.in/courses/115/101/115101005/

CO-PO mapping

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

II-Year-I Semester PC2101L	ELECTRICAL MACHINES-1 LAB	L	T	P	C
		0	0	3	1.5

PRE-REQUISITES: 1) Electrical Machines-1 Theory

Preamble: Electrical Machines-1 Lab provides the essential facilities to the students to augment their concepts about the fundamentals of rotating machines and Transformers. The lab is equipped with DC Shunt, Series, Compound machines**,** Single phase and three phase Transformers. The lab covers the determination of characteristics, speed control methods of DC rotating machines. Performance calculations of dc rotating machines and Static device.

Course Objectives: The student should be able to

1. To plot the magnetizing characteristics and understand the load characteristics of DC shunt generator.
2. Learn the methods of speed control of DC shunt motors.
3. To determine the performance of DC machines by direct and indirect loading methods.
4. To predetermine the efficiency and regulation of single-phase transformer and assess their performance.
5. To study the conversion of three phase to two-phase by Scott connection.

LIST OF EXPERIMENTS

Any Ten of the following experiments are to be conducted:

1. Magnetization characteristics of DC shunt generator-critical Resistance and critical speed.
2. Load test on DC shunt generator. Determination of characteristics.
3. Load test on DC Compound generator. Determination of characteristics.
4. Brake test on DC Shunt motor. Determination of performance characteristics.
5. Separation of losses in DC Shunt Motor.
6. Hopkinson's test on DC shunt machines (Predetermination of efficiency).
7. Swinburne's test on DC shunt motor.
8. Speed control of DC shunt motor.
9. OC& SC test on single phase transformer.
10. Sumpner's test on single phase transformers.
11. Scott connection of transformers
12. Separation of core losses of a single-phase transformer.

List of Additional Experiments: Any of the two experiments are to be conducted

13. Load test on DC shunt generator. Determination of characteristics.
14. Field test on DC series machines. Determination of efficiency.
15. Brake test on DC compound motor. Determination of performance characteristics.

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

Course Outcomes	
CO1	Analyze the characteristics and performance of DC generator. (**Analyze**)
CO2	Analyze the speed control and testing methods of DC motors. (**Analyze**)
CO3	Determine the performance of DC machines by direct and indirect loading methods. (**Remember and Understand**).
CO4	Perform various types of tests on transformers for assessing losses. (**Evaluate**)
CO5	Three-phase to two phase transformation. (**Understand, Apply and Analyze**)

Learning Resources
Text books:
1. Theory & Performance of Electrical Machines by J.B.Guptha. S.K.Kataria& Sons. 2. Electrical Machines – P.S. Bhimbra, Khanna Publishers.
Reference books:
1. Electrical Machines by D. P.Kothari, I .J .Nagarth, Mc Graw Hill Publications, 4th edition. 2. Electrical Machinery by AbijithChakrabarthi and Sudhipta Debnath, Mc Graw Hill education 2015. 3. Electrical Machinery Fundamentals by Stephen J Chapman McGraw Hill education 2010. 4. Electric Machinery by A.E. Fitzgerald, Charles kingsley, Stephen D.Umans, TMH.
e- Resources & other digital material
1.https://nptel.ac.in/courses/108/105/108105017
2.https://nptel.ac.in/courses/103/102/108102146
3.www.nptelvideos.in/2012/11/electrical-machines-i.html
4. https://www.electrical4u.com/losses-in-dc-machine

CO-PO Mapping:

Mapping	P01	P02	P03	P04	P05	P06	P07	P08	P09	P010	P011	P012	PS01	PSO2
C01	2	2	1	1	-	-	-	-	-	-	-	1	-	1
C02	2	2	1	1	-	-	-	-	-	-	-	1	-	-
C03	2	2	1	1	-	-	-	-	-	-	-	1	-	1
C04	2	2	1	1	-	-	-	-	-	-	-	1	-	1
C05	2	2	1	-	-	-	-	-	-	-	-	-	-	-

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II-Year-I Semester PC2102L	ELECTRICAL CIRCUIT ANALYSIS LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. Familiarity with DC and AC circuit analysis techniques.
2. Analyze complicated circuits using different network theorems.
3. Analyse the resonance condition of ac circuits
4. Determine the self and mutual inductance of coupled coils.
5. Acquire skills of using MATLAB software for electrical circuit studies.

LIST OF EXPERIMENTS

1.	Verification of Thevenin's and Norton's theorem
2.	Verification of maximum power transfer theorem
3.	Verification of super position theorem
4.	Verification of compensation theorem
5.	Verification of Milliman's theorem using hard ware
6.	Verification of series resonance of Ac circuit
7.	Verification of Kirchhoff's current law and voltage law using Matlab Simulink.
8.	Verification of mesh analysis using Matlab Simulink.
9.	Verification of nodal analysis using Matlab Simulink.
10.	Determination of average value, rms value, form factor, peak factor of sinusoidal wave, square wave using Matlab Simulink.
11.	Verification of parallel resonance of Ac circuit using Matlab Simulink
12.	Verification of self inductanceand mutual inductance using Matlab Simulink
13.	Determination of Choke coil parameters
14.	Determination of Z and Y Parameters of a network
15.	Determination of Transmission and hybrid parameters of a network

Course Outcomes:

Upon the completion of Electrical Circuit and simulation practical course, the student will be able to attain the Following:

1. Familiarity with DC and AC circuit analysis techniques.
2. Analyze complicated circuits using different network theorems.
3. Analyse the resonance condition of ac circuits
4. Determine the self and mutual inductance of coupled coils.
5. Acquire skills of using MATLAB software for electrical circuit studies.

Text Books:

1. Fundamentals of Electric Circuits by CHARLES K.ALEXANDER, Matthew N.O.SADIKU
2. Engineering Circuit Analysis by William H. Hayt and E.Kemmerly

Reference books:

1.Circuit Theory by CHAKRABARTI

2. Network Analysis by M.E.VanValkenburg

CO-PO Mapping:

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

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II-Year-I Semester	FUNDAMENTALS OF INTERNET OF THINGS	L	T	P	C
SOC2101		1	0	2	2

PRE-REQUISITES: 1) Basic programming knowledge

Preamble: The Internet of Things (IoT) is a course about the new paradigm of objects interacting with people, with information systems, and with other objects. The course will focus on creative thinking and on hands-on project development.

Course objectives: The main objectives are

1. Describe what IoT is and how it works today as well as recognise the factors that contributed to the emergence of IoT.
2. To give a fundamental knowledge on the basic phenomena on which operation of sensor transformation of energy is based.
3. Design an IoT platforms design methodology.
4. To train the students to build IoT systems using Raspberry pi for IoT platforms.
5. To train the students to build IoT systems using Arduino for IoT platforms.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction to IoT** **(12 hrs)** Definition and characteristics of IoT, Physical Design and Logical Design of IoT, IoT Architecture and Protocols. IoT Enabling Technologies, IoT levels. (Basic concepts only). Difference between IoTand M2M.	**CO1**
II	**Sensors and actuators:** **(11 hrs)** Definition of sensor, Classifications of sensors and actuators, Principle of sensors, Selection of sensors, Generation of sensors.	**CO2**
III	**IoT Platforms Design Methodology** **(10 hrs)** Introduction, Step by step procedure of IoT Design Methodology, Challenges in IoT Design, IoT System Management.	**CO3**
IV	**Interfacing with Arduino** **(13 hrs)** Introduction, Types of Arduinos, Arduino IDE, Basic Commands for Arduino, Interfacing Arduino with LED, Interfacing Arduino with LCD. Controlling Arduino with python.	**CO4**
V	**Interfacing with Raspberry Pi** **(10 hrs)** Basic building blocks of an IoT device, Introduction to Raspberry Pi, hardware & software requirements for Raspberry Pi, Raspberry interfaces, Programming Raspberry Pi with python-Controlling LED with Raspberry Pi - Interfacing an LED and switch with Raspberry Pi-Interfacing a Light Sensor (LDR) with Raspberry Pi-Interfacing of a DC motor with Raspberry Pi.	**CO5**
List of Experiments:		

1. Raspberry Pi Motion Sensor Alarm using PIR Sensor 2. Raspberry Pi based Smart Phone Controlled Home Automation 3. Interfacing DHT11 (Temperature and Humidity) Sensor with Raspberry Pi 4. Interfacing ultrasonic Sensor with Raspberry Pi 5. Interfacing camera Sensor with Raspberry Pi 6. DC Motor Control with Raspberry Pi 7. Stepper Motor Control with Raspberry Pi 8. Interfacing DS18B20 (Temperature Sensor) with Raspberry Pi and Arduino. 9. Interfacing Flame Sensor with Raspberry Pi and Arduino. 10. Interfacing LED with Raspberry Pi and Arduino.

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Explain the emergence and challenges in IoT. **{Explain level, KL2}**
CO2	Understand the importance of sensors and actuators. **{understand level, KL3}**
CO3	Understand the design methodologies and application areas of IoT.**{ Evaluate level, KL4}**
CO4	Design and develop programs in Raspberry Pi for sensor applications. **{Analyze level, KL4}**
CO5	Interface and deploy sensors with Arduino **{ Evaluate level, KL5}**

Learning Resources
Text books:
1. "Internet of Things A Hands-On- Approach", VijayMadisetti, Arshdeep Bahga1st edition, University press, 2014. 2. "Internet of things with Raspberry Pi and arduino" Rajesh Singh, Anita Gehlot, Lovi Raj Gupta,Bhupendra Singh, and Mahendra Swain, 1st edition, CRC Press, 2020.
Reference books:
1. "Internet of Things A to Z: Technologies and Applications" Qusay F. Hassan,1st edition, Wiley Publishers, 2018. 2. "Introduction to IoT" Sudip Misra, Anandarup Mukherjee, Arijit Roy, 1st edition, Cambridge University Press, 2021.
e- Resources & other digital material
1. https://nptel.ac.in/courses/106/105/106105166/
2. https://nptel.ac.in/courses/108/108/108108098/
3. https://www.classcentral.com/course/iot-4338
4. https://www.coursera.org/learn/interface-with-arduino?specialization=iot

Micro-Syllabus

Unit-1: Introduction to IoT (12 hrs) Understanding IoT fundamentals, IoT Architecture and protocols, Various Platforms for IoT, Real time examples of IoT, Overview of IoT components and IoT Communication Technologies, Challenges in IoT.		
Unit No	**Module**	**Micro content**
1.a .Introduction to IoT	Introduction to IoT	Definition and characteristics of IoT
		Physical Design and Logical Design of IoT
		IoT Architecture and Protocols
		IoT Enabling Technologies
		Difference between IoT and M2M
		IoT Communication Technologies
1.b .Challenges in IoT	Challenges in IoT	Big Data Management.
		Connectivity challenges
		Mission critical applications
Unit-2:Sensors and actuators: (11 hrs) Definition of sensor, Classifications of sensors and actuators, Principle of sensors, Selection of sensors, Generation of sensors.		
Unit No	**Module**	**Micro content**
2.a.Sensors	About Sensors	Definition of sensor
		Classifications of sensors
		Principle of sensors
		Selection of sensors, Generation of sensors
2.b.Actuators	About Actuators	Definition of Actuators
		Classifications of Actuators
Unit-3:IoT Platforms Design Methodology (10 hrs) Introduction, Step by step procedure of IoT Design Methodology, Challenges in IoT Design, IoT System Management.		
Unit No	**Module**	**Micro content**
3.a.Introduction to IoT Platforms	IoT Platforms	Introduction
		Step by step procedure of IoT Design Methodology
3.b.Challenges in IoT Platforms	Challenges in IoT	Challenges in IoT Design
		IoT System Management.
Unit-4:Interfacing with Arduino (13 hrs) Introduction, Types of Arduino, Arduino IDE, Basic Commands for Arduino, Interfacing Arduino with LED, Interfacing Arduino with LCD.Controlling Arduino with python.		
Unit No	**Module**	**Micro content**
4.a.Introduction to	Basic features &	Introduction to Arduino

Arduino	types	Types of Arduino
		Arduino IDE, Basic Commands for Arduino
4.b .Interfacing with Arduino	Interfacing with Arduino	Interfacing Arduino with LED
		Interfacing Arduino with LCD
		Controlling Arduino with python

Unit-5:Interfacing with Raspberry Pi **(10 hrs)**

Basic building blocks of an IoT device, Introduction to Raspberry Pi, hardware & software requirements for Raspberry Pi, Raspberry interfaces, Programming Raspberry Pi with python- Controlling LED with Raspberry Pi - Interfacing an LED and switch with Raspberry Pi- Interfacing a Light Sensor (LDR) with Raspberry Pi- Interfacing of a DC motor with Raspberry Pi.

Unit No	Module	Micro content
5.a.Introduction to Raspberry Pi	Basic features & types	Introduction to Raspberry Pi
		hardware & software requirements for Raspberry Pi
		Raspberry pi IDE, Basic Commands for Raspberry pi
5.b.Interfacing with Raspberry Pi	Interfacing with Raspberry Pi	Interfacing an LED and switch with Raspberry Pi
		Interfacing a Light Sensor (LDR) with Raspberry Pi
		Interfacing of a DC motor with Raspberry Pi

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

CO1	Explain the emergence and challenges in IoT. **{Explain level, KL2}**
CO2	Understand the importance of sensors and actuators. **{understand level, KL3}**
CO3	Understand the design methodologies and application areas of IoT.**{ Evaluate level, KL4}**
CO4	Design and develop programs in Raspberry Pi for sensor applications. **{Analyze level, KL4}**
CO5	Interface and deploy sensors with Arduino **{ Evaluate level, KL5}**

Text books:

1. "Internet of Things A Hands-On- Approach", Vijay Madisetti, Arshdeep Bahga1st edition, University press, 2014.
2. "Internet of things with Raspberry Pi and arduino" Rajesh Singh, Anita Gehlot, Lovi Raj Gupta,Bhupendra Singh, and Mahendra Swain, 1st edition, CRC Press, 2020.

Reference books:

1. "Internet of Things A to Z: Technologies and Applications" Qusay F. Hassan,1st edition, Wiley Publishers, 2018.
2. "Introduction to IoT" Sudip Misra, Anandarup Mukherjee, Arijit Roy, 1st edition, Cambridge University Press, 2021.

CO-PO Mapping :

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

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II-Year-I Semester	INDUSTRIAL SAFETY ,CODES AND STANDARDS	L	T	P	C
SOC2101		1	0	2	2

PRE-REQUISITES:

Course objectives: The student should be able to

1. Study the concept and importance of safety in industries.
2. Study the basic hazards in chemical industry and their control methods.
3. Study the various hazards in engineering industry and their safety methods.
4. Know the major electrical hazards and their safety control schemes.
5. Study the causes of fire accidents and their controlling schemes and also know the importance of machine guarding

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction to safety (08 hrs)** The Concept of Safety, Derivation of the Concept of Safety, Nature of the Concept of Safety, Philosophy of Safety, Safety Terminology, Basic safety requirements, Message of the work “SAFETY, Safety Psychology, Need of Safety Psychology, Behaviour Based Safety (BBS).	**CO1**
II	**Safety in Chemical Industry(10 hrs)** Need of Safety in Chemical Industry, Types of Chemical Industry ,Statutory Provisions & Indian Standards, Types of Chemical Hazards & Controls, Material (Property) Hazards and Controls, Storage &, Process Hazards & their Controls, Utility& Pollution Hazards & Controls. Instrumentation for Safe Plant Operations, Safe Transfer of Chemicals, Safe Transportation of Chemicals, Indian Standards & National Building Code for industries.	**CO2**
III	**Safety in Engineering Industry(9hrs)** Need of Safety in Engineering Industry , Indian Standards ,Introduction to Hot & Cold Processes, Hot Working of Metals, Safety in Other Operations, Heat Treatment Operations, General Health Hazards & Control Measures in Engineering Industry, Safety in Use of Machine Tools, Selection and Care of Cutting Tools, Safe Operations &Maintenance of Machines, safety in other operation like welding &fire. Heat Treatment operations, General Health Hazards & Control Measures in Engineering Industry.	**CO3**
IV	**Electrical Safety(8 hrs)** Electricity, its Usefulness and Hazards, Statutory Provisions & Indian Standards, Effects of Electrical Parameters on Human Body ,Safety Measures for Electric work , Different types of Protections , Portable Electrical Apparatus, Earthing standards ,Electric Work in Hazardous Atmosphere , Static Electricity ,Energy Conservation and Safety.	**CO4**

V	**Fire Hazards &Machine Guarding (09 hrs)** **Fire Hazards**: Fire Phenomena, Classification of Fire and Extinguishers, Statutory and other standards, Design for Fire Safety, Fire Prevention and Protection System.**(06 hrs)** **Machine Guarding:** Requirements of Machine Guarding ,Indian Standards , Principles of Machine Guarding ,Types and Selection of Guards ,Materials for Guard Construction**(03 hrs)**	**CO5**
Content Beyond the syllabus: **Accident Causation and Prevention:** Causation or Occurrence, Reasons for Accident Prevention, Factors Impeding Safety, Basic Terms in Accident Prevention. **Safety Management:** The Concept of Management, Management Principles, Safety Management and its Responsibilities, Safety environment. **Chemical industry:** Inspection, Testing &Maintenance, Work Permits of Hazardous Work, Reports of Some Expert Committees, **Fire explosion and Guarding importance:** Explosion Phenomena ,Inspection, Maintenance and Training for Fire Protection ,Ergonomics of Machine Guarding ,Maintenance and Repairs of Guards, **Personal Protective Equipment:** Need and Limitation, Selection and Classification, Training, PPE Testing Procedures & Standards		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the Basics &importance of safety in industries.**{Understand level, KL2}**
CO2	**Explain** the hazards in chemical industry and their control methods.**{Apply level, KL3}**
CO3	**Analyze** chemical industry hazards and their control methods.**{Analyze level, KL4}**
CO4	**Evaluate the major electrical hazards and their safety schemes**. **{Evaluate level, KL5}**
CO5	**Analyze** fire safety methods and machine guarding. **{Apply level, KL4}**

Learning Resources
Text books:
1. Dr. K U. Mistry- Fundamentals of Industrial Safety and Health, SiddharthPrakashan, Ahmadabad. 2. Industrial Hazards and Safety Handbook, King and Magid, Butterworth
Reference books:

1. Fundamentals of Electrical Safety, V. Manoilov, Mir Publishers, Moscow.
2. Occupational Safety Management and Engineering, Willie Hammer, Prentice-Hall.
3. Chemical Hazards in the Workplace, Measurement & Control, Gangadhar Choudhary, American Chemical Society
4. Accident Prevention Manual for Industrial Operations, National safety Council, Chicago, Illinois.
5. The Factories Act 1948 and the Gujarat Factories Rules 1963.

e- Resources & other digital material

1. Industrial Accident Prevention, H. W. Heinrich, McGraw-Hill BC.
2. Electrical Safety Forum site - www.electricalsafety.com
3. Chemical safety - www.chemicalsafety.co.in
4. Young Worker Health and Safety www.youngworkers.org
5. Fire web - www.fireweb.com
6. National Institute of Occupational Health (NIOH) http://www.nioh.org/
7. National Institute of Disaster Management http: / / www.ni dm. net/ index.htm

Micro-Syllabus

Unit – 1: Introduction to safety (08 hrs)

The Concept of Safety, Derivation of the Concept of Safety, Nature of the Concept of Safety, Philosophy of Safety, Safety Terminology, Basic safety requirements, Message of the work "SAFETY, Safety Psychology, Need of Safety Psychology, Behaviour Based Safety (BBS).

Unit No	Module	Micro content
1a.Introduction to safety	**Introduction to safety**	**The concept of safety** ➢ **Dead Vs. Live Resources,** ➢ **Health Vs. Wealth and** ➢ **Industrialization Vs accidents.** **Derivation and nature of concept of safety**
		What is Philosophy
		Philosophy of Accident Causation
		Philosophy of Total Safety Concept, **Need of Safety Psychology,** **Industrial Psychology**
1b.SafetyPsychology	**SafetyPsychology**	Safety Psychology,AccidentCausativeFactors
		MotivationforSafety
		BehaviourBasedSafety(BBS)

Unit-2: **Safety in Chemical Industry(10 hrs)**

Need of Safety in Chemical Industry, Types of Chemical Industry ,Statutory Provisions & Indian Standards ,Types of Chemical Hazards & Controls ,Material (Property) Hazards and Controls ,.

Storage &, ProcessHazards& their Controls, Utility& Pollution Hazards & Controls. **(7 hrs)**

Instrumentation for Safe Plant Operations , Safe Transfer of Chemicals , Safe Transportation of Chemicals, Indian Standards & National Building Code for industries. . **(3 hrs)**

Unit No	Module	Micro content
2 Safety in Chemical Industry	**Safety in Chemical Industry**	NeedofSafetyinChemicalIndustry
		StatutoryProvisions,IndianStandards
		TypesofChemicalHazards&Controls
		Material(Property)Hazardsand Controls
		Storage Hazards &Controls, ProcessHazards&Controls,UtilityHazards&Controls
		PollutionHazards&Controls
		InstrumentationforSafePlantOperations
		SafeTransferofChemicals,SafeTransportationofChemicals

Unit-3: Safety in Engineering Industry(9hrs)

Need of Safety in Engineering Industry , Indian Standards ,Introduction to Hot & Cold Processes , Hot Working of Metals ,Safety in Other Operations , Heat Treatment Operations, General Health Hazards & Control Measures in Engineering Industry, Safety in Use of Machine Tools, Selection and Care of Cutting Tools, Safe Operations & Maintenance of Machines, safety in other operation like welding &fire. Heat Treatment operations, GeneralHealth Hazards & Control Measures in Engineering Industry.

Unit No	Module	Micro content
3a.Safety in Engineering Industry	**Safety in Engineering Industry**	Need of safety in Engineering Industry
		StatutoryProvisions,IndianStandards
		IntroductiontoHot&ColdProcesses
		Types of Hot and Cold Processes ➢ Types of Furnaces, Uses ➢ Steel Manufacture, Hazards and Safety Measures ➢ Manufacture of Steel Machine Tools ➢ Hazards &Safety Measures
		Heat Treatment Operations
		General Health Hazards & Control Measures in Engineering Industry
		Safety in Use of Machine Tools ,Selection and Care of Cutting Tools
		Safe Operations & Maintenance of Machines
		safety in other operation like welding &fire

		Heat Treatment operations, Hazards & Safety Measures
		GeneralHealth Hazards & Control Measures in Engineering Industry

Unit-4: Electrical Safety(8 hrs)

Electricity, its Usefulness and Hazards, Statutory Provisions & Indian Standards, Effects of Electrical Parameters on Human Body ,Safety Measures for Electric work , Different types of Protections , Portable Electrical Apparatus, Earthing standards ,Electric Work in Hazardous Atmosphere , Static Electricity ,Energy Conservation and Safety.

Unit No	Module	Micro content
4a. Electrical safety	**Electrical safety**	Electricity, its Usefulness and Hazards
		Statutory Provisions & Indian Standards, Effects of Electrical Parameters on Human Body, ➢ Physiology of Electric Shocks ➢ Effects of Amperages ➢ Effects of Voltages ➢ Resistance of Skin ➢ Resistance of Materials Safety Measures for Electric work
		Different types of Protections ➢ Capacity and Protection of conductors, joints and connectors ➢ Overload and Short Circuit Protection ➢ Earth Fault Protection ➢ No Load Protection ➢ Earth, Insulation and Continuity Tests ➢ Earthing Standards ➢ Protection against Surges and Voltages Fluctuation Hazards of Borrowed Neutrals Human Body. Lockout & Tag-out
		Portable Electrical Apparatus
		Earthing standards
		Electric Work in Hazardous Atmosphere
		Static Electricity ➢ Electrostatic Charges & Discharges ➢ Operations and Machines generating Static charge. ➢ Hazards and Controls

		Energy Conservation and Safety

Unit-5: Fire Hazards &Machine Guarding (09 hrs)

Fire Hazards: Fire Phenomena, Classification of Fire and Extinguishers, Statutory and other standards, Design for Fire Safety, Fire Prevention and Protection System.**(06 hrs)**

Machine Guarding: Requirements of Machine Guarding ,Indian Standards , Principles of Machine Guarding ,Types and Selection of Guards ,Materials for Guard Construction**(03 hrs)**

Unit No	Module	Micro content
5a.Fire Hazards	**Fire Hazards**	Fire Phenomena ➢ Nature of Fire, ➢ Need of Fire Safety, ➢ Chemistry & Pyramid of Fire Sprinklers, Water spray, Foam, ➢ Stages of Fire, ➢ Spread of Fire, ➢ Definitions, Factors Contributing to Fire Flammable Substances, Common Cause of Industrial Fire.
		Classification of Fire and Extinguishers
		Statutory Provisions, Indian Standards, Guidelines of Regional Tariff Advisory, NFPA code (NFC).
		Design for Fire Safety ➢ Fire Resistance of Building Materials, ➢ Fire Safety of Building, Plant, Exit, ➢ Fire Prevention and Protection systems, ➢ General Control Measures, ➢ Fire Detection and Alarm Systems, ➢ Fire Load Determination.
		Fire Suppression or Extinguishing Systems ➢ Portable Fire Extinguishers, ➢ Fixed Fire Installations : Hydrants, Sprinklers, Water spray, Foam, ➢ Automatic Fire Detection & Extinguishing System, ➢ Control of Fire and Explosion in Flammable Substances, ➢ Fighting Fires of Pesticides,

		➢ Electrical Fires.
5b. Machine Guarding	**Machine Guarding**	Requirements of Machine Guarding Indian Standards Principles of Machine Guarding, ➢ Definitions, ➢ Elimination of Hazard, ➢ Groups of Dangerous Parts, ➢ According to Motions, ➢ According to H.A. Hepburn. Types and Selection of Guards: ➢ Built-in Safety Devices, ➢ Incidental Safety Devices and Methods, ➢ Guarding of Different Machines Materials for Guard Construction.

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

CO1	**Understand**the Basics &importance of safety in industries**{Understand level, KL2}**
CO2	**Explain** the hazards in chemical industry and their control methods .**{Apply level, KL3}**
CO3	**Analyze** chemical industry hazards and their control methods. **{Analyze level, KL4}**
CO4	**Evaluate**the major electrical hazards and their safety schemes.**{Evaluate level, KL5}**
CO5	**Analyze** fire safety methods and machine guarding. **{Apply level, KL4}**

Text books:

1. Dr. K U. Mistry- Fundamentals of Industrial Safety and Health, SiddharthPrakashan, Ahmadabad.

2. Industrial Hazards and Safety Handbook, King and Magid, Butterworth.

Reference books:

1. . Fundamentals of Electrical Safety, V. Manoilov, Mir Publishers, Moscow.
2. Occupational Safety Management and Engineering, Willie Hammer, Prentice-Hall.
3. Chemical Hazards in the Workplace, Measurement & Control, GangadharChoudhary, American Chemical Society
4. Accident Prevention Manual for Industrial Operations, National safety Council, Chicago, Illinois.
5. The Factories Act 1948 and the Gujarat Factories Rules 1963.

CO-PO Mapping:

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

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II-Year-I Semester SOC2101	DC DRIVES	L T P C 1 0 2 2

PRE-REQUISITES: 1) DC Drives

Course objectives: The student should be able to

6. Study the fundamentals of Drives .
7. Study the principle and working of DC motors.
8. Studies the parameterization, Wiring and its Application .
9. Study the principle and working of DC Drives.
10. Study Features of DC Drives.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Basic of Power Electronic , Concept of Drive & Expectation from Drive , Starters (6 hrs)** Basic principles of Diodes, Thyristors, IGBT, BJT, Comparison of power electronics, Application **(02 hrs)** Basic fundamentals of Drives **(02 hrs)** Basic concept, Wiring **(02 hrs)**	**CO1**
II	**DC MOTOR (08 hrs)** Basic on DC motors-working, principle, **(02 hrs)** types of DC motors **(02 hrs)** Parameterization **(04 hrs)**	**CO2**
III	**Features of SINAMIC DCM DC Drive (06 hrs)** Introduction, parameterization, Wiring, Application	**CO3**
IV	**Concept of DC DRIVE (06hrs)** Concept of DC Drive in details **(02 hrs)** types of dc drives **(02 hrs)** working, principle **(02 hrs)**	**CO4**
V	**Features of DC Drive (06 hrs)** Important features .**(02 hrs)** Selection of DC Drive and its applications .**(02 hrs)** Design and protection for DC Drives **(02hrs)**	**CO5**

Content Beyond the syllabus:

Induction motor drives: Volts/Hertz Control, Vector or Field oriented control.

Industrial application: Drive consideration for Textile mills, Steel rolling mills, Cement mills, Paper mills, Machine tools. Cranes & hoist drives.

LIST OF EXPERIMENTS

1. To obtain speed control of Switched Reluctance Motor using DSP controller

TMS320F2812.
2. To obtain speed control of Permanent magnet synchronous Motor using SPARTAN 6 FPGA controller.
3. To obtain speed control of three phase induction motor using dsPIC controller MICRO-4011.
4. To visualize the speed and position control of servo motor by various inputs of DSP CONTROLLER kit.
5. To study the operation of speed control of dc motor fed from four quadrant chopper using FPGA controller
6. To simulate the three phase voltage source inverter with resistive load using SPWM.
7. To simulate the chopper fed dc motor (matlab)
8. To study the simulation of Z source inverter using matlab - simulink.

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the fundamentals of Drives .**{Understand level, KL2}**
CO2	**Explain** the principle and working of DC motors.**{Apply level, KL3}**
CO3	**Analyze** parameterization, Wiring and its Application **{Analyze level, KL4}**
CO4	**Evaluate** the working of DC Drives **{Evaluate level, KL5}**
CO5	**Analyze** the Design and protection for DC Drives.**{Apply level, KL4}**

Learning Resources

Text books:

1. “Electric Drive: Control of DC and AC Drives” by Srinivas Vemula and Ramaiah Veerlapati.
2. VEDAM SUBRAMANIAM “Electric drives (concepts and applications)”, Tata McGraw-Hill.2001.
3. “Electric motor drives”, R. Krishnan, PHI.
4. “Electric Motor & Drives”. Austin Hughes, Newnes.
5. “Modern Power Electronics & Ac drives”, B.K. Bose, Pearson Education.

Reference books:

1. PILLAI.S.K, “A first course on Electric drives”, Wiley Eastern Limited, 1998
2. M.D. SINGH, K.B.KHANCHANDANI, “Power electronics”, Tata McGraw-Hill.1998

e- Resources & other digital material

1. http://www.hccl.ie/uploads/1/4/7/3/1473854/ha472742_iss4a_ac-dc_catalog.pdf
2. https://www.industrial-electronics.com/MDPTG_4.html
3. http://freetutorials.name/Reference1/Electrical_Engineering.html

Micro-Syllabus

Unit – 1 Basic of Power Electronic, Concept of Drive & Expectation from Drive, Starters (6 hrs)

Basic principles of Diodes, Thyristors, IGBT, BJT, Comparison of power electronics, Application **(02 hrs)**

Basic fundamentals of Drives **(02 hrs)**

Basic concept, Wiring **(02 hrs)**

Unit No	Module	Micro content
1a. Basic of Power Electronic, Concept of Drive	Basic of Power Electronic, Concept of Drive	Basic principles of Diodes, Thyristors, IGBT, BJT
		Comparisons of power electronics
		Applications
		Advantages and Disadvantages.
1b. Concept of Drive & Expectation from Drive, Starters	Concept of Drive & Expectation from Drive, Starters	Basic fundamentals of Drives
		Classifications of Drives
		Power Modulators, Control Unit, Motor Duty classes
		Types of Braking
		Load Equalisation of Electrical Drives, Basic concept, Wiring
		Advantages and Disadvantages.

Unit-2: DC MOTOR (08 hrs)

Basic on DC motors-working, principle, **(02 hrs)**

types of DC motors **(02 hrs)**

Parameterization **(04 hrs)**

Unit No	Module	Micro content
2a. DC MOTOR	DC MOTOR	Basic on DC motors-
		working and principle
		types of DC motors
		Advantages and Disadvantages.
2b. Types of DC motors	Types of DC motors	Types of DC motors
		Working and principle
		Parameterization
		Advantages and Disadvantages.

Unit-3: **Features of SINAMIC DCM DC Drive (06 hrs)**

Introduction, parameterization, Wiring, Applications

Unit No	Module	Micro content
3a. Features of SINAMIC DCM	Features of SINAMIC DCM	Introduction **of SINAMIC DCM**
		parameterization
		Wiring
		Applications

		Advantages and Disadvantages.
3b. DC Drive Converter	DC Drive Converter	Introduction **of DC Converter**
		Types of **DC Converter**
		Advantages
Unit-4: **Concept of DC DRIVE (06hrs)** Concept of DC Drive in details **(02 hrs)** types of dc drives **(02 hrs)** working, principle **(02 hrs)**		
Unit No	**Module**	**Micro content**
4a. DC Drive	DC Drive	Concept of DC Drive
		construction & working principle
		Advantages and Disadvantages
4b. Types of dc drives	Types of dc drives	Types of DC Drives
		Characteristics and its specifications
		Advantages and Disadvantages
Unit-5: Features of DC Drive (06 hrs) Important features of DC Drives.**(02 hrs)** Selection of DC Drive and its applications .**(02 hrs)** Design and protection for DC Drives **(02hrs)**		
Unit	**Module**	**Micro content**
5a. Features of DC Drives	Features of DC Drives	Important features of **AC DRIVE**
		Selection of AC Drive
		Applications
		Advantages and Disadvantages
5b. Design and protection for DC Drives	Design and protection for DC Drives	Design of DC Drives
		Protection of Drives
		Applications
		Advantages and Disadvantages

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

CO1	**Understand** the fundamentals of Drives . **{Understand level, KL2}**
CO2	**Explain** principle and working of DC motors. **{Apply level, KL3}**
CO3	**Analyze** parameterization **{Analyze level, KL4}**
CO4	**Evaluate** the working of DC Drives. **{Evaluate level, KL5}**
CO5	**Analyze** Design and protection for DC Drives.**{Apply level, KL4}**

Learning Resources
Text books:
1. "Electric Drive: Control of DC and AC Drives" by Srinivas Vemula and Ramaiah Veerlapati. 2. VEDAM SUBRAMANIAM "Electric drives (concepts and applications)", Tata McGraw-Hill.2001. 3. "Electric motor drives", R. Krishnan, PHI. 4. "Electric Motor & Drives". Austin Hughes, Newnes. 5. "Modern Power Electronics & Ac drives", B.K. Bose, Pearson Education.
Reference books:
1. PILLAI.S.K, "A first course on Electric drives", Wiley Eastern Limited, 1998 2. M.D. SINGH, K.B.KHANCHANDANI, "Power electronics", Tata McGraw-Hill.1998
e- Resources & other digital material
1. http://www.hccl.ie/uploads/1/4/7/3/1473854/ha472742_iss4a_ac-dc_catalog.pdf
2. https://www.industrial-electronics.com/MDPTG_4.html
3. http://freetutorials.name/Reference1/Electrical_Engineering.html

CO-PO Mapping

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

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II-Year-I Semester	PYTHON LIBRARY TOOLS	L	T	P	C
SOC2101		1	0	2	2

PRE-REQUISITES: Python Programming

Matplotlib is written in Python and makes use of NumPy, the numerical mathematics extension of Python. We assume that the readers of this tutorial have basic knowledge of Python.

Course objectives: The student should be able to

- Learn how to use Jupyter notebooks
- Learn how to work with NumPy data types
- Be proficient in pandas Series
- Be proficient in pandas Data Frames
- Understand how to use data visualization
- Know how to import and clean data
- Introduce statistical tools for working with data sets
- An introduction to the problems of working with PDF data sources

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Unit I:NUMPY:** Introduction, Installation of numpy, Features, Uses, Ndarray object, Data types, array attributes, Array creation, indexing and slicing. Binary operations, matrix operations, numpy functions, numpy sorting and searching, Numpy copy Vs view, linear algebra, I/O with numpy.	**CO1**
II	**UNIT:2 : SCIPY:** Introduction, basic functionality, cluster, constants, Fftpack, Integrate, Interpolate, I/O, linalg, Image Processing, optimizers, matlab arrays.	**CO2**
III	**Unit 3: PANDAS:** Introduction, data structures, pandas- series, data frame, panel, basic functionality, Function applications. Reindexing, Iteration, sorting, indexing and satical functions, window function, cleaning data.	**CO3**
IV	**Unit:4 MATPOLTLIB:** Introduction , Environment Setup, Anaconda distribution, Jupyter Notebook , Pyplot API, Simple Plot , PyLab module , Object-oriented Interface , Figure Class, Axes Class , Multiplots .	**CO4**
V	**Unit: 5 PLOTLY :** Introduction,Environment Setup,Online and Offline Plotting ,Package Structure, Exporting to Static Images,Legends ,Format Axis and Ticks,Subplots and Inset Plots ,Bar Chart and Pie Chart .	**CO5**

Content Beyond the syllabus:

- identify core aspects of programming and features of the Python language
- Understand and apply core programming concepts like data structures, conditionals, loops, variables, and functions
- Use different tools for writing and running Python code
- Design and write fully-functional Python programs using commonly used data structures, custom functions, and reading and writing to files
- Introduce machine learning tools for working with data sets
- Work through a complete data analysis to understand how the tools interact with each other.

List of Experiments

1) Determination of chock coil parameters
2) Determination of z and y parameters of a network
3) Determination of transmission and hybrid parameters of a network
4) Determination of self inductance and mutual inductance of coupled circuits
5) Determination of form factor ,peak factor of sinusoidal wave ,square wave using MAT LAB simulink
6) Draw the performance characteristics of series resonance
7) Draw the performance characteristics of parallel resonance
8) Magnetization characteristics of dc shunt generator-critical resistance and critical speed
9) Load test on dc shunt generator
10) Brake test dc shunt motor
11) Hopkinson's test on dc shunt machines .predetermination of efficiency
12) Swinburne's test on dc shunt motor
13) Speed control of dc shunt motor
14) OC and SC test on single phase transformer
15) Separation of core losses of a single phase transformer

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the operation Introduction, Installation of numpy **{Understand level, KL2}**
CO2	**Explain** the operation of Environment Setup, Anaconda distribution.**{Apply level, KL3}**
CO3	**Analyze**data structures, pandas- series **{Analyze level, KL4}**
CO4	**Evaluate**Environment Setup, Anaconda distribution, Jupyter Notebook in maypoltlib. **{Evaluate level, KL5}**
CO5	**Analyze**Environment Setup,Online and Offline Plotting. **{Apply level, KL4}**

Learning Resources
Text books:

The Python Language Reference Manual (version 3.2)		
1. Guido van Rossum, and Fred L. Drake, Jr. (Editor),ISBN: 1906966141,Network Theory Ltd, 120 pages (Revised November 2006).		
Reference books:		
e- Resources & other digital material		
1. https://nptel.ac.in/courses/108/102/108102047/		
2. https://www.coursera.org/learn/electric-power-systems		
3. https://www.classcentral.com/course/electric-power-systems-12053#		
4. https://pdhonline.com/courses/e104a/e104a_new.htm		
5. https://emp.lbl.gov/sites/all/files/advanced-transmission-technologies.pdf		
6. https://www.hitachi.com/rev/pdf/2002/r2002_04_106.pdf		
7. http://regulationbodyofknowledge.org/wp-content/uploads/2013/03/NERA_Structure.pdf		

Micro-Syllabus

Unit-1: NUMPY: **(12 hrs)**

NumPy is a Python library that provides a simple yet powerful data structure: the n-dimensional array. This is the foundation on which almost all the power of Python's data science toolkit is built, and **learning NumPy** is the first step on any Python data scientist's journey.

Unit No	Module	Micro content
1.a .Introduction to NUMPY	Introduction to NUMPY	Introduction, Installation of numpy,
		Features, Uses, Ndarray object
		Data types, array
		attributes, Array creation
		indexing and slicing
		Binary operations, matrix operations
1.b .Challenges in NUMPY	Challenges in NUMPY	numpy functions, numpy sorting and searching
		Numpy copy Vs view
		linear algebra, I/O with numpy.

Unit-2:SCIPY: **(11 hrs)**

SciPy, a scientific library for Python is an open source, readers, who want to ***learn*** the basic features along with the various functions of ***SciPy***.

Unit No	Module	Micro content
2.a. SCIPY	Introduction to SCIPY	Definition of SCIPY
		basic functionality, cluster, constants,
		Fftpack, Integrate
		Interpolate, I/O, linalg,
2.b. Image Processing	About Image Processing	About the Image Processing
		optimizers, matlab arrays

Unit-3:PANDAS (10 hrs) Introduction, data structures, pandas- series, data frame, panel, basic functionality, Function applications. Reindexing, Iteration, sorting, indexing and satical functions, window function, cleaning data.		
Unit No	**Module**	**Micro content**
3.a.Introduction to PANDS	PANDS Platforms	Introduction
		data structures, pandas- series, data frame
3.b.Challenges in PANDS	Challenges in IoT	Challenges in Function applications. Reindexing,
		window function, cleaning data.
Unit-4: MATPOLTLIB (13 hrs) Introduction , Environment Setup, Anaconda distribution, Jupyter Notebook , Pyplot API, Simple Plot , PyLab module , Object-oriented Interface , Figure Class, Axes Class , Multiplots		
Unit No	**Module**	**Micro content**
4.a.Introduction to **MATPLOTLIB**	Basic features & types	Introduction to **MATPLOTLIB**
		Environment Setup, Anaconda distribution
		, Jupyter Notebook
4.b . PyLab module ,	PyLab module ,	Pyplot API, Simple Plot ,
		PyLab module , Object-oriented Interface
		Figure Class, Axes Class , Multiplots
Unit-5: PLOTLY (10 hrs) Introduction, Environment Setup, Online and Offline Plotting , Package Structure, Exporting to Static Images, Legends , Format Axis and Ticks, Subplots and Inset Plots , Bar Chart and Pie Chart .		
Unit No	**Module**	**Micro content**
5.a.Introduction to **PLOTLY**	Basic features & types	Introduction, Environment Setup
		Online and Offline Plotting , Package Structure
		Exporting to Static Images, Legends
5.b. Format Axis	Format Axis and	Format Axis and Ticks, Subplots and Inset Plots
		Bar Chart and Pie Chart

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

CO1	Explain the Introduction to NUMPY. **{Explain level, KL2}**
CO2	Understand the importance of **SciPy**, a scientific library for Python is an open source. **{understand level, KL3}**
CO3	Understand the design methodologies Environment Setup, Anaconda distribution, Jupyter Notebook.**{ Evaluate level, KL4}**
CO4	Design and develop programs Environment Setup, Anaconda distribution, IN MATPLOTLIB. **{Analyze level, KL4}**
CO5	Online and Offline Plotting in PLOTLY**{ Evaluate level, KL5}**

Text books:

The Python Language Reference Manual (version 3.2)

3. Guido van Rossum, and Fred L. Drake, Jr. (Editor),ISBN: 1906966141,Network Theory Ltd, 120 pages (Revised November 2006).

Reference books:

“**The Python Language Reference Manual** (version 3.2)

3. Guido van Rossum, and Fred L. Drake, Jr. (Editor),ISBN: 1906966141,Network Theory Ltd, 120 pages (Revised November 2006).

CO-PO mapping Table with Justification

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	3	1												
CO2	3		1										1	
CO3			2		3									1
CO4			2		3									
CO5			2		3									

****

II-Year-I Semester	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	L	T	P	C
MC2101		2	0	0	0

Pre-Requisites:

1. Basics of General Science
2. Basics of Social Studies

Course Objectives: The objectives of the course are to impart:

To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.

- The course aim of the imparting basic principle of third process reasoning and inference sustainability is at the course of Indian traditional knowledge system
- To understand the legal framework and traditional knowledge and biological diversity act 2002 and geographical indication act 2003.
- The courses focus on traditional knowledge and intellectual property mechanism of traditional knowledge and protection.
- To know the student traditional knowledge in different sector.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Unit-I: (10 hrs)** Introduction to traditional knowledge: Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge	**CO1**
II	**Unit-II: (8 hrs)** Protection of traditional knowledge: the need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.	**CO2**
III	**Unit-III:(8 hrs)** Legal framework and TK: A: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmers Rights Act, 2001 (PPVFR Act);B:The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016. Geographical indications act 2003.	**CO3**

IV	**Unit-IV:(10 hrs)** Traditional knowledge and intellectual property: Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, global legal FORA for increasing protection of Indian Traditional Knowledge.	**CO4**
V	**Unit-V:(8 hrs)** Traditional knowledge in different sectors: Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.	**CO5**
Content Beyond the Syllabus: Unit-I: NGOS Role in TK. Unit-III: Forest Conservation Act, 1980 Unit-IV:IPR		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Able to **Understand**traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge
CO2	Able to **Understand**Protection of traditional knowledge
CO3	Able to understand and apply Legal framework and Traditional Knowledge
CO4	Able to **Understand**Traditional knowledge and intellectual property
CO5	Able to Understand Traditional knowledge in different sectors
Text books:	
1. Traditional Knowledge System in India, by Amit Jha, 2009.	
Reference books	
1. Traditional Knowledge System in India, by Amit Jha, 2009. 2. Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh, Pratibha Prakashan 2012. 3. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002 4. "Knowledge Traditions and Practices of India" Kapil Kapoor, Michel Danino	
e- Resources & other digital material	
1.http://moef.gov.in/en/resource/e-books/	
2.https://www.youtube.com/watch?v=LZP1StpYEPM 2.http://nptel.ac.in/courses/121106003/	

Micro-Syllabus

Unit-I:	**(10 hrs)**
Introduction to traditional knowledge: Define traditional knowledge, nature and characteristics,	

scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge

Unit No	Module	Micro content
1. Introduction to traditional knowledge	Nature and characteristics, scope and importance, kinds of traditional knowledge,	Define traditional knowledge, nature and characteristics,
		scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop,
		the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics,
		traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge .

Unit-II: (8 hrs)

Protection of traditional knowledge: the need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

Unit No	**Module**	
2. Protection of traditional knowledge	Protection of traditional knowledge	the need for protecting traditional knowledge
		Significance of TK Protection, value of TK in global economy
		Role of Government to harness TK.

Unit-III:(8 hrs)

Legal framework and TK: A: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmers Rights Act, 2001 (PPVFR Act);B:The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016. Geographical indications act 2003.

Unit No	**Module**	**Micro content**
3a.Legal framework and TK	Traditional Forest Dwellers Act, 2006	The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006
		Plant Varieties Protection and Farmers Rights Act, 2001 (PPVFR Act)
3.b.The Biological Diversity Act 2002 and Rules 2004,	The Biological Diversity Act 2002 and Rules 2004,	The Biological Diversity Act 2002 and Rules 2004,
		the protection of traditional knowledge bill, 2016

		Geographical indications act 2003.

Unit-IV:(10 hrs)

Traditional knowledge and intellectual property: Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, global legal FORA for increasing protection of Indian Traditional Knowledge.

Unit No	**Module**	**Micro content**
4.Traditional knowledgeand intellectual property	Systems of traditional knowledge protection	Systems of traditional knowledge protection
		Legal concepts for the protection of traditional knowledge
		Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge
		Strategies to increase protection of traditional knowledge
		Global legal FORA for increasing protection of Indian Traditional Knowledge.

Unit-V:(8 hrs)

Traditional knowledge in different sectors: Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.

Unit No	**Module**	**Micro content**
5.Traditional knowledge in different sectors:	Traditional knowledge in different sectors	Traditional knowledge and engineering
		Traditional medicine system, TK and biotechnology
		TK in agriculture, Traditional societies depend on it for their food and healthcare needs,
		Importance of conservation and sustainable development of environment, Management of biodiversity,
		Food security of the country and protection of TK.

CO-PO Mapping :

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**	**PSO-1**	**PSO-2**
CO1						-	3			-				
CO2						-	3			-				
CO3						-	3			-				

CO4						3	3	3		-				
CO5						-	3			-				

****

II-Year-II Semester	COMPLEX VARIABLES AND STATISTICAL METHODS	L	T	P	C
BS2201		3	1	0	3

Pre-Requisites:

1. Calculus
2. Partial Differentiation
3. Multiple Integrals
4. Basics of Probability

Course objectives: To learn

1. Differentiation and integration of complex functions.
2. Expansion of complex functions using Taylor's and Laurent's series and residue of complex functions.
3. The ideas of probability and random variables and various discrete and continuous probability distributions and their properties.
4. The statistical methods of studying data samples using test of hypothesis.
5. The basic ideas of statistical measures like correlation and regression.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Functions of complex variable and complex integration:** Introduction – Continuity – Differentiability – Analyticity – Properties – Cauchy-Riemann equations in cartesian and polar coordinates – Harmonic and conjugate harmonic functions – Milne-Thompson method. **(05hrs)** Complex integration: Line integral – Cauchy's integral theorem – Cauchy's integral formula (all without proofs). **(05 hrs)**	**CO1**
II	**Series expansions and Residue Theorem:** Radius of convergence –Expansion in Taylor's series, Maclaurin's series - Laurent's series.**(05 hrs)** Types of singularities: Isolated – pole of order m – Essential – Residues – Residue theorem (without proof).**(05hrs)**	**CO2**
III	**Probability, Distributions and Sampling Theory:** Probability-Baye'stheorem-Random variables-Discrete and Continuous random variables-Distribution function-Mathematical Expectation and Variance- **Application approach:** Binomial, Poisson and Normal distributions.**(07 hrs)** Population and samples-Sampling distribution of Means -Point and Interval estimations. **Applications:** Maximum error of estimate Bayesian estimate.**(07 hrs)**	**CO3**

IV	**Test of Hypothesis:** Introduction–Hypothesis-Null and Alternative Hypothesis-Type I and Type II errors-Level of significance-One tail and two-tail tests-Tests concerning one mean and two means (Large and Small samples)-Tests on proportions. **Applications:** Chi-square test and F-test on small samples. **(14 hrs)**	**CO4**
V	**Curve fitting and Correlation:** Method of least squares-Straight line-Parabola-Exponential-Powercurves-Correlation-Correlation coefficient-Rank correlation-Regression coefficient and properties-Regression lines-Multiple regression.**(12 hrs)**	**CO5**
Content Beyond the Syllabus: Unit-3: Maximum error of estimate – Bayesian estimate. Unit-4: Chi-square test and F-test on small samples. Unit-5: Multiple regressions.		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Apply** Cauchy-Riemann equations to complex function in order to determine whether a given continuous function is analytic. (L3)
CO2	**Find** the differentiation, integration of complex functions used in engineering problems and make use of Cauchy residue theorem to evaluate certain integrals. (L3)
CO3	**Apply** discrete and continuous probability distributions and **Design** the components of a classical hypothesis test. (L3 &L6)
CO4	**Infer** the statistical inferential methods (hypothesis testing) based on small and large sampling tests. (L4)
CO5	**Interpret** the association of characteristics and through correlation and regression tools. (L4)

Text books:

1. **B.S. Grewal,** Higher Engineering Mathematics, 44th Edition, Khanna Publishers.
2. **S. C. Gupta and V. K. Kapoor,** Fundamentals of Mathematical Statistics, 11/e (Reprint) 2019, Sultan Chand & Sons Publications.
3. **B.V. Ramana,** Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

Reference books

1. **Miller and Freund's,**Probability and Statistics for Engineers, 7/e, Pearson, 2008.
2. **T. K. V. Iyenger**, Probability and Statistics, S. Chand & Company Ltd, 2015.
3. **Jay I. Devore,** Probability and Statistics for Engineering and the Sciences, 8th Edition, Cengage.
4. **Erwin Kreyszig,** Advanced Engineering Mathematics, 10th Edition, Wiley-India.
5. **H. K. Das,** Advanced Engineering Mathematics, 22ndEdition,S. Chand & Company Ltd.

e- Resources & other digital material

1. https://www.youtube.com/watch?v=Mwpz1zjPlzI&list=PLbMVogVj5nJS_i8vfVWJG16

	mPcoEKMuWT (For Complex Variables)
2.	https://www.youtube.com/playlist?list=PLiUVvsKxTUr66oLF6Pzirc1EgSstMbRZR (For Complex Variables from 1-13)
3.	https://www.youtube.com/watch?v=COI0BUmNHT8&list=PLyqSpQzTE6M_JcleDbrVyPnE0PixKs2JE (For Probability and Statistics)
4.	https://www.youtube.com/watch?v=VVYLpmKRfQ8&list=PL6C92B335BD4238AB (For Probability and Statistics)
5.	https://www.mathsisfun.com/data/standard-normal-distribution-table.html (Information about Normal distribution)
6.	https://www.statisticshowto.com/tables/t-distribution-table/ (Information about T- distribution)
Statistical Tables to be allowed in examinations:	
1.	Normal distribution table
2.	T- distribution table

Micro-Syllabus

Unit-1: Functions of a complex variable and complex integration: (12 hrs)

Introduction – Continuity – Differentiability – Analyticity – Properties – Cauchy-Riemann equations in Cartesian and polar coordinates – Harmonic and conjugate harmonic functions – Milne-Thompson method.

Complex integration: Line integral – Cauchy's integral theorem – Cauchy's integral formula. (all without proofs).

Unit No	Module	Micro content
1a.Analytic functions	Introduction of Analytic function	Cauchy-Riemann equations in cartesian form.
		Cauchy-Riemann equation in Polar form.
		Verify the given function is analytic or not.
	Harmonic function	Prove that real and imaginary parts of analytic function are harmonic.
		Finding conjugate harmonic function for given part of analytic function.
	Orthogonal trajectory	Prove that real and imaginary parts of analytic function are Orthogonal.
		Find orthogonal trajectory of given function.
	Finding analytic function	Using Milne-Thomson method find analytic function whose real or imaginary are known.
1b.Complex integration	Introduction of Complex integration	Evaluation of Complex Integration Using line integral along the given curve.
	Cauchy's Integration	Verification of Cauchy's integral theorem.
		Evaluation of Complex integration using

		Cauchy's integral theorem.
		Evaluation of Complex integration using Cauchy's integral formula.

Unit-2: Series expansions and Residue Theorem: (12 hrs)

Radius of convergence – Expansion in Taylor's series, Maclaurin's series - Laurent's series.

Types of singularities: Isolated – pole of order m – Essential – Residues – Residue theorem (without proof)

Unit No	Module	Micro content
2a.Series Expansion of Complex function	Taylor's Expansion	Expand given function as Taylor's series about z = a.
		Expand given function as Taylor's series in powers of z.
	Laurent's Expansion	Expand given function as Laurent series about z = a.
		Expand given function as Laurent series in powers of z.
2b.Residuetheorem	Evaluation of integration using residue theorem	Find poles and residue at each pole of f(z).
		Evaluate integral of f(z) using residue theorem.

Unit-3: Probability, Distributions and Sampling Theory: (14 hrs)

Probability-Baye'stheorem-Random Variables-Discrete and Continuous random variables-Distribution Function-Mathematical Expectation and Variance-Binomial, Poisson and Normal distributions.

Population and samples-Sampling distribution of Means -Point and Interval estimations - Maximum error of estimate.

Unit No	Module	Micro content
3.a.ProbabilityDistributions	Probability	Find probability using Baye'e theorem.
		Write probability distribution for given random variable. And find mean, variance and S.D. of random variable.
3.b.Random variables and Sampling Theory	Probability distributions	Mean and variance of Binomial, Poisson and normal distributions.
		Find probability of Binomial event.
		Find probability of Poisson event.
		Find probability of Normal event.
	Sampling theory	Write sampling distribution of sample mean. And find mean of sampling distribution and S.D. of sampling distribution.

Unit 4: Test of Hypothesis: **(14 hrs)**

Introduction–Hypothesis-Null and Alternative Hypothesis-Type I and Type II Errors-Level of significance-One tail and two-tail tests-Tests concerning one mean and two means (Large and Small samples)-Tests on proportions.

Unit No	Module	Micro content
4.a.Test of Hypothesis	Test significance of large samples	Test significance of single mean or proportions.
		Test significance of two means or proportions.
4.b.Test of hypothesis	Test significance of small samples	Test significance of single mean.
		Test significance of two means.
		Test significance of variances.

Unit 5: Curve fitting and Correlation: **(12 hrs)**

Method of least squares-Straight line -Parabola-Exponential-Power curves -Correlation-Correlation coefficient -Rank correlation -Regression coefficient and properties-Regression lines.

Unit No	Module	Micro content
5.a.Curve fitting	By least square approximation method fit the data in to given curve	Fit the data in to line equation.
		Fit the data into a second-degree polynomial or parabola.
		Fit the data into power curve $y = a\,x^{b}$
		Fit the data into power curve $y = a\,b^{x}$
		Fit the data into power curve $y = ae^{bx}$
5.b.Correlation and regression	Correlation	Find correlation coefficient.
		Find Karl Pearson's coefficient of correlation.
	Regression	Find regression coefficient and lines.

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Apply** Cauchy-Riemann equations to complex function in order to determine whether a given continuous function is analytic. (L3)
CO2	**Find** the differentiation, integration of complex functions used in engineering problems and make use of Cauchy residue theorem to evaluate certain integrals. (L3)
CO3	**Apply** discrete and continuous probability distributions and **Design** the componentsof a classical hypothesis test. (L3 &L6)
CO4	**Infer** the statistical inferential methods (hypothesis testing) based on small and large sampling tests. (L4)
CO5	**Interpret** the association of characteristics and through correlation and regression tools. (L4)
Text books:	

1. **B.S. Grewal,** Higher Engineering Mathematics, 44th Edition, Khanna Publishers. 2. **S. C. Gupta and V. K. Kapoor,** Fundamentals of Mathematical Statistics, 11/e (Reprint) 2019, Sultan Chand & Sons Publications. 3. **B.V. Ramana,** Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.
Reference books
1. **Miller and Freund's,**Probability and Statistics for Engineers, 7/e, Pearson, 2008. 2. **T. K. V. Iyenger**, Probability and Statistics, S. Chand & Company Ltd, 2015. 3. **Jay I. Devore,** Probability and Statistics for Engineering and the Sciences, 8th Edition, Cengage. 4. **Erwin Kreyszig,** Advanced Engineering Mathematics, 10th Edition, Wiley-India. 5. **H. K. Das,** Advanced Engineering Mathematics, 22ndEdition,S. Chand & Company Ltd.
e- Resources & other digital material
1. https://www.youtube.com/watch?v=Mwpz1zjPlzI&list=PLbMVogVj5nJS_i8vfVWJG16mPcoEKMuWT (For Complex Variables)
2. https://www.youtube.com/playlist?list=PLiUVvsKxTUr66oLF6Pzirc1EgSstMbRZR (For Complex Variables from 1-13)
3. https://www.youtube.com/watch?v=COI0BUmNHT8&list=PLyqSpQzTE6M_JcleDbrVyPnE0PixKs2JE(For Probability and Statistics)
4. https://www.youtube.com/watch?v=VVYLpmKRfQ8&list=PL6C92B335BD4238AB (For Probability and Statistics)
5. https://www.mathsisfun.com/data/standard-normal-distribution-table.html (Information about Normal distribution)
6. https://www.statisticshowto.com/tables/t-distribution-table/(Information about T-distribution)
Statistical Tables to be allowed in examinations:
7. Normal distribution table
8. T- distribution table

CO-PO Mapping :

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO1 2**	**PSO-1**	**PSO-2**
CO1		2												
CO2		2												
CO3	2	1												
CO4	1	1												
CO5	2	3												

****

II-Year-II Semester	THERMAL AND HYDRO PRIME MOVERS	L	T	P	C
ES2201		3	0	0	3

Prerequisites: Engineering Mathematics, Engineering Physics, Engineering Thermodynamics

Course Objectives:The student should be able to

1. Identify the unique vocabulary associated with thermodynamics through the precise definition of basic concepts and also apply the laws of thermodynamics to cycles, cyclic devices.
2. Familiarize with the various I.C.Engine systems along with their function and necessity, also performance analysis of I.C. Engines and Gas turbine Power plants.
3. Provide the basic knowledge of components being used in steam power plant cycles and to analyze the energy transfers and transformations in steam turbine.
4. Describe briefly the concepts of different fluid properties, present numerous examples related to variation of pressure in a fluid and measurement of pressure and flow rate.
5. Illustrate briefly impact of jets, hydraulic pumps and also evaluate the performance of hydraulic turbines.

Syllabus

Unit No	Contents	Mapped CO
I	**BASIC CONCEPTS OF THERMODYNAMICS:** Thermodynamic System, Surrounding, Boundary, Universe, Control Volume, Control Surface, Classes of Systems, State, Thermodynamic Properties, Process and Cycles, Thermodynamic Equilibrium, Reversibility, Quasi static Process. **ZEROTH LAW OF THERMODYNAMICS:** Equality of temperature. **FIRST OF THERMODYNAMICS:** Statement, Internal energy, Flow work, The Steady Flow Process-Steady Flow Energy Equation, simple Problems. **SECOND LAW OF THERMODYNAMICS:** Kelvin-Planck & Clausius Statements of Second law of Thermodynamics, Differences between reversible and Irreversible Process, Carnot Cycle and its specialties. **(13 hrs)**	**CO1**
II	**AIR STANDARD CYCLES:** Otto, Diesel and Dual cycles, its comparisons, Brayton Cycle. **I. C. ENGINES :** Classification, Working principles, Valve and Port Timing Diagrams, Engine systems- fuel injection, carburetion, ignition, cooling and lubrication – Parameters of performance, Determination of Frictional Power & Indicated Power, Engine performance evaluation. **GAS TURBINES:** Simple gas turbine plant, Classification, Analysis of closed and open cycle plants, Applications, Performance parameters, Basic Problems. **(13 hrs)**	**CO2**
III	**STEAM TURBINES:** Working Principle, Classification, Simple Impulse Turbine, Vector diagrams of velocities, Combined Velocity diagram, Work done on the blade, Axial Thrust, Blade efficiency, stage efficiency, overall efficiency,	**CO3**

	Effect of blade friction on velocity diagram, simple problems on Impulse turbine, Compounding of Impulse Turbine, Reaction Turbine, Velocity Diagram for Reaction Turbine, Degree of Reaction (only theory Part on reaction Turbines). **(13 hrs)**	
IV	**FUNDAMENTALS OF FLUID MECHANICS:** Definition of fluid, differences between a solid and fluid, physical properties of fluids- Density, Specific Weight, Specific gravity, viscosity, Types of Fluids and Fluid flows, Continuity and Bernoulli's equations. **MEASUREMENT OF PRESSURE AND FLOW:** Pascal's law for pressure at a point, pressure variation in a fluid at rest, Absolute, gauge, Atmospheric and vacuum pressures, Simple Manometers- Piezometer, U-tube and Differential manometers, Venture meter and Orifice meter. **(13 hrs)**	**CO4**
V	**IMPACT OF JETS:** Impulse momentum equation, Impact of Jet on stationary and moving vanes (flat and curved). **HYDRAULIC TURBINES:** Essential elements of a hydroelectric power plant, head and efficiencies of hydraulic turbines, Classification of turbines, Working principle, Efficiency calculation and Design principles for Pelton Wheel, Francis and for Kaplan turbines. **PUMPS:** Types of pumps, main components and working principle of centrifugal and reciprocating type pumps (theory part only), Submersible pump working. **(13 hrs)**	**CO5**
Advanced topics in this course: Submersible pump working		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Explain** the fundamental concepts of Thermodynamics and also **apply** the laws of thermodynamics to cycles, cyclic devices. **{Apply level, KL3}**
CO2	**Understand** about the working of IC engines and gas turbine plants including its performance **evaluation.** **{Apply level, KL3}**
CO3	**Analyze** the energy transfers and transformations while steam is flowing through the blades of steam turbine. **{Analyze level, KL4}**
CO4	**Understand** about fluid properties and also **apply** the Bernoulli's theorem for flowing fluids. **{Apply level, KL3}**
CO5	**Compute** the performance of hydraulic turbines and also **understand** working of the hydraulic pumps. **{Apply level, KL3}**

Learning Resources
Text books:
1. Thermal Engineering by Mahesh Rathore, McGraw- Hill,2010. 2. Hydraulics and Fluid mechanics including Hydraulic machinery by MODI and SETH, Standard Book House Publications,2019.

Reference books
1. I.C. Engines by V. Ganesan, McGraw- Hill,4th edition. 2. Thermal Engineering by RK Rajput, Lakshmi Publications,2010. 3. Fluid Mechanics and Hydraulic Machines by R.K.Rajput, Lakshmi Publications, Sixth Edition 4. "Fluid Mechanics" by Victor. L. Streeter &E.Benjamin Wylie, McGraw- Hill, Indian edition.
e- Resources & other digital material
1. https://nptel.ac.in/courses/112/105/112105171/
2. https://nptel.ac.in/courses/112/105/112105183/
3. https://nptel.ac.in/courses/105/101/105101082/
4. https://nptel.ac.in/courses/105/103/105103095/
5. http://nptel.ac.in/courses/112105123/
6. http://nptel.ac.in/courses/112108148/

Micro-Syllabus

Unit-1:

BASIC CONCEPTS OF THERMODYNAMICS: Thermodynamic System, Surrounding, Boundary, Universe, Control Volume, Control Surface, Classes of Systems, State, Thermodynamic Properties, Process and Cycles, Thermodynamic Equilibrium, Reversibility, Quasi static Process.

ZEROTH LAW OF THERMODYNAMICS: Equality of temperature.

FIRST LAW OF THERMODYNAMICS: Statement, Internal energy, Flow work, The Steady Flow Process-Steady Flow Energy Equation, simple Problems.

SECOND LAW OF THERMODYNAMICS: Kelvin-Planck & Clausius Statements of Second law of Thermodynamics, Differences between reversible and Irreversible Process, Carnot Cycle and its specialties.

Unit	Module	Micro content
1a.or 2a. Basic Concepts of Thermodynamics & Zeroth Law of Thermodynamics	Basic Concepts of Thermodynamics	Thermodynamic System, Surrounding, Boundary, Universe, Control Volume, Control Surface, Classes of Systems.
		State, Thermodynamic Properties, Process and Cycles.
		Thermodynamic Equilibrium,Reversibility, Quasi static Process.
	Zeroth Law of Thermodynamics	Zeroth Law of Thermodynamics-Statement with Examples.
1b.or 2b. First Law of Thermodynamics & Second Law of Thermodynamics	First Law of Thermodynamics	Statement, Internal energy, Simple Problems on Internal energy.
		Flow work,The Steady Flow Process-Steady Flow Energy Equation.
		Simple Problems on Steady Flow Energy Equation
	Second Law of	Kelvin-Planck & Clausius Statements.

	Thermodynamics	Differences between reversible and Irreversible Process.
		Carnot Cycle and its specialties.

Unit-2:

AIR STANDARD CYCLES: Otto, Diesel and Dual cycles, its comparisons, Brayton Cycle.

I. C. ENGINES: Classification, Working principles, Valve and Port Timing Diagrams, Engine systems- fuel injection, carburetion, ignition, cooling and lubrication – Parameters of performance, Determination of Frictional Power & Indicated Power, Engine performance evaluation.

GAS TURBINES: Simple gas turbine plant, Classification, Analysis of closed and open cycle plants, Applications, Performance parameters, Basic Problems.

Unit	Module	Micro content
3a.or 4a. Air Standard Cycles & I. C. Engines	Air Standard Cycles	Otto, Diesel and Dual cycles.
		Comparisons of Otto, Diesel and Dual cycles
		Brayton Cycle
	I. C. Engines	Classification, Working principles
		Valve and Port Timing Diagrams
		Engine systems- carburetion, fuel injection, ignition, cooling and lubrication.
3b. or 4b. I. C. Engines & Gas Turbines	I. C. Engines	Parameters of performance, Determination of Frictional Power & Indicated Power.
		Engine performance evaluation.
		Simple problems on performance of IC Engines.
	Gas Turbines	Simple gas turbine plant, Classification.
		Analysis of closed and open cycle plants, Applications
		Performance parameters, Simple Problems on open cycle.

Unit-3:

STEAM TURBINES: Working Principle, Classification, Simple Impulse Turbine, Vector diagrams of velocities, Combined Velocity diagram, Work done on the blade, Axial Thrust, Blade efficiency, stage efficiency, overall efficiency, Effect of blade friction on velocity diagram, simple problems on Impulse turbine, Compounding of Impulse Turbine, Reaction Turbine, Velocity Diagram for Reaction Turbine, Degree of Reaction (only theory Part on reaction Turbines).

Unit	Module	Micro content
5a. or 6a.	Steam Turbines	Working Principle, Classification, Simple

Steam Turbines		Impulse Turbine.
		Vector diagrams of velocities, Combined Velocity diagram.
		Work done on the blade, Axial Thrust.
		Blade efficiency, stage efficiency, overall efficiency.
5b. or 6b. Steam Turbines	Steam Turbines	Effect of blade friction on velocity diagram.
		Simple problems on Impulse turbine.
		Compounding of Impulse Turbine.
		Reaction Turbine, Velocity Diagram for Reaction Turbine.
		Degree of Reaction. (Only theory on Reaction Turbines)
Unit-4: **FUNDAMENTALS OF FLUID MECHANICS:** Definition of fluid, differences between a solid and fluid, physical properties of fluids- Density, Specific Weight, Specific gravity, viscosity, Types of Fluids and Fluid flows, Continuity and Bernoulli's equations. **MEASUREMENT OF PRESSURE AND FLOW:** Pascal's law for pressure at a point, pressure variation in a fluid at rest, Absolute, gauge, Atmospheric and vacuum pressures, Simple Manometers- Piezometer, U-tube and Differential manometers, Venture meter and Orifice meter.		
Unit	**Module**	**Micro content**
7a. or 8a. Fundamentals of Fluid Mechanics	Fundamentals of Fluid Mechanics	Definition of fluid, Differences between a solid and fluid.
		Physical properties of fluids- Density, Specific Weight, Specific gravity, viscosity, Simple Problems.
		Types of Fluids and Fluid flows.
		Continuity and Bernoulli's equations,Simple Problems
7b. or 8b. Measurement of Pressure and Flow	Measurement of Pressure and Flow	Pascal's law for pressure at a point, Pressure variation in a fluid at rest, Simple problems
		Absolute, gauge, Atmospheric and vacuum pressures, Simple Problems.
		Simple Manometers- Piezometer, U-tube and Differential manometers, Simple Problems .
		Venture meter and Orifice meter, Simple Problems.
Unit-5: **IMPACT OF JETS:** Impulse momentum equation, Impact of Jet on stationary and moving vanes (flat and curved).		

HYDRAULIC TURBINES: Essential elements of a hydroelectric power plant, head and efficiencies of hydraulic turbines, Classification of turbines, Working principle, Efficiency calculation and Design principles for Pelton Wheel, Francis and for Kaplan turbines.		
Unit	**Module**	**Micro content**
9a.or 10a. Impact of Jets	Impact of Jets	Impulse momentum equation.
		Impact of Jet on stationary and moving vanes (flat and curved), Simple problems.
9b.or 10b. Hydraulic Turbines	Hydraulic Turbines	Essential elements of a hydroelectric power plant
		Head and efficiencies of hydraulic turbines
		Classification of turbines, Working principles.
		Efficiency calculation and Design principles for Pelton Wheel, Francis and for Kaplan turbines.

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Explain** the fundamental concepts of Thermodynamics and also **apply** the laws of thermodynamics to cycles, cyclic devices. **{Apply level, KL3}**
CO2	**Understand** about the working of IC engines and gas turbine plants including its performance **evaluation.** **{Apply level, KL3}**
CO3	**Analyze** the energy transfers and transformations while steam is flowing through the blades of steam turbine. **{Analyze level, KL4}**
CO4	**Understand** about fluid properties and also **apply** the Bernoulli's theorem for flowing fluids. **{Apply level, KL3}**
CO5	**Compute** the performance of hydraulic turbines and also **understand** working of the hydraulic pumps. **{Apply level, KL3}**

Learning Resources
Text books:
1. Thermal Engineering by Mahesh Rathore, McGraw- Hill,2010. 2. Hydraulics and Fluid mechanics including Hydraulic machinery by MODI and SETH, Standard Book House Publications,2019.
Reference books
1. I.C. Engines by V. Ganesan, McGraw- Hill,4th edition. 2. Thermal Engineering by RK Rajput, Lakshmi Publications,2010. 3. Fluid Mechanics and Hydraulic Machines by R.K.Rajput, Lakshmi Publications, Sixth Edition 4. "Fluid Mechanics" by Victor. L. Streeter &E.Benjamin Wylie, McGraw- Hill, Indian edition.
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7. https://nptel.ac.in/courses/105/101/105101082/
8. https://nptel.ac.in/courses/105/103/105103095/
5. http://nptel.ac.in/courses/112105123/
6. http://nptel.ac.in/courses/112108148/

CO-PO Mapping:

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

II-Year-II Semester PC2201	POWER SYSTEMS-1	L	T	P	C
		3	0	0	3

PRE-REQUISITES: 1) Basic Circuit Analysis

Course objectives: The student should be able to

1. study the principle of operation of hydro and thermal power stations.
2. study the principle of operation of nuclear, gas, diesel power stations and non-conventional energy sources.
3. compute transmission line parameters and understand the concepts of GMD/GMR.
4. know the working of substation equipment and to calculate voltage and power loss in distribution systems.
5. study different types of load curves and tariffs applicable to consumers.

Syllabus

Unit No	Contents	Mapped CO
I	**Hydel and Thermal Power Plants** **Hydro Electric Power Station:** Principle of operation, Schematic arrangement & its components, Selection of site, Advantages and Disadvantages. **(05 hrs)** **Thermal Power Station (Steam):** Principle of operation, Schematic arrangement & its components, Selection of site, Efficiency, Advantages and Disadvantages. **(06 hrs)**	CO1
II	**Nuclear, Gas, Diesel Power Plants and Non-conventional Energy Sources** **Nuclear Power Station:** Principle of operation, Schematic arrangement & its components, Selection of site, working of BWR, PWR, FBR. **(07 hrs)** **Gas and Diesel Power Stations:** Principle of operation and Equipment (Block diagram approach only). **(02 hrs)** **Non-conventional Energy Sources:** Working principle of solar, wind, geo thermal and tidal power stations (Elementary treatment only). **(04 hrs)**	CO2
III	**Transmission Line Parameters** Types of conductors, calculation of resistance, inductance and capacitance of single phase and three phase lines with symmetrical and unsymmetrical spacing, transposition, bundled conductors, concept of GMD and GMR, effect of earth on capacitance, skin and proximity effects, Numerical Problems. **(12 hrs)**	CO3
IV	**Substations and Distribution Systems** **Substations:** Classification, Equipment and its location, Layout of 33/11 kV substation. **(06 hrs)** **Distribution Systems:** Classification, Design features, Voltage drop and power loss calculations, Comparison between DC and AC distribution systems, Numerical Problems. **(06 hrs)**	CO4
V	**Economics aspects of Power Generation and Tariff** **Economic aspects of Power Generation:** Loadcurve, load duration, integrated	CO5

	load duration curves and mass curve, connected load, maximum demand, demand factor, load factor, diversity factor, plant capacity factor, plant use factor, utilization factor, base and peak load plants, Numerical problems. **(06 hrs)** **Tariff:** Costs of generation and its division, objectives, characteristics, classification, Numerical problems. **(06 hrs)**	

Advanced topics in this course:

Powering A Generation: Generating Electricity using Fossil-fuelled plants, Cogeneration, Combined-cycle and Biomass plants, Geothermal plants, and Decentralized generation. (Elementary treatment only)

Advanced Transmission Technologies: High-temperature super conducting technology, Advanced composite conductors. (Elementary treatment only)

New Technologies for Electric power Distribution Systems: Concept of Intelligent Substations (Elementary treatment only).

Tariff structure design process: Identification of tariff structures, tariff constraints (Elementary treatment only)

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the working of hydro and thermal power plants**{Understand level, KL2}**
CO2	**Explain** the working of nuclear, gas, diesel power plants and non-conventional energy sources.**{Apply level, KL3}**
CO3	**Analyze** transmission lines parameters **{Analyze level, KL4}**
CO4	**Evaluate** the performance of AC and DC distribution systems. **{Evaluate level, KL5}**
CO5	**Analyze** the different load curves and tariff methods. **{Apply level, KL4}**

Learning Resources

Text books:

1. A text book on Power System Engineering by M.L. Soni, P.V.Gupta, U.S. Bhatnagar and A. Chakrabarti, Dhanpat Rai & Co Pvt. Ltd.
2. Generation, Distribution and Utilization of Electric Energy by C.L.Wadhawa, New Age International Private Limited.

Reference books

1. Electrical power systems by C.L.Wadhwa, New Age International (P) Ltd, Publishers, 1998.
2. Electrical Power Distribution Systems by V. Kamaraju, TMH.
3. Elements of Electrical Power Station Design by M.V. Deshpande, PHI.
4. Modern Power System Analysis by I.J.Nagarath and D.P.Kothari, Tata McGraw Hill, 2ndEdition

e- Resources & other digital material

1. https://nptel.ac.in/courses/108/102/108102047/
2. https://www.coursera.org/learn/electric-power-systems

3.	https://www.classcentral.com/course/electric-power-systems-12053#
4.	https://pdhonline.com/courses/e104a/e104a_new.htm
5.	https://emp.lbl.gov/sites/all/files/advanced-transmission-technologies.pdf
6.	https://www.hitachi.com/rev/pdf/2002/r2002_04_106.pdf
7.	http://regulationbodyofknowledge.org/wp-content/uploads/2013/03/NERA_Electricity_Tariff_Structure.pdf

Micro Syllabus

Unit – 1: Hydel and Thermal Power Plants

Hydro Electric Power Station: Principle of operation, Schematic arrangement & its components, Selection of site, Advantages and Disadvantages. **(05 hrs)**

Thermal Power Station (Steam): Principle of operation, Schematic arrangement & its components, Selection of site, Efficiency, Advantages and Disadvantages. **(06 hrs)**

Unit No	Module	Micro content
1a.. Hydro Electric Power Station	**Hydro Electric Power Station**	Principle of operation (Working),
		Schematic arrangement (Diagram),
		Factors to be considered for selection of site,
		Equipment used and its operation,
		Advantages and Disadvantages.
1b..Thermal Power Station (Steam)	**Thermal Power Station (Steam)**	Principle of operation (Working),
		Schematic arrangement (Diagram),
		Factors to be considered for selection of site,
		Efficiency (Formula orientation),
		Equipment used and its operation,
		Advantages and Disadvantages.

Unit-2:Nuclear, Gas, Diesel Power Plants and Non-conventional Energy Sources

Nuclear Power Station: Principle of operation, Schematic arrangement & its components, Selection of site, working of BWR, PWR, FBR. **(07 hrs)**

Gas and Diesel Power Stations: Principle of operation and Equipment (Block diagram approach only). **(02 hrs)**

Non-conventional Energy Sources: Working principle of solar, wind, geo thermal and tidal power stations (Elementary treatment only). **(04 hrs)**

Unit No	Module	Micro content
2a. Nuclear Power Station	**Nuclear Power Station**	Principle of operation (Working),
		Schematic arrangement (Diagram),
		Factors to be considered for selection of site,
		Equipment used and its operation,
		Working of BWR (Diagram and its operation, Advantages and Disadvantages)

		Working of PWR (Diagram and its operation, Advantages and Disadvantages)
		Working of FBR (Diagram and its operation, Advantages and Disadvantages)
2b. Gas and Diesel Power Stations, Non-conventional Energy Sources	**Gas and Diesel Power Stations**	Principle of operation (Working),
		Equipment used and its operation (Block diagram approach only).
	Non-conventional Energy Sources	Working principle of solar, wind, geo thermal and tidal power stations (Elementary treatment only).

Unit-3:**Transmission Line Parameters**

Types of conductors, calculation of resistance, inductance and capacitance of single phase and three phase lines with symmetrical and unsymmetrical spacing, transposition, bundled conductors, concept of GMD and GMR, effect of earth on capacitance, skin and proximity effects, Numerical Problems. **(12 hrs)**

Unit No	Module	Micro content
3a. Transmission Line Parameters (Theory & Derivation)	**Transmission Line Parameters (Theory & Derivation)**	Types of conductors,
		calculation of resistance,
		Line Inductance& Capacitance
		Magnetic Field Intensity due to a Long Current Carrying Conductor
		Inductance of Two-Wire Transmission Line
		Flux Linkages of One Conductor in a Group of Conductors
		Inductance of 3-Φ Unsymmetrically Spaced Transmission Line
3b. Transmission Line Parameters (Calculations & Problems)	**Transmission Line Parameters (Calculations & Problems)**	Composite Conductors
		Inductance of Composite Conductors
		Inductance of Double Circuit 3-Φ Line
		Concept of GMD & GMR
		Bundled Conductors
		Skin and Proximity Effect
		Two Infinite Lines of Charge
		Capacitance of a 1-Φ Transmission Line
		Capacitance of a 3-phase, unsymmetrical spaced transmission line
		Capacitance of a Double Circuit Line
		Effect of Earth on the Capacitance of Conductors

Unit-4:Substations and Distribution Systems
Substations: Classification, Equipment and its location, Layout of 33/11 kV substation. **(06 hrs)**
Distribution Systems: Classification, Design features, Voltage drop and power loss calculations, Comparison between DC and AC distribution systems, Numerical Problems. **(06 hrs)**

<table>
<tr><th>Unit No</th><th>Module</th><th>Micro content</th></tr>
<tr><td rowspan="7">4a.
Substations</td><td rowspan="3">Factors & Classification</td><td>Factors to be considered for selection of site,</td></tr>
<tr><td>Classification based on service requirement
➢ Transformer substations
➢ Switching substations
➢ Synchronous substations
➢ Frequency change substations
➢ Converting substations
➢ Industrial substations</td></tr>
<tr><td>Classification based on design
➢ Indoor substations
➢ Outdoor substations
➢ Underground substations
➢ Pole mounted and plinth mounted substations</td></tr>
<tr><td rowspan="4">Equipment and Layout</td><td>Equipment used and its operation only
➢ Bus-bars
➢ Insulators
➢ Isolating switches
➢ Circuit breakers
➢ Power transformers
➢ Instrument transformers
➢ Protective relays
➢ Metering and indicating instruments
➢ Other auxiliary equipment</td></tr>
<tr><td>Layout of 33/11 kV substation (Diagram and arrangement of equipment)</td></tr>
<tr style="display:none"><td></td></tr>
<tr style="display:none"><td></td></tr>
<tr><td rowspan="4">4b.
Distribution Systems</td><td rowspan="4">Distribution Systems</td><td>Classification based on type of current, type of construction, type of service, number of wires, scheme of connection.</td></tr>
<tr><td>Design features,</td></tr>
<tr><td>AC distribution (i.e.primary and secondary distribution systems)</td></tr>
<tr><td>DC distribution (Elementary treatment only)</td></tr>
</table>

		Explanation about Radial, Ring main and Interconnected systems (Layout, Working, Advantages, Disadvantages)
		Voltage drop and power loss calculations in a distributor for the following cases (Derivation and numerical problems for AC and DC systems) ➢ feeding from one end ➢ feeding from both ends (Equal and Unequal voltages) ➢ feeding from center ➢ ring mains
		Comparison between DC and AC distribution systems.
Unit-5:Economics aspects of Power Generation and Tariff **Economic aspects of Power Generation:** Loadcurve, load duration, integrated load duration curves and mass curve, connected load, maximum demand, demand factor, load factor, diversity factor, plant capacity factor, plant use factor, utilization factor, base and peak load plants, Numerical problems. **(06 hrs)** **Tariff:** Costs of generation and its division, objectives, characteristics, classification, Numerical problems. **(06 hrs)**		
Unit No	**Module**	**Micro content**
5a. Economic aspects of Power Generation	**Economic aspects of Power Generation**	Loadcurve,
		Load duration curve,
		Integrated load duration curves
		Mass curve
		Explanation and numerical problems on ➢ connected load, ➢ maximum demand, ➢ demand factor, ➢ load factor, ➢ diversity factor, ➢ plant capacity factor, ➢ plant use factor, ➢ utilization factor, ➢ base and peak load plants
5b. Tariff	**Tariff**	Costs of generation and its division (i.e. Fixed, Semi-fixed and Variable costs)
		Objectives of tariff,
		Characteristics,
		Classification ➢ Simple tariff

		➢ Flat rate tariff ➢ Block rate tariff ➢ Two part tariff ➢ Maximum demand tariff ➢ Power factor tariff • KVA maximum demand tariff • Sliding scale tariff • KW and KVAr tariff ➢ Three part tariff

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

CO1	**Understand** the working of hydro and thermal power plants **{Understand level, KL2}**
CO2	**Explain** the working of nuclear, gas, diesel power plants and non-conventional energy sources.**{Apply level, KL3}**
CO3	**Analyze** transmission lines parameters **{Analyze level, KL4}**
CO4	**Evaluate** the performance of AC and DC distribution systems. **{Evaluate level, KL5}**
CO5	**Analyze** the different load curves and tariff methods. **{Apply level, KL4}**

Text books:

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2. Generation, Distribution and Utilization of Electric Energy by C.L.Wadhawa, New Age International Private Limited.

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3. Elements of Electrical Power Station Design by M.V. Deshpande, PHI.
4. Modern Power System Analysis by I.J.Nagarath and D.P.Kothari, Tata McGraw Hill, 2ndEdition

CO-PO Mapping :

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

****

II-Year-II Semester	ELECTRICAL MACHINES-II	L	T	P	C
PC2202		3	1	0	3

PRE-REQUISITES: 1) Electrical Machines-I

Course objectives: The student should be able to

1. Understand the principle of operation and performance of 3-phase induction motor.
2. Quantify the starting and speed control of induction motor.
3. Study the mechanism of torque producing and starting methods of a single-phase Induction Motor.
4. Understand the Principle, Voltage Regulation and Parallel operation of synchronous generator.
5. Understand the operation, performance and starting methods of synchronous motor.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**3-phase Induction Motors (14 hrs)** Constructional details of cage and wound rotor machines- production of rotating magnetic field - principle of operation -rotor EMF and rotor frequency - rotor current and pf at standstill and during running conditions - rotor power input, rotor copper loss and mechanical power developed and their interrelationship – equivalent circuit – phasor diagram- Numerical Problems.	**CO1**
II	**Characteristics of Induction Motors (06 hrs)** Torque equation -expressions for maximum torque and starting torque - torque slip characteristics - crawling and cogging. **Starting and testing methods of Induction Motors(08 hrs)** No load and blocked rotor tests - circle diagram for predetermination of performance–Numerical Problems-Methods of starting (Auto-Transformer and DOL Starters)-Speed control using V/f method.	**CO2**
III	**Single Phase Motors (08 hrs)** Single phase induction motors– Constructional features-Problem of starting–Double revolving field theory–Equivalent circuit. Starting methods of single phase Induction motor – shaded pole motors-A.C Series Motor.	**CO3**
IV	**Synchronous generator (10 hrs)** Constructional features of non–salient and salient pole type–E.M.F equation—Voltage regulation by synchronous impedance method(EMF)– MMF method and Potier triangle method–phasor diagrams– Two reaction analysis of salient pole machines and phasor diagram. **Parallel operation of synchronous Generators (07 hrs)** Parallel operation with infinite bus and other alternators-Synchronizing power–	**CO4**

	Load sharing-Numerical problems.	
V	**Synchronous motor operation, starting and performance (10 hrs)** Principle operation– Phasor diagram –Variation of current and power factor with excitation –Methods of starting –Hunting and its suppression methods-Synchronous condenser-Applications-Numerical problems.	**CO5**

Content Beyond the Syllabus:

1. Voltage regulation of synchronous generator by A.S.A Method (Modified MMF Method).
2. Brake test on Slip ring induction motor.
3. No load and Blocked rotor test on Single phase Induction Motor (Determination of Equivalent Circuit parameters of Single Phase Induction Motor).

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Explain** the operation and performance of three phase induction motor. **{Knowledge level, KL1}**
CO2	**Analyse**the torque-speed relation, starting and speed control of induction motor. **{ Analyze level, KL4}**
CO3	**Describe** the torque production and starting methods of single-Phase induction motor. **{Knowledge level, KL1}**
CO4	**Empathise**the Principle, Voltage Regulation and Parallel operation of synchronous generator. **{Understand level, KL2}**
CO5	**Realize** the operation, performance and starting methods of synchronous motor. **{ Analyze level, KL4}**

Learning Resources

Text books:

1. Theory & Performance of Electrical Machines by J.B.Guptha. S.K.Kataria& Sons.
2. Electrical Machines – P.S. Bhimbra, Khanna Publishers.

Reference books:

1. Electrical Machines by D. P.Kothari, I .J .Nagarth, Mc Graw Hill Publications, 4th edition.
2. Electrical Machinery by AbijithChakrabarthi and Sudhipta Debnath, Mc Graw Hill education 2015.
3. Electrical Machinery Fundamentals by Stephen J Chapman McGraw Hill education 2010.
4. Electric Machinery by A.E. Fitzgerald, Charles kingsley, Stephen D.Umans, TMH.

e- Resources & other digital material

5. https://nptel.ac.in/courses/108/106/108106072/
6. https://nptel.ac.in/courses/108/105/108105131/
7. www.nptelvideos.in/2012/11/electrical-machines-ii.html
8. https://nptel.ac.in/courses/108/106/108106023/

Micro-Syllabus

Unit-1:3-phase Induction Motors (14 hrs)
Constructional details of cage and wound rotor machines- production of rotating magnetic field - principle of operation -rotor emf and rotor frequency - rotor current and pf at standstill and during running conditions - rotor power input, rotor copper loss and mechanical power developed and their interrelationship – equivalent circuit – phasor diagram- Numerical Problems.

Unit No	Module	Micro content
1.a .3-phase Induction Motors construction and principle operation	Construction of 3-phase induction motor	Constructional details of cage and wound rotor machines.
	Principle operation	Production of rotating magnetic field -principle of operation -rotor emf and rotor frequency- rotor current and pf at standstill and during running conditions.
1.b.Losses and equivalent circuit of 3-phase Induction Motors	Rotor power input and losses	Rotor power input, rotor copper loss and mechanical power developed and their interrelationship.
	Equivalent circuit	Equivalent circuit – phasor diagram- Numerical Problems.

Unit-2: Characteristics of Induction Motors (06 hrs)
Torque equation -expressions for maximum torque and starting torque - torque slip characteristics - crawling and cogging.
Starting and Testing methods of Induction Motors (08 hrs)
No load and blocked rotor tests - circle diagram for predetermination of performance–Numerical Problems-Methods of starting (Auto-Transformer and DOL Starters)-Speed control using V/f method.

Unit No	Module	Micro content
2.a.Characteristics of Induction Motors	Torque equation	Torque equation -expressions for maximum torque and starting torque
	Characteristics	Torque slip characteristics
	Crawling and Cogging	Crawling and Cogging
2.b.Starting and Testing methods of Induction Motors:	Tests	No load and blocked rotor tests
	Predetermination of performance	Circle diagram for predetermination of performance–Numerical Problems
	Methods of starting	Auto-Transformer and DOL Starters- Speed control using V/f method.

Unit-3:**Single Phase Motors (08 hrs)**
Single phase induction motors– Constructional features-Problem of starting–Double revolving field theory–Equivalent circuit.
Starting methods of single phase Induction motor – shaded pole motors-A.C Series Motor.

Unit No	Module	Micro content

3.a.Single phase induction motors	Constructional features & Problem of starting	Constructional features- Problem of starting–Double revolving field theory–Equivalent circuit.
3.b.Starting methods of single phase Induction motor	Starting methods of single phase Induction motor	Starting methods of single phase Induction motor – shaded pole motors-A.C Series Motor.

Unit-4:Synchronous generator (10 hrs)

Constructional features of non–salient and salient pole type–E.M.F equation—Voltage regulation by synchronous impedance method– MMF method and Potier triangle method–phasor diagrams–Two reaction analysis of salient pole machines and phasor diagram.

Parallel operation of synchronous Generators(07 hrs)

Parallel operation with infinite bus and other alternators-Synchronizing power– Load sharing-Numerical problems.

Unit No	Module	Micro content
4.a.Synchronous generator	Constructional features	Constructional features of non–salient and salient pole type– E.M.F equation
	Voltage regulation	Voltage regulation by synchronous impedance method– MMF method and Potier triangle method-phasor diagrams
	Two reaction analysis	Two reaction analysis of salient pole machines and phasor diagram.
4.b.Parallel operation of synchronous Generators:	Parallel operation& Load sharing	Parallel operation with infinite bus and other alternators -Synchronizing power – Load sharing-Numerical problems.

Unit-5:Synchronous motor operation, starting and performance (10 hrs)

Principle operation– Phasor diagram –Variation of current and power factor with excitation –Methods of starting –Hunting and its suppression methods-Synchronous condenser-Applications-Numerical problems.

Unit No	Module	Micro content
5.a.Synchronous motor	Principle of operation	Principle operation– Phasor diagram –Variation of current and power factor with excitation
5.b.Methods of starting Synchronous motor	Methods of starting	Methods of starting –Hunting and its suppression methods - Synchronous condenser-Applications-Numerical problems.

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

Course Outcomes

Upon successful completion of the course, the student will be able to	
CO1	**Explain** the operation and performance of three phase induction motor. **{Knowledge level, KL1}**
CO2	**Analyse**the torque-speed relation, starting and speed control of induction motor. **{ Analyze level, KL4}**
CO3	**Describe** the torque production and starting methods of single-Phase induction motor. **{Knowledge level, KL1}**
CO4	**Empathise**the Principle, Voltage Regulation and Parallel operation of synchronous generator. **{Understand level, KL2}**
CO5	**Realize** the operation, performance and starting methods of synchronous motor. **{ Analyze level, KL4}**

Learning Resources
Text books:
1. Theory & Performance of Electrical Machines by J.B.Guptha. S.K.Kataria& Sons. 2. Electrical Machines – P.S. Bhimbra, Khanna Publishers.
Reference books:
1. Electrical Machines by D. P.Kothari, I .J .Nagarth, Mc Graw Hill Publications, 4th edition. 2. Electrical Machinery by AbijithChakrabarthi and Sudhipta Debnath, Mc Graw Hill education 2015. 3. Electrical Machinery Fundamentals by Stephen J Chapman McGraw Hill education 2010. 4. Electric Machinery by A.E. Fitzgerald, Charles kingsley, Stephen D.Umans, TMH.
e- Resources & other digital material
1. https://nptel.ac.in/courses/108/106/108106072/
2. https://nptel.ac.in/courses/108/105/108105131/
3. www.nptelvideos.in/2012/11/electrical-machines-ii.html
4. https://nptel.ac.in/courses/108/106/108106023/

CO-PO Mapping :

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	2	2	-	-	1	-	-	-	-	-	-	1	2	2
CO2	2	3	-	-	1	-	-	-	-	-	-	-	2	-
CO3	3	1	-	-	1	-	-	-	-	-	-	1	1	2
CO4	2	3	-	-		-	-	-	-	-	-	-	2	1
CO5	2	1	-	-	1	-	-	-	-	-	-	-	1	-

II-Year-II Semester PC2203	CONTROL SYSTEMS	L	T	P	C
		3	1	0	3

PRE-REQUISITES: Laplace Transforms, Differential equations, Matrix Algebra, Basic Circuit Analysis.

Course Objectives: The student should be able to

1. To learn the mathematical modelling of electrical and mechanical systems
2. To analyze the time response of first and second order systems
3. To investigate the stability using Routh's stability criterion and Root locus
4. To investigate the stability using Bode plot and Nyquist plot
5. To formulate the state models and the concepts of Controllability and Observability

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Mathematical Modelling of Control Systems (12 hrs)** Introduction to control systems, Classifications - Open Loop and closed loop, transfer function, Mathematical Modelling ofelectricalnetworks,TranslationalandRotationalsystems,analogoussystems,Transfer Function of DC & AC Servo motor- Synchros, Block diagram algebra–Signal flow graph-Mason's gain formula	**CO1**
II	**Time Response Analysis (12 hrs)** Standardtestsignals-Timeresponseoffirstandsecondordersystems-Timedomainspecifications - Steady state errors and error constants – Effects of Feedback-Dominant Closed loop poles- P-PD-PI-PID controllers.	**CO2**
III	**Stability and Root locus Technique:(13 hrs)** The concept of stability - Routh'sstabilitycriterionProcedureandproblems–limitationsofRouth'sstability–Rootlocusconcept-construction of root loci –Effect of Adding open loop poles and Zeros on Root Loci	**CO3**
IV	**Frequency Response Analysis (16 hrs)** Introduction - Frequency domain specifications- Bode diagrams- transfer function from theBodeDiagram-PolarPlots,NyquistStabilitycriterion-relativestabilityanalysis-PhasemarginandGainmargin-CharacteristicsofLag,LeadandLag-Leadcompensators.	**CO4**
V	**State Space Analysis (12 hrs)** Concepts of state, state variables, state equation and state model, state space modeling of control systems, Solution of the state equation-State Transition Matrix and its Properties-Transfer function from state model.	**CO5**

Content Beyond the syllabus:
• The principle of argument which is useful for applications where we want to know the location of zeros and poles. • Design procedure of Lead and Lag compensator • MATLAB for control systems: Time domain analysis, stability analysis and state space analysis

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Derivethetransferfunctionusingblockdiagramalgebraandsignalflowgraph **(Remember, Understand, and Apply)**
CO2	DeterminetimeresponsespecificationsofsecondordersystemsandErrorconstants **(Understand, Apply and Analyze)**
CO3	AnalyzestabilityusingRouth'sstabilitycriterionandtherootlocusmethod (**Apply, Analyze)**
CO4	Analyze the stability using Bode plot and Nyquist criterion **(Understand, Apply, and Analyze)**
CO5	Obtain the state models and understanding the concepts of controllability and observability **(Understand, Apply)**
Learning Resources	
Text books:	
1. "Control Systems Engineering" by I.J.Nagarath and M.Gopal, 5th Edition , New age International Publications. 2. "Automatic control systems" by Benjamin C.Kuo, 2ndEdition, Prentice Hall of India.	
Reference books:	
1. "Control Systems principles and design" by M.Gopal,4th Edition , Tata McGraw Hill education PvtLtd. 2. "Modern Control Engineering" by Kotsuhiko Ogata, Prentice Hall of India. 3. "Control Systems" by Manik Dhanesh N, Cengage publications. 4. "Control Systems Engineering" by S.Palani, Tata Mc Graw Hill Publications.	
e- Resources & other digital material	
1. https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ee84/	
2. https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ee25/	
3. https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ee45/	

Micro-Syllabus

Unit-1: Mathematical Modelling of Control Systems

Introduction tocontrol systems, Classifications - Open Loop and closed loop,transferfunction,EffectsofFeed-Back, MathematicalModelling ofelectricalnetworks,TranslationalandRotationalsystems,analogoussystems,Transfer Function of DC & AC Servo motor- Synchros, -Blockdiagramalgebra–Signalflowgraph-Mason'sgainformula

Unit No	Module	Micro content
1. Mathematical Modelling of Control Systems	Introduction tocontrol systems, classifications - Open Loop and closed loop	Concept of system, control system
		Classification as Open loop and closed loop
		Different examples of control systems
	EffectsofFeed-Back	Effect of feedback on sensitivity, gain, band width, noise, time constant and speed of response
	MathematicalModelling	Differential equations of simple RLC electrical networks
		Translational and Rotational mechanical systems – analogous systems - problems
	Transfer Function of DC Servo motor - AC Servo motor- Synchro transmitter and Receiver	(armature controlled and field controlled DC Servo motor –AC Servo motor – Synchros- derivations
	Block diagram algebra	Block diagram reduction techniques and problems
	Representation by Signal flow graph - Reduction using Mason's gain formula	Representation by Signal flow graph - Reduction using Mason's gain formula - problems

Unit-2: TimeResponseAnalysis:

Standardtestsignals-Timeresponseoffirstandsecondordersystems-Timedomainspecifications - Steady state errors and error constants – DominantClosedlooppoles- P-PD-PI-PID controllers.

Unit No	Module	Micro content
2. TimeResponseAnalysis	Standardtestsignals	Impulse, step, ramp and parabolic signals
	Timeresponseoffirstandseco	derivations

	ndordersystems	
	Timedomainspecifications	Rise time, peak time, maximum over shoot, settling time -definitions and derivations - problems
	Steady state errors and error constants	Definitions – derivations and problems
	DominantClosedlooppoles-	Explanation on location of closed loop poles
	P- PD -PI-PID controllers	Effects of controllers on time response

Unit-3: StabilityandRootlocusTechnique:
Theconceptofstability -Routh'sstabilitycriterionProcedureandproblems–limitationsofRouth'sstability–Rootlocusconcept-construction of root loci –Effect of Adding open loop poles andZerosonRootLoci.

Unit No	Module	Micro content
3. StabilityandRootlocus Technique	Theconceptofstability	Explanation of BIBO stability
	Routh'sstabilitycriterion	Procedureandproblems
		limitationsofRouth'sstability
	Rootlocus	concept-construction of root loci – problems- Effect of Adding open loop poles andZerosonRootLoci

Unit-4: Frequency Response Analysis:
Introduction - Frequency domain specifications- Bode diagrams- transfer function from theBodeDiagram-PolarPlots,NyquistStabilitycriterion-relativestabilityanalysis-PhasemarginandGainmargin-CharacteristicsofLag,LeadandLag-Leadcompensators.

Unit No	Module	Micro content
4. Frequency Response Analysis	Introduction	Introduction to frequency varying signals
	Frequency domain specifications	Definitions and derivations - problems
	Bode diagrams	Procedure - problems
		transfer functionfrom theBodeDiagram

	PolarPlots	Procedure - problems
	NyquistStabilitycriterion	Procedure – problems – PhasemarginandGain margin
		Relativestabilityanalysis
	Lag,LeadandLag-Leadcompensators.	Characteristics with derivations of transfer functions only

Unit-5: State Space Analysis:
Concepts of state, state variables, stateequationandstatemodel,statespacemodelingofcontrolsystems,Solutionofthestateequation-StateTransitionMatrixandit'sProperties-Transferfunctionfromstatemodel

Unit No	Module	Micro content
5. State Space Analysis	state, state variables, stateequationandstatemodel	Concepts, definitions
	statespacemodelingofcontrolsystems	Problems on finding state model from the given transfer function and electrical circuits
	Solutionofthestateequation	Derivation - problems
	StateTransitionMatrix	Derivation – problems -properties
	Transferfunctionfromstatemodel	Derivation - problems
	ConceptsofControllabilityandObservability	Problems only

Course Outcomes: Upon successful completion of the course		**POs, PSOs**	**KL**
CO1	Derivethetransferfunctionusingblockdiagramalgebraandsignalflowgraph **(Remember, Understand, and Apply)**	PO3, PSO2	1,3
CO2	DeterminetimeresponsespecificationsofsecondordersystemsandErrorconstants **(Understand, Apply and Analyze)**	PO1, PSO2	2,3
CO3	AnalyzestabilityusingRouth'sstabilitycriterionandtherootlocusmethod (**Apply, Analyze)**	PO1, PSO2	1,2
CO4	AnalyzethestabilityusingBodeplotandNyquistcriterion **(Understand,**	PO2,	2,3

	Apply, and Analyze)	PSO2	
CO5	Obtain the state models and understanding the concepts of controllability and observability **(Understand, Apply)**	PO2, PSO2	1,2

Learning Resources
Text books:
1. "Control Systems Engineering" by I.J.Nagarath and M.Gopal, 5thEdition , New ageInternationalPublications. 2. "Automatic control systems" by Benjamin C.Kuo, 2ndEdition , Prentice Hall ofIndia.
Reference books:
1. "ControlSystemsprinciplesanddesign" by M.Gopal,4thEdition , TataMcGrawHilleducationPvtLtd. 2. "ModernControlEngineering" byKotsuhikoOgata,PrenticeHallofIndia. 3. "ControlSystems" byManikDhaneshN,Cengage publications. 4. "ControlSystemsEngineering" byS.Palani,TataMcGrawHillPublications.
e- Resources & other digital material
1. https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ee84/
2. https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ee25/
3. https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ee45/

CO-PO Mapping :

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

II-Year-II Semester	THERMAL AND HYDRO PRIME MOVERS LAB	L	T	P	C
ES2201L		0	0	3	1.5

Prerequisite: -Nil-

COURSE OBJECTIVE: To impart practical knowledge on the performance evaluation methods of various internal combustion engines, flow measuring equipment and hydraulic turbines and pumps.

Note: To Conduct A Minimum Of 10 Experiments By Conducting A Minimum Of Five From Each Section.

LIST OF EXPERIMENTS:

SECTION A - THERMAL ENGINEERING LAB

1. I.C. Engines valve / port timing diagrams.
2. I.C. Engines performance test on 4 -stroke Diesel engine.
3. I.C. Engines performance test on 2-stroke petrol engine.
4. Evaluation of engine friction by conducting Morse test on 4-stroke multi cylinder petrol engine
5. Determination of FHP by retardation and motoring test on IC engine.
6. I.C. Engines heat balance on petrol / Diesel engines.
7. Study of boilers.

SECTION B – HYDRAULIC MACHINES LAB

1. Calibration of Venturimeter.
2. Calibration of Orifice meter.
3. Impact of jets on Vanes.
4. Performance Test on Pelton Wheel.
5. Performance Test on Francis Turbine.
6. Performance Test on Centrifugal Pump.
7. Performance Test on Reciprocating Pump.

COURSE OUTCOMES: After completion of the course , students are able to:

CO1:Compute the performance of the IC Engines for a given conditions and also draw the valve and port timing diagrams. **(Apply Level)**

CO2:Determine the frictional power by using the Morse test, retardation test and motoring test. **(Apply Level)**

CO3: Calibrate discharge measuring devices and **finding** discharge through the venture meter and the orifice meter. **(Apply Level)**

CO4:Analyze the performance of hydraulic machines. **(Analyze Level)**

CO-PO Mapping :

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

II-Year-II Semester PC2202L	ELECTRICAL MACHINES-II LAB	L	T	P	C
		0	0	3	1.5

PRE-REQUISITES: 1) Electrical Machines-1 Theory

Preamble: Electrical Machines-II Lab provides the essential facilities to the students to augment their concepts about the fundamentals of rotating Asynchronous and Synchronous machines. The lab is equipped with three phase induction motors, synchronous generators, synchronous motorandSingle phase induction motor. The lab covers the determination of performance characteristics, speed control method of induction motor, voltage regulation of synchronous generator and v and inverted v curves of synchronous motor.

Course Objectives: The student should be able to

1. To control the speed of three phase induction motors.
2. To determine /predetermine the performance of three phase induction.
3. To determine /predetermine the performance of single phase induction.
4. To improve the power factor of single phase induction motor.
5. To predetermine the regulation of three–phase alternator by various methods, find Xd/ Xq ratio of alternator and asses the performance of three–phase synchronous motor.

LIST OF EXPERIMENTS: Any Ten of the following experiments are to be conducted:

1. Brake test on three phase Slip ring Induction Motor
2. No–load & Blocked rotor tests on three phase Slip ring Induction motor
3. Load test on single phase induction motor.
4. Equivalent circuit of single phase induction motor
5. Regulation of a three –phase alternator by synchronous impedance method
6. Regulation of a three –phase alternator by M.M.F method
7. Regulation of three–phase alternator by Potier triangle method
8. Determination of Xd and Xq of a salient pole synchronous machine
9. V and Inverted V curves of a three—phase synchronous motor.
10. Determination of efficiency of three phase alternator by loading with three phase induction motor.
11. Determination of sub transient direct axis (Xd’’) and quadrature axis (Xq”) synchronous reactance of an alternator.
12. To perform parallel operation of two alternators.

List of Additional Experiments: Any of the two experiments are to be conducted

16. Brake test on three phase Squirrel cage Induction Motor.
17. Determination of the symmetrical impedances of a synchronous machine.
18. Speed control of induction motor by V/f method.

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

Course Outcomes	
CO1	Able to assess the performance of three phase induction motor. (**Analyze**)
CO2	Able to control the speed of three phase induction motor. (**Remember and Understand**)
CO3	Able to assess the performance of single phase induction motor. (**Analyze**)
CO4	Able to predetermine the regulation of three–phase alternator by various methods. (**Evaluate**)
CO5	Able to find the Xd / Xq ratio of alternator and asses the performance of three–phase synchronous motor. (**Understand, Apply and Analyze**).

Learning Resources
Text books:
1. Theory & Performance of Electrical Machines by J.B.Guptha. S.K.Kataria& Sons. 2. Electrical Machines – P.S. Bhimbra, Khanna Publishers.
Reference books:
1. Electrical Machines by D. P.Kothari, I .J .Nagarth, Mc Graw Hill Publications, 4th edition. 2. Electrical Machinery by AbijithChakrabarthi and Sudhipta Debnath, Mc Graw Hill education 2015. 3. Electrical Machinery Fundamentals by Stephen J Chapman McGraw Hill education 2010. 4. Electric Machinery by A.E. Fitzgerald, Charles kingsley, Stephen D.Umans, TMH.
e- Resources & other digital material
1.https://nptel.ac.in/courses/108/105/108105017
2.https://nptel.ac.in/courses/103/102/108102146
3.www.nptelvideos.in/2012/11/electrical-machines-i.html
*4.*https://www.electrical4u.com/losses-in-dc-machine

CO-PO Mapping::

Mapping	P01	P02	P03	P04	P05	P06	P07	P08	P09	P010	P01 1	P012	PS01	PSO2
C01	2	2	1	1	-	-	-	-	-	-	-	1	2	2
C02	2	2	1	1	-	-	-	-	-	-	-	-	-	-
C03	3	1	-	1	-	-	-	-	-	-	-	1	1	2
C04	2	3	-	1	-	-	-	-	-	-	-	1	2	2
C05	2	2	-	-	-	-	-	-	-	-	-	-	1	-

II-Year-II Semester PC2204L	CONTROL SYSTEMS LAB	L	T	P	C
		0	0	3	1.5

Pre-Requisites: Control Systems, Electrical Machines

Preamble: Control Systems Lab consists of workstations equipped with an oscilloscope, digital multi-meter, DC,AC servomotor, synchros, DC position control and PID trainers. This lab also covers the computer tools such as MATLAB. The aim of this Control system laboratory is to provide sound knowledge in the basic concepts of design of control system, adequate knowledge in the time response and frequency responses of systems.

Course Objectives:

The main objectives are

1. Toimparthandsonexperiencetounderstandtheperformanceofbasiccontrolsystem componentssuchasmagneticamplifiers,D.Cservo motors and Synchros.
2. To understandtime responses of control system with and without controllers
3. Tounderstandfrequencyresponses ofcontrolsystemwithandwithout compensators.

List of Experiments: Any 10 of the following experiments are to be conducted

1. Time responseofSecondordersystem
2. Characteristics ofSynchros
3. EffectofP, PD,PI,PIDControlleronasecondordersystems
4. StudyofLagandleadcompensation–Magnitudeandphaseplot
5. Effect of feedback on DC servomotor
6. BodePlot, Root locus,Nyquist Plotsforthetransfer functions of systemsupto 5thorder using MATLAB
7. Potentiometer as error detector
8. TemperaturecontrollerusingPID
9. Characteristics ofmagneticamplifiers
10. Characteristics ofDC servomotor
11. State model using MATLAB
12. Transfer function of DC Motor

List of Additional Experiments: Any 2 of the following experiments are to be conducted

13. Programmable logic controller – verification of truth tables of logic gates
14. Characteristics of AC servomotor
15. Determination of steady state error
16. Test for controllability and Observability using MATLAB

CourseOutcomes:

After the completion of the course the student should be:

No	Description	POs, PSOs	KL
CO1	Able to analyze the time response of a second order system	PO1, PSO2	1,3
CO2	Able to analyze the effect of P, PI,PD, PID controllers and Lag, Lead compensators	PO1, PSO2	2,3
CO3	Able to judge the stability in time and frequency domain	PO1, PSO2	1,2

Text books:
1. “Control Systems Engineering” by I.J.Nagarath and M.Gopal, 5th Edition, New ageInternationalPublications. 2. “Automatic control systems” by Benjamin C.Kuo, 2nd Edition, Prentice Hall ofIndia.
Reference books:
1. “ControlSystemsprinciplesanddesign” by M.Gopal,4th Edition , TataMcGrawHilleducationPvtLtd. 2. “ModernControlEngineering” byKotsuhikoOgata,PrenticeHallofIndia.
e- Resources & other digital material
1. https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ee84/
2. https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ee25/
3. https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ee45/

CO-PO Mapping:

Mapping	P01	P02	P03	P04	P05	P06	P07	P08	P09	P010	P011	P012	PS01	PSO2
C01	2	1	-	1	1	-	-	-	-	-	-	1	2	1
C02	2	1	1	1	1	-	-	-	-	-	1	1	1	1
C03	1	-	-	-	1	-	-	-	-	-	-	1	2	1

II-Year-II Semester	FUNDAMENTS OF MATLAB AND PSPICE	L	T	P	C
SOC2201		1	0	2	2

PRE-REQUISITES: Any computer programming (like C, C++ or Java)

Course Objectives: The objective of the course is to

1. Create an environment to work with different software technologies.
2. Build confidence in writing programmes.
3. Make familiar about logical operations.
4. Provide a platform to know about modeling of components.
5. Become aware about the analysis of DC & AC circuits.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Basics:** **(8 hrs)** Overview, Environment, Basic Syntax, variable, Input and Output commands, Basic Data Types, Relational and Logical operators, conditional statements, Loop Types..	**CO1**
II	**Matrices**: **(8 hrs)** Vectors operations, Matrix operations, Multi dimensional and Cell arrays, Colon Notation, Conversion of Numbers, combining Strings into a cell array.	**CO2**
III	**M–file Scripts:(8 hrs)** Creating saving and running an M–file, creating and running of a function, Data import, Data Output, Basic plots , subplots, Bar charts and 3D plots, Algebra:- Solving basic Equation-Expanding, factorization and simplification of algebraic Equations.	**CO3**
IV	**PSpice for Circuit Analysis:** **(8 hrs)** Introduction to PSpice, Description of circuit elements, nodes and sources, input and output variables, modeling of the above elements, DC analysis, AC analysis and Transient Analysis.	**CO4**
V	**PSpice for Electronic Devices and Circuits**: **(8 hrs)** Diode model, BJT model, MOSFET model, IGBT model, SCR model, Subroutines, diode rectifiers.	**CO5**

List of Experiments: practice any 5 programs **(10 hrs)**

1. Write a script for adding two matrixes.
2. Plot the following cosine function, $y = 2 \cos(x)$ in the interval $0 \le x \le 2\pi$.
3. Write a function file that converts temperature in degrees Fahrenheit (◦F) to degrees Centigrade (◦C).
4. **Write a Program on ‘for’ loop with simple example.**
5. **Write a Program on ‘While’ condition with simple example.**
6. **Write a Program on ‘If-else’ with simple example.**
7. Single phase half wave Rectifier with R load

8. Single phase half wave Rectifier with RL load 9. Single phase Full wave Rectifier with R load 10. Single phase Full wave Rectifier with RL load

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Infer various logical operations.**{Apply level, KL3}**
CO2	Recite different matrix and vector operations.**{Understand level, KL5}**
CO3	Draw the graphs for analysis of data.**{Analyze level, KL4}**
CO4	Model circuit elements by distinguishing them AC and DC. **{Understand level, KL3}**
CO5	Simulate the given circuit and validate by conventional means. **{Apply level, KL4}**

Learning Resources
Text books:
1. D Hanselmanand B little field, "Mastering MATLAB 7", Pearson Education, 2005. 2. Y Kirani Singh and B BChaudhari,"MATLABProgramming", Prentice Hall of India,2007.
Reference books:
1. Muhammad H.Rashid,"Spice for Power Electronics and Electric Power", CRC Press 3rdEdition,2012. 2. AGilat,"MATLAB: An Introduction with Applications ",John Wiley and Sons,2004. 3. StevenTKarris,"Introduction to Simulink with Engineering Applications", Orchard Publication, 2ndEdition,2008.
e- Resources & other digital material
5. https://www.mathworks.com/matlabcentral/answers/index
6. www.tutorialspoint.com

Micro-Syllabus

Unit–1: Basics: **(8 hrs)**

Overview, Environment, Basic Syntax, variable, Input and Output commands, Basic Data Types, Relational and Logical operators, conditional statements, Loop Types.

Unit No	Module Name	Micro content
1a.Basics	Overview	Introduction
		Environment
	Basic Syntax	Basic Syntax
		variable
		Input and Output commands
1.b. Operators	Arithmetic operators	Basic Data Types
		Relational and Logical operators
	Decision Making	conditional statements

	statements	Loop Types

Unit–2: Matrices: **(8 hrs)**
Vectors operations, Matrix operations, Multi dimensional and Cell arrays, Colon Notation, Conversion of Numbers, combining Strings into a cell array.

Unit No	Module Name	Micro content
2a. Vector & Matrix operations	Vector operations	Row and column vectors
		Addition and subtraction of vectors
		Dot product
	Matrix operations	Deleting and adding Rows
		Addition and subtraction of matrix
		Matrix multiplication
2b. Arry& String	Array Colon Notation String	Array function
		Multi dimensional and Cell arrays
		Colon Notation
		Conversion of Numbers
		combining Strings into a cell array

Unit–3: M–file Scripts:(8 hrs)
Creating saving and running an M–file, creating and running of a function, Data import, Data Output, Basic plots , subplots, Bar charts and 3D plots, Algebra:-Solving basic Equation-Expanding, factorization and simplification of algebraic Equations.

Unit No	Module Name	Micro content
3a.Functions	Functions	Creating saving and running an M–file
		creating and running of a function
		creating of a Sub-function
	Data import and output	Data import
		Data Output
3b.Algebra	Plotting	Basic plots- subplots
		Bar charts
		3D plots
	algebra	Solving basic algebraic Equations
		Expanding algebraic Equations
		simplification of algebraic Equations

Unit–4: PSpice for Circuit Analysis: (8 hrs)
Introduction to PSpice, Description of circuit elements, nodes and sources, input and output variables, modeling of the above elements, DC analysis, AC analysis and Transient Analysis.

Unit No	Module Name	Micro content
4a. Description of	Description of circuit	Introduction to PSpice

circuit elements	elements	Description of circuit elements
		nodes and sources
		input and output variables
4b. Analysis	Analysis	DC analysis
		AC analysis
		Transient Analysis

Unit–5: PSpice for Electronic Devices and Circuits: **(8 hrs)**

Diode model, BJT model, MOSFET model, IGBT model, SCR model, Subroutines, diode rectifiers.

Unit No	Module Name	Micro content
5a. Electronic Devices	Electronic Devices Models	Diode model
		BJT model
		MOSFET model
		IGBT model
		SCR model
5b. Electronic Circuits	Electronic Circuits Simulation	Subroutines
		Half wave diode rectifiers with R and RL Loads
		Full wave diode rectifiers with R and RL Loads

Course Outcomes

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

CO1	Infer various logical operations.**{Apply level, KL3}**
CO2	Recite different matrix and vector operations.**{Understand level, KL5}**
CO3	Draw the graphs for analysis of data.**{Analyze level, KL4}**
CO4	Model circuit elements by distinguishing them AC and DC. **{Understand level, KL3}**
CO5	Simulate the given circuit and validate by conventional means. **{Apply level, KL4}**

Learning Resources

Text books:

1. D Hanselmanand B little field, “Mastering MATLAB 7”, Pearson Education, 2005.
2. Y Kirani Singh and B BChaudhari,“MATLABProgramming”, Prentice Hall of India,2007.

Reference books:

1.Muhammad H.Rashid,“Spice for Power Electronics and Electric Power”, CRC Press 3rdEdition,2012.

2.AGilat,“MATLAB: An Introduction with Applications ”,John Wiley and Sons,2004.

3.StevenTKarris,“Introduction to Simulink with Engineering Applications”, Orchard Publication, 2ndEdition,2008.

e- Resources & other digital material

1. https://www.mathworks.com/matlabcentral/answers/index
2. www.tutorialspoint.com

CO–PO Mapping:

CO No.	PO Number												PSO Number		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1					1						2				
CO2					3						2			1	
CO3					3						2			1	
CO4				1							2				
CO5				1							2				

II-Year-II Semester SOC2201	SOLAR PANEL INSTALLATION	L	T	P	C
		1	0	2	2

PRE-REQUISITES: 1) Basic Circuit Analysis

Course objectives: The student should be able to

1. Study the Principle of solar energy conversion
2. Study various PV performance measure terminologies,
3. KNOW about manufacturing of PV cells & sizing aspects of PV systems.
4. Know about PV system components and apply them in installation practices,& associated trouble shootings.
5. study PV system applications & associated safety measures

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**SOLAR CELL FUNDAMENTALS (11 hrs)** Principle of solar energy conversion, Photovoltaic effect, Semiconductor properties, energy levels, basic equations. Solar cell structure, parameters of solar cell.	**CO1**
II	**PV MODULE PERFORMANCE (13 hrs)** Solar PV modules & arrays, I-V &P-V characteristics, maximum power point ,series parallel combination, cell efficiency, fill factor, role of bypass & blocking diode, factors affecting output of a solar cell .	**CO2**
III	**MANUFACTURING OF PV CELLS & DESIGN OF PV SYSTEMS (12 hrs)** Commercial solar cells - Production process of single crystalline silicon cells, multi crystalline silicon cells, amorphous silicon, cadmium telluride, copper indium gallium diselenide cells. Design of solar PV systems, cost estimation, various aspects, system simulation tools.	**CO3**
IV	**SOLAR PV SYSTEMS INSTALLATIONS & TROUBLE SHOOTING (12 hrs)** Classification - Central Power Station System, Distributed PV System, Stand alone PV system, grid Interactive PV System, small system for consumer applications, hybrid solar PV system, concentrator solar photovoltaic. System components - PV arrays, inverters, batteries, charge controllers, net metering, PV array installation, operation, costs, reliability. Troubleshooting of PV system components.	**CO4**
V	**PV SYSTEM APPLICATIONS & SAFETY (12 hrs)** Building-integrated photovoltaic units, grid connected central power stations, stand-alone devices for distributed power supply in remote and rural areas,	**CO5**

	Outlook for the Indian PV industry& challenges, Applications: solar home system, solar cars, Solar Charger, aircraft, space solar power satellites. Socio-economic and environmental merits of photovoltaic systems safety in Installation of solar PV systems.	

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the principle of direct solar energy conversion to power using PV
CO2	**Contrast** the performance measures of PV
CO3	**Infer** on various solar cells &**design** aspects of solar PV
CO4	**Identify** various PV components & construct few systems
CO5	**Develop** ideas for working on solar PV systems & associated safety practices

Learning Resources

Text books:

1. Chetan Singh Solanki., Solar Photovoltaic: "Fundamentals, Technologies and Application", PHI Learning Pvt., Ltd., 2009.
2. Jha A.R., "Solar Cell Technology and Applications", CRC Press,2010.
3. John R. Balfour, Michael L. Shaw, SharlaveJarosek., "Introduction to Photovoltaics", Jones & Bartlett Publishers, Burlington, 2011.

Reference books:

1. Chetan Singh Solanki "Solar PV technology and system", PHI learning private limited, 2015.
2. Luque A. L. and Andreev V.M., "Concentrator Photovoltaic",Springer, 2007.
3. Partain L.D., Fraas L.M., "Solar Cells and Their Applications", 2nd ed., Wiley, 2010.
4. S.P. Sukhatme, J.K.Nayak., "Solar Energy", Tata McGraw Hill Education Private Limited, New Delhi, 2010.
5. R.K Pachauri "From Sun light to Electricity" TERI, 15th Reprint , 2013.

e- Resources & other digital material

https://www.nrel.gov

https://nise.res.in/

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https://nptel.ac.in/courses/117/108/117108141/#

https://onlinecourses.nptel.ac.in/noc20_ee57/preview

Micro-Syllabus

UNIT 1:SOLAR CELL FUNDAMENTALS (11 hrs)

Principle of solar energy conversion, Photovoltaic effect, Semiconductor properties, energy levels, basic equations. Solar cell structure, parameters of solar cell.

Unit No	Module	Micro content

1a. solar energy conversion	solar energy conversion	Principle of solar energy conversion (Working),
		Photovoltaic effect
		Semiconductor properties
		energy levels
1.b. Solar cell structure,	Solar cell structure,	basic equations of solar
		Solar cell structure
		parameters of solar cell.

Unit-2:PV MODULE PERFORMANCE (13 hrs)

Solar PV modules & arrays, I-V &P-V characteristics, maximum power point ,series parallel combination, cell efficiency, fill factor, role of bypass & blocking diode, factors affecting output of a solar cell .

Unit No	Module	Micro content
2a. Solar PV modules	Solar PV modules	Solar PV modules & arrays (Working)
		I-V &P-V characteristics, (Diagram)
		maximum power point
		Series parallel combination
2b.solar cell efficiency	solar cell efficiency	cell efficiency, fill factor, role of bypass & blocking diode (Working),
		factors affecting output of a solar cell.

Unit-3:MANUFACTURING OF PV CELLS & DESIGN OF PV SYSTEMS (12 hrs)

Commercial solar cells - Production process of single crystalline silicon cells, multi crystalline silicon cells, amorphous silicon, cadmium telluride, copper indium gallium diselenide cells. Design of solar PV systems, cost estimation, various aspects, system simulation tools.

Unit No	Module	Micro content
3a.Manufacturing of Pv Cells	Manufacturing Of Pv Cells	Production process of single crystalline silicon cells
		multi crystalline silicon cells
		amorphous silicon, cadmium telluride,
		copper indium gallium diselenide cells
3b.Design Of Pv Systems	Design Of Pv Systems	Design of solar PV systems
		cost estimation
		Various aspects, system simulation tools.

Unit-4:SOLAR PV SYSTEMS INSTALLATIONS & TROUBLE SHOOTING (12 hrs)

Classification - Central Power Station System, Distributed PV System, Stand alone PV system, grid Interactive PV System, small system for consumer applications, hybrid solar PV system, concentrator solar photovoltaic. System components - PV arrays, inverters, batteries, charge controllers, net metering, PV array installation, operation, costs, reliability. Troubleshooting of PV system components.

Unit No	Module	Micro content

4a. Solar PV Systems Installations	Solar PV Systems Installations	Classification
		➢ Central Power Station System ➢ Distributed PV System ➢ Stand alone PV system ➢ grid Interactive PV System ➢ small system for consumer applications, ➢ hybrid solar PV system, concentrator solar photovoltaic.
4b.Trouble Shooting	Trouble Shooting	System components - PV arrays, inverters, batteries, charge controllers , net metering
		PV array installation, operation, costs, reliability.
		Troubleshooting of PV system components

Unit-5:PV SYSTEM APPLICATIONS & SAFETY (12 hrs)

Building-integrated photovoltaic units, grid connected central power stations, stand-alone devices for distributed power supply in remote and rural areas, Outlook for the Indian PV industry& challenges,

Applications: solar home system, solar cars, Solar Charger, aircraft, space solar power satellites. Socio-economic and environmental merits of photovoltaic systems safety in Installation of solar PV systems.

Unit No	Module	Micro content
5a.PV System Applications	Pv System Applications	Building-integrated photovoltaic units
		grid connected central power stations
		stand-alone devices for distributed power supply in remote and rural areas,
		➢ Outlook for the Indian PV industry& challenges,
5b.Safety	Safety	Socio-economic and environmental merits of photovoltaic systems
		safety in Installation of solar PV systems

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

CO1	**Understand** the principle of direct solar energy conversion to power using PV
CO2	**Contrast** the performance measures of PV
CO3	**Infer** on various solar cells &**design** aspects of solar PV
CO4	**Identify** various PV components & construct few systems
CO5	**Develop** ideas for working on solar PV systems & associated safety practices

Text books:

1. Chetan Singh Solanki., Solar Photovoltaic: “Fundamentals, Technologies and Application”, PHI Learning Pvt., Ltd., 2009.

2. Jha A.R., “Solar Cell Technology and Applications”, CRC Press, 2010. 3. John R. Balfour, Michael L. Shaw, SharlaveJarosek., “Introduction to Photovoltaics”, Jones & Bartlett Publishers, Burlington, 2011.
Reference books:
1. Chetan Singh Solanki “Solar PV technology and system”, PHI learning private limited, 2015. 2. Luque A. L. and Andreev V.M., “Concentrator Photovoltaic”,Springer, 2007. 3. Partain L.D., Fraas L.M., “Solar Cells and Their Applications”, 2nd ed., Wiley, 2010. 4. S.P. Sukhatme, J.K.Nayak., “Solar Energy”, Tata McGraw Hill Education Private Limited, New Delhi, 2010. 5. R.K Pachauri “From Sun light to Electricity” TERI, 15th Reprint , 2013.

CO-PO Mapping:

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

II-Year-II Semester	SENSORS AND ACTUATORS FOR IOT	L	T	P	C
SOC2201		1	0	2	2

PRE-REQUISITES: 1) IOT

Course objectives: The student should be able to

1. Study the concept on IOT and phenomena on which operation of Sensor transformation of energy is based
2. Know the depth knowledge in physical principles applied in sensing
3. Know the Characteristics, analysis and how measurement systems are designed, calibrated
4. Impart a competence in the design, construction, and execution of mechanical measurements in application point of view

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Sensors:** **(3 hrs)** Introduction of IOT, Transducers and definition of sensors.	**CO1**
II	**Classification of Sensors** **(3 hrs)** Active, Analog, Digital, Scalar, Vector, - Inductive Sensors: Sensitivity and Linearity of the Sensor, Types-Capacitive Sensors:– Electrostatic Transducer– Force/Stress Sensors Using Quartz Resonators – Ultrasonic Sensors,-PIR Motion Sensor - Rain Drop Sensor - Moisture Sensor. -Temperature Sensor - Touch Sensor -Infrared Sensor - Servo Motor- RFID Sensor -- Bluetooth Module, Wi-Fi Module.	**CO2**
III	**Characteristics of Sensors** **(2hrs)** **Static** -Accuracy, Range, Resolution, Error ;**Dynamic**	**CO3**
IV	**Actuators** **(1hr)** Classification – Electric, Fluid, Linear, Manual	**CO4**
V	**Applications** **(6hrs)** Sensors and actuators,Processors,Transceivers (Mobile Phone Based Sensors., Neural Sensors ,Environmental and Chemical Sensors, Medical Sensors., Radio Frequency Identification (RFID)-Applications on IOT- Arduino, Raspberry Pi.- Smart home, health, logistics, transport, agriculture, social, environment.	**CO5**
List of Experiments 1. Interfacing DHT11 Temperature and Humidity Sensor with Raspberry Pi 2. LDR controlled blub by Arduino 3. Sun tracker using 4-LDR by Arduino 4. Moisture content of soil by Arduino 5. Rain water alarm by Arduino		

6. Raspberry Pi Motion Sensor Alarm using PIR Sensor 7. Smart Phone Controlled Home Automation by Raspberry Pi 8. Interfacing Hall Sensor with Raspberry Pi 9. Stepper Motor Control with Raspberry Pi 10. Servomotor control with Arduino 11. Fire alarm using Arduino 12. Real time intrusion detection for Smart home 13. LED Blinking by light sensor with Raspberry Pi and Python Program 14. Smart Blind-stick by Arduino 15. Remote controlled AC fan regulator by IR Sensor	

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Understand the concept of IOT
CO2	Explain thephysical parameter into an electrical quantity
CO3	Analyze the Characteristics and develop sensors using different methods with desired properties
CO4	Evaluate the sensor and actuators as an application on industry and /or device type

Learning Resources
Text books:
1. Internet of Things : Architecture, Design principles and applications, Rajkamal, McGraw Hill Higher Education. 2. Jon. S. Wilson, “Sensor Technology Hand Book”, 2011, 1st edition, Elsevier, Netherland.
Reference books:
1. Dr. Guillaume Girardin , Antoine Bonnabel, Dr. Eric Mounier, 'Technologies & Sensors for the Internet of Things Businesses & Market Trends 2014 - 2024',Yole Dévelopment Copyrights ,2014 2. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015 3. N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014.

Micro-Syllabus

Unit – 1: Sensors: (3hrs)
Introduction of IOT, Transducers and Definition of sensors.

Unit No	Module	Micro content
1a. IOT	Introduction of IOT	IOT Architecture
		Physical, Network, Application
		Technoigical developments
		Advantages and Disadvantages.

1b. Sensors	Definition of Sensors	Introduction of Transducers
		Definition of Sensors
		Working of Sensors

Unit-2:Classification of Sensors (3hrs)

Active, Analog, Digital, Scalar, Vector, **Types** : Inductive Sensors: Sensitivity and Linearity of the Sensor, Types-Capacitive Sensors:– Electrostatic Transducer– Force/Stress Sensors Using Quartz Resonators – Ultrasonic Sensors,-PIR Motion Sensor - Rain Drop Sensor - Moisture Sensor. -Temperature Sensor - Touch Sensor -Infrared Sensor - Servo Motor- RFID Sensor -- Bluetooth Module, Wi-Fi Module.

Unit No	Module	Micro content
2. Classification of Sensors	**Types of Sensors**	Active, Analog, Digital, Scalar, Vector
		Inductive Sensors - Sensitivity and Linearity of the Sensor
		Capacitive Sensors:– Electrostatic Transducer– Force/Stress Sensors Using Quartz Resonators
		Ultrasonic Sensors
		PIR Motion Sensor - Rain Drop Sensor - Moisture Sensor. -Temperature Sensor - Touch Sensor -Infrared Sensor - Servo Motor
		RFID Sensor, Bluetooth Module, Wi-Fi Module.

Unit-3: **Characteristics of Sensors (2hrs)**

Static -Accuracy, Range, Resolution, Error :**Dynamic**

Unit No	Module	Micro content
3a.Characteristics of Sensors	**Static**	Accuracy
		Range
		Resolution
		Error
3b.Characteristics of Sensors	**Dynamic**	Dynamic

Unit-4 : Actuators (1hr)

Classification – Electric, Fluid, Linear, Manual

Unit No	Module	Micro content
4. Actuators	Classification of Actuators	Classification based on Performance ,type ➢ Electric ➢ Fluid ➢ Linear ➢ Manual

Unit-5: Applications (6hrs)		
Sensors and actuators, Processors, Transceivers (Mobile Phone Based Sensors., Neural Sensors ,Environmental and Chemical Sensors, Medical Sensors., Radio Frequency Identification (RFID)-Applications on IOT- Arduino, Raspberry Pi.- Smart home, health, logistics, transport, agriculture, social, environment		
Unit No	**Module**	**Micro content**
5. Applications	**Applications of Sensors and actuators for IOT by Arduino , Raspberry Pi**	Mobile Phone Based Sensors
		Neural Sensors
		Environmental and Chemical Sensors
		Medical Sensors
		Radio Frequency Identification (RFID)
		Based on requirement : ➢ Smart home ➢ Health ➢ Logistics ➢ Transport ➢ Agriculture ➢ Social ➢ Environment.

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

CO1	Understand the concept of IOT **{Understand level, KL2}**
CO2	Explain thephysical parameter into an electrical quantity **{Apply level, KL3}**
CO3	Analyze the Characteristics and develop sensors using different methods with desired properties **{Analyze level, KL4}**
CO4	Evaluate the sensor and actuators as an application on industry and /or device type**{Evaluate level, KL5}**

Learning Resources
Text books:
1. Internet of Things : Architecture, Design principles and applications, Rajkamal, McGraw Hill Higher Education. 2. Jon. S. Wilson, “Sensor Technology Hand Book”, 2011, 1st edition, Elsevier, Netherland.
Reference books:
1. Dr. Guillaume Girardin , Antoine Bonnabel, Dr. Eric Mounier, 'Technologies & Sensors for the Internet of Things Businesses & Market Trends 2014 - 2024',Yole Dévelopment Copyrights ,2014 2. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015 3. N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014.

e- Resources & other digital material
1.https://nptel.ac.in/courses/108/108/108108147/
2.https://www.coursera.org/lecture/iot/lecture-2-3-sensors-and-actuators-in-the-lab-852CL
3.https://www.avsystem.com/blog/iot-sensors-iot-actuators/
4.https://www.youtube.com/watch?v=hIISiYs7lDo
5.https://www.mdpi.com/1424-8220/19/20/4567/pdf

CO-PO Mapping:

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

II-Year-II Semester SOC2201	AC DRIVES	L	T	P	C
		1	0	2	2

PRE-REQUISITES: 1) AC Drives

Course objectives: The student should be able to

1. Study the fundamentals of AC Drives .
2. Study the Types of AC motors construction & working principle.
3. Study the Concept of AC Drive and construction & working principle.
4. Study the Applications of AC Drives.
5. Study the Design and protection for AC and MV Drives.

Unit No	Contents	Mapped CO
	Syllabus	
I	**Basic principles of AC Drive (6 hrs)** Basic principles of AC Drive and its Application **(02 hrs)** Benefits of AC Drives **(02 hrs)** Basic concept, Wiring **(02 hrs)**	**CO1**
II	**Types of AC MOTOR (08 hrs)** Basic on AC motors-Types of AC motors **(02 hrs)** construction and working, principle, **(02 hrs)** Parameterization **(04 hrs)**	**CO2**
III	**Concept of AC DRIVE (10 hrs)** Concept of AC Drive in details.**(02hrs)** construction & working principle **(04 hrs)** Selection of AC Drive (**02 hrs)** Important features .**(02 hrs)**	**CO3**
IV	**Applications of AC Drives (06 hrs)** Applications of AC Drives (**02 hrs)** AC Drive Harmonics (**02 hrs)** Effects of Harmonics (**02 hrs)**	**CO4**
V	**Features of SINAMIC G-120 AC Drive , MEDIUM VOLTAG (MV) DRIVE (10 hrs)** Introduction, parameterization, Wiring, Application **(06 hrs)** Introduction, features and application **(02hrs)** Design and protection for AC and MV Drives **(02hrs)**	**CO5**

Content Beyond the syllabus:
Induction motor drives: Volts/Hertz Control, Vector or Field oriented control.
Industrial application: Drive consideration for Textile mills, Steel rolling mills, Cement mills, Paper mills, Machine tools. Cranes & hoist drives.

LIST OF EXPERIMENTS

1. To obtain speed control of Switched Reluctance Motor using DSP controller TMS320F2812.
2. To obtain speed control of Permanent magnet synchronous Motor using SPARTAN 6 FPGA controller.
3. To obtain speed control of three phase induction motor using dsPIC controller MICRO-4011.
4. To visualize the speed and position control of servo motor by various inputs of DSP CONTROLLER kit.
5. To study the operation of speed control of dc motor fed from four quadrant chopper using FPGA controller
6. To simulate the three phase voltage source inverter with resistive load using SPWM.
7. To simulate the chopper fed dc motor (matlab)
8. To study the simulation of Z source inverter using matlab - simulink.

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the fundamentals of AC Drives **{Understand level, KL2}**
CO2	**Explain** the principle and working of AC motors.**{Apply level, KL3}**
CO3	**Analyze** the Concept of AC Drive **{Analyze level, KL4}**
CO4	**Evaluate** the Applications of AC Drives.**{Evaluate level, KL5}**
CO5	**Analyze** the Design and protection for AC and MV Drives.**{Apply level, KL4}**

Learning Resources

Text books:

1. "Electric Drive: Control of DC and AC Drives" by Srinivas Vemula and Ramaiah Veerlapati.
2. VEDAM SUBRAMANIAM "Electric drives (concepts and applications)", Tata McGraw-Hill.2001.
3. "Electric motor drives", R. Krishnan, PHI.
4. "Electric Motor & Drives". Austin Hughes, Newnes.
5. "Modern Power Electronics & Ac drives", B.K. Bose, Pearson Education.

Reference books:

1. PILLAI.S.K, "A first course on Electric drives", Wiley Eastern Limited, 1998
2. M.D. SINGH, K.B.KHANCHANDANI, "Power electronics", Tata McGraw-Hill.1998

e- Resources & other digital material

1. http://www.hccl.ie/uploads/1/4/7/3/1473854/ha472742_iss4a_ac-dc_catalog.pdf
2. https://www.industrial-electronics.com/MDPTG_4.html
3. http://freetutorials.name/Reference1/Electrical_Engineering.html

Micro-Syllabus

Unit – 1 Basic principles of AC Drive (6 hrs)
Basic principles of AC Drive and its Application **(02 hrs)**, Benefits of AC Drives **(02 hrs)**
Basic concept, Wiring **(02 hrs)**

Unit No	Module	Micro content
1a. Basic principles of AC Drive	Basic principles of AC Drive	Basic principles of AC Drive
		Importance of AC Drive
		Applications
		Advantages and Disadvantages.
1b. Benefits of AC Drives	Benefits of AC Drives	Benefits of AC Drives
		Classifications of Drives
		Advantages and Disadvantages.

Unit-2: Types of AC MOTOR (08 hrs)
Basics on AC motors-Types of AC motors **(02 hrs)**, construction and working, principle, **(02 hrs)**
Parameterization **(04 hrs)**

Unit No	Module	Micro content
2a Basics on AC motors, Types of AC motors	Basics on AC motors, Types of AC motors	Basic on AC motors
		principle
		types of DC motors
		Advantages and Disadvantages.
2b. construction and working, principle	construction and working, principle	construction and working, principle
		Parameterization
		Advantages and Disadvantages.

Unit-3: **Concept of AC DRIVE (10 hrs)**
Concept of AC Drive in details.**(02hrs),** construction & working principle **(04 hrs)**
Selection of AC Drive (**02 hrs),** Important features .**(02 hrs)**

Unit No	Module	Micro content
3a. Concept of AC Drive	Concept of AC Drive	Concept of AC Drive
		construction & working principle
		Applications
		Advantages and Disadvantages.
3b. Selection of AC Drive	Selection of AC Drive	Selection of AC Drive
		Advantages

Unit-4: Applications of AC Drives (06 hrs)
Applications of AC Drives (**02 hrs)**, AC Drive Harmonics (**02 hrs),** Effects of Harmonics (**02 hrs)**

Unit No	Module	Micro content
4a. Applications	Applications of AC	Applications of AC Drives

of AC Drives	Drives	construction & working principle
		Advantages and Disadvantages
4b. AC Drive Harmonics	AC Drive Harmonics	AC Drive Harmonics
		Working principle
		Effects of Harmonics
		Applications
		Advantages and Disadvantages

Unit-5: Features of SINAMIC G-120 AC Drive , MEDIUM VOLTAG (MV) DRIVE (10 hrs)
Introduction, parameterization, Wiring, Application **(06 hrs)**
Introduction, features and application **(02hrs)**
Design and protection for AC and MV Drives **(02hrs)**

Unit	Module	Micro content
5a. Features of SINAMIC G-120 AC Drive	Features of SINAMIC G-120 AC Drive	Introduction of **of SINAMIC G-120 AC Drive**
		parameterization
		Wiring
		Application
		Advantages and Disadvantages
5b. Design and protection for AC and MV Drives	Design and protection for AC and MV Drives	Design of AC and MV Drives
		Protection of AC and MV Drives
		Applications
		Advantages and Disadvantages

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

CO1	**Understand** the fundamentals of AC Drives. **{Understand level, KL2}**
CO2	**Explain** the principle and working of AC motors. **{Apply level, KL3}**
CO3	**Analyze** the Concept of AC Drive **{Analyze level, KL4}**
CO4	**Evaluate** the Applications of AC Drives.**{Evaluate level, KL5}**
CO5	**Analyze** Design and protection for AC and MV Drives.**{Apply level, KL4}**

Learning Resources

Text books:

6. “Electric Drive: Control of DC and AC Drives” by Srinivas Vemula and Ramaiah Veerlapati.
7. VEDAM SUBRAMANIAM “Electric drives (concepts and applications)”, Tata McGraw-Hill.2001.
8. “Electric motor drives”, R. Krishnan, PHI.

9. “Electric Motor & Drives”. Austin Hughes, Newnes. 10. “Modern Power Electronics & Ac drives”, B.K. Bose, Pearson Education.
Reference books:
3. PILLAI.S.K, “A first course on Electric drives”, Wiley Eastern Limited, 1998 4. M.D. SINGH, K.B.KHANCHANDANI, “Power electronics”, Tata McGraw-Hill.1998
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4. http://www.hccl.ie/uploads/1/4/7/3/1473854/ha472742_iss4a_ac-dc_catalog.pdf
5. https://www.industrial-electronics.com/MDPTG_4.html
6. http://freetutorials.name/Reference1/Electrical_Engineering.html

CO-PO Mapping

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

II-Year-II Semester MC2201	ENVIRONMENTAL STUDIES	L	T	P	C
		2	0	0	0

Pre-Requisites:

1. Basics of General Science
2. Basics of Social Studies

Course Objectives: The objectives of the course are to impart:

1. Overall understanding of the natural resources
2. Basic understanding of the ecosystem and its diversity.
3. Acquaintance on various environmental challenges induced due to unplanned anthropogenic activities.
4. An understanding of the environmental impact of developmental activities.
5. Awareness on the social issues, environmental legislation and global treaties.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**UNIT – I: MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES (12 Hrs)** Definition, Scope and Importance – Need for Public Awareness. **NATURAL RESOURCES :** Renewable and non-renewable resources – Natural resources and associated problems – Forest resources – Use and over – exploitation, deforestation, case studies – Timber extraction – Mining, dams and other effects on forest and tribal people – Water resources – Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. – Energy resources:	**CO1**
II	**UNIT – II: Ecosystems, Biodiversity, and its Conservation (12 hrs)** **ECOSYSTEMS:** Concept of an ecosystem. – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem. b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) **BIODIVERSITY AND ITS CONSERVATION :** Definition: genetic, species	**CO2**

	and ecosystem diversity – Bio-geographical classification of India – Value of biodiversity: consumptive use, Productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-sports of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.	
III	**UNIT-III: Environmental Pollution and Solid Waste Management (10 hrs)** **ENVIRONMENTAL POLLUTION:** Definition, Cause, effects and control measures of : a. Air Pollution. b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear hazards **SOLID WASTE MANAGEMENT :**Causes**,** effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.	**CO3**
IV	**UNIT – IV: Social Issues and the Environment (12 hrs)** **SOCIAL ISSUES AND THE ENVIRONMENT:** From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns. Case studies – Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies – Wasteland reclamation. – Consumerism and waste products. – Environment Protection Act. – Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness.	**CO4**
V	**UNIT – V: Human Population and the Environment (14 hrs)** **HUMAN POPULATION AND THE ENVIRONMENT:** Population growth, variation among nations. Population explosion – Family Welfare Programmed. – Environment and human health – Human Rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of information Technology in Environment and human health – Case studies. **FIELD WORK :** Visit to a local area to document environmental assets River/forest grassland/hill/mountain – Visit to a local polluted site-	**CO5**

	Urban/Rural/Industrial/Agricultural Study of common plants, insects, and birds – river, hill slopes, etc..	

Content Beyond the Syllabus:
Unit-I: International Environmental Summit, Kyoto Protocol
Unit-III: Solid waste Disposal: Bio Medical Waste Management
Unit-V: Epidemiology

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Able to U**nderstand** Natural resources and their importance
CO2	Able to U**nderstand**TheThe concepts of the ecosystem, learn biodiversity of India and the threats to biodiversity and **Apply** conservation practices
CO3	Able to learn Various attributes of the pollution and their impacts.
CO4	Able to U**nderstand** Social issues both rural and urban environment and Environmental Legislation.
CO5	Able to Understand Popultion Explosion and Apply Structure and Functions of Ecosystem.

Text books:

1. Text book of Environmental Studies for Undergraduate Courses by ErachBharucha for University Grants Commission, Universities Press.
2. Environmental Studies by Palaniswamy – Pearson education
3. Environmental Studies by Dr.S.AzeemUnnisa, Academic Publishing Company.

Reference books

1. Textbook of Environmental Science by Deeksha Dave and E.Sai Baba Reddy, Cengage Publications.
2. Text book of Environmental Sciences and Technology by M.Anji Reddy, BS Publication.
3. Comprehensive Environmental studies byJ.P.Sharma, Laxmi publications.
4. Environmental sciences and engineering – J. Glynn Henry and Gary W. Heinke – Prentice hall of India Private limited.
5. A Text Book of Environmental Studies by G.R.Chatwal, Himalaya Publishing House
6. Introduction to Environmental engineering and science by Gilbert M. Masters and Wendell P. Ela - Prentice hall of India Private limited.

e- Resources & other digital material

1.http://moef.gov.in/en/resource/e-books/
2.https://cpcb.nic.in/
3.https://www.unep.org/

Micro-Syllabus

<table>
<tr><td colspan="3">

Unit-1: MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES (12 Hrs)
Definition, Scope and Importance – Need for Public Awareness.
NATURAL RESOURCES : Renewable and non-renewable resources – Natural resources and associated problems – Forest resources – Use and over – exploitation, deforestation, case studies – Timber extraction – Mining, dams and other effects on forest and tribal people – Water resources – Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. – Energy resources:
</td></tr>
<tr><th>Unit No</th><th>Module</th><th>Micro content</th></tr>
<tr><td rowspan="4">1a. Multidisciplinary Nature Of Environmental Studies</td><td rowspan="4">Scope and Multidisciplinary nature</td><td>Scope of Environmental Studies</td></tr>
<tr><td>Importance of Environmental Studies</td></tr>
<tr><td>Need for Public Awareness</td></tr>
<tr><td>Multidisciplinary nature of Environmental Studies</td></tr>
<tr><td rowspan="2">1b. Natural Resources</td><td>Energy Resources</td><td>Renewable and Non–Renewable resources</td></tr>
<tr><td>Forest, Mining</td><td>Deforestation causes and Effects, Dams Impacts, Effects of Modern Agriculture</td></tr>
<tr><td colspan="3">

UNIT – II: Ecosystems, Biodiversity, and its Conservation (12 hrs)
ECOSYSTEMS: Concept of an ecosystem. – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the following ecosystem:
a. Forest ecosystem.
b. Grassland ecosystem
c. Desert ecosystem
d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)
BIODIVERSITY AND ITS CONSERVATION : Definition: genetic, species and ecosystem diversity – Bio-geographical classification of India – Value of biodiversity: consumptive use, Productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-sports of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.
</td></tr>
<tr><td>Unit No</td><th>Module</th><th>Micro content</th></tr>
<tr><td>2a. Ecosystems</td><td>Structure and function of an ecosystem</td><td>Producers, consumers and decomposers – Energy flow in the</td></tr>
</table>

		ecosystem
		Food chains, food webs and ecological pyramids
		Ecological succession
	types, characteristic features of Ecosystems	a.Forest ecosystem. b.Grassland ecosystem c.Desert ecosystem d.Aquatic ecosytems
2b. Bio diversity and its conservation.	Bio Diversity Levels, Values, Threats, and Conservation	Values of biodiversity, Biodiversity at global, National and local levels, Hot-spots of biodiversity, – Threats to biodiversity
		Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT-III: Environmental Pollution and Solid Waste Management (10 hrs)

ENVIRONMENTAL POLLUTION: Definition, Cause, effects and control measures of :

a. Air Pollution.
b. Water pollution
c. Soil pollution
d. Marine pollution
e. Noise pollution
f. Thermal pollution
g. Nuclear hazards

SOLID WASTE MANAGEMENT: Causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.

Unit No	**Module**	**Micro content**
3.a. Environmental Pollution	Environmental Pollution	Air Pollution.
		Water pollution
		Soil pollution, Marine Pollution
		Noise Pollution, Thermal Pollution
		Nuclear Hazards
3. b. Solid Waste Management.	Solid Waste Management	urban and industrial wastes
		Pollution case studies
		Disaster management: floods, earthquake, cyclone and landslides.

UNIT – IV: Social Issues and the Environment (12 hrs)

SOCIAL ISSUES AND THE ENVIRONMENT: From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns. Case studies – Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies – Wasteland reclamation. – Consumerism and waste products. – Environment Protection Act. – Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness

Unit No	Module	Micro content
4a. Social Issues and the Environment	Sustainable development	Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management
		Resettlement and rehabilitation of people; its problems and concerns. Case studies
		Environmental ethics, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.
4b.Environmnetal Legislation	Environmental Acts	Air Act, Water Act, Environment Protection Act
		Wildlife Protection Act – Forest Conservation Act
		– Issues involved in enforcement of environmental legislation

UNIT – V: Human Population and the Environment (14 hrs)

HUMAN POPULATION AND THE ENVIRONMENT: Population growth, variation among nations. Population explosion – Family Welfare Programmes. – Environment and human health – Human Rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of information Technology in Environment and human health –

FIELD WORK: Visit to a local area to document environmental assets River/forest grassland/hill/mountain – Visit to a local polluted site-Urban/Rural/Industrial/Agricultural Study of common plants, insects, and birds – river, hill slopes, etc..

Unit No	**Module**	**Micro content**
5 a. Human Population and Environment	Population Characteristics	Population explosion – Family Welfare Programmes.
		HIV/AIDS

	Role of IT in Environment and Human Health	Role of information Technology in Environment and human health
	Value Education	Value Education
		Environment and human health
		Women and Child Welfare
		Case studies.
5.b. Field work	River/forest grassland/hill/mountain	Visit to a local area to document environmental assets River
		Forest
		Grassland
		Hill/Mountain
	local polluted site-Urban/Rural/Industrial/Agricultural Study	Visit to a local polluted site
		Urban/Industrial
		Rural Field Visit
		Agricultural Study of common plants, insects, and birds – river, hill slopes, etc..

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Able to U**nderstand** Natural resources and their importance
CO2	Able to U**nderstand**TheThe concepts of the ecosystem, learn biodiversity of India and the threats to biodiversity and **Apply** conservation practices
CO3	Able to learn Various attributes of the pollution and their impacts.
CO4	Able to U**nderstand** Social issues both rural and urban environment and Environmental Legislation.
CO5	Able to Understand Popultion Explosion and Apply Structure and Functions of Ecosystem.

Text books:

1. Text book of Environmental Studies for Undergraduate Courses by ErachBharucha for University Grants Commission, Universities Press.
2. Environmental Studies by Palaniswamy – Pearson education
3. Environmental Studies by Dr.S.AzeemUnnisa, Academic Publishing Company.

Reference books

1. Textbook of Environmental Science by Deeksha Dave and E.Sai Baba Reddy, Cengage Publications.
2. Text book of Environmental Sciences and Technology by M.Anji Reddy, BS Publication.
3. Comprehensive Environmental studies byJ.P.Sharma, Laxmi publications.
4. Environmental sciences and engineering – J. Glynn Henry and Gary W. Heinke –

Prentice hall of India Private limited. 5. A Text Book of Environmental Studies by G.R.Chatwal, Himalaya Publishing House 6. Introduction to Environmental engineering and science by Gilbert M. Masters and Wendell P. Ela - Prentice hall of India Private limited.
e- Resources & other digital material
1.http://moef.gov.in/en/resource/e-books/
2.https://cpcb.nic.in/
3.https://www.unep.org/

CO-PO Mapping:

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

II-Year-II Semester	ANALYSIS OF LINEAR SYSTEMS	L	T	P	C
HO2201		3	0	2	4

PRE-REQUISITES: 1) Basic Circuit Analysis
2) Electrical Circuit Analysis
3) Engineering Mathematics

Course objectives: The student should be able to

1. Formulate state equations for Electrical networks.
2. Study Fourier series and Fourier transform of a periodic function.
3. Compute an Effective value and an average values of non-sinusoidal periodic waves
4. Analyze Response of RL, RC, and RLC Networks to Step, Ramp, and impulse functions.
5. Study the Hurwitz polynomials and Positive Real Functions.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**STATE VARIABLE ANALYSIS (10 hrs)** Choice of state variables in Electrical networks-Formulation of state equations for Electrical networks-Equivalent source method. Network topological method - Solution of state equations-Analysis of simple networks with state variable approach.	**CO1**
II	**FOURIER SERIES &FOURIER TRANSFORM REPRESENTATION (15hrs)** Introduction, Trigonometric form of Fourier series, Exponential form of Fourier series, Wave symmetry, Fourier integrals and transforms, Fourier transform of a periodic function , Properties of Fourier Transform , Parseval's theorem , Fourier transform of some common signals, Fourier transform relationship with Laplace Transform.	**CO2**
III	**APPLICATIONS OF FOURIER SERIES AND FOURIER TRANSFORM REPRESENTATION (15hrs)** Introduction, Effective value and average values of non-sinusoidal periodic waves, currents, Power Factor, Effects of harmonics, Application in Circuit Analysis, Circuit Analysis using Fourier Series.	**CO3**
IV	**LAPLACE TRANSFORM APPLICATIONS (15hrs)** Application of Laplace transform Methods of Ananlysis – Response of RL, RC, RLC Networks to Step,Ramp, and impulse functions, Shifting Theorem – Convolution Integral – Applications	**CO4**
V	**TESTING OF POLYNOMIALS (10hrs)** Elements of reliability-Hurwitz polynomials, Properties of Hurwitz polynomials - positive real functions-Properties-Testing-Sturm's Test, examples.	**CO5**
Content Beyond the syllabus:		

Response of RL network to sinusoidal signals
Response of RC network to sinusoidal signal
Response of RLC network to sinusoidal signal
Properties of LC Immittence
Transfer function of an electrical network

List of Experiments: practice any 5 programs**(10 hrs)**

1. Compute the response of RL Circuit with step input.
2. Compute the response of RC Circuit with step input.
3. Compute the response of RLC Circuit with step input.
4. Compute the response of RL Circuit with impulse input.
5. Compute the response of RL Circuit with impulse input.
6. Compute the response of RC Circuit with impulse input.
7. Compute the response of RL Circuit with impulse input.
8. Study the Effects of harmonics in a RLC Circuit.
9. Obtain the Response of RC network to Non-sinusoidal signal.
10. Obtain the solution of a network using state space analysis.

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the Formulation of state equations for Electrical networks**{Understand level, KL2}**
CO2	**Analyze** Fourier series and Fourier transform of a periodic function.**{ Understand Analyze level, KL2&KL4}**
CO3	**Analyze** Effective value and average values of non-sinusoidal periodic waves**{Analyze level, KL4}**
CO4	**Analyze** Response of RL, RC, RLC Networks to Step, Ramp, and impulse functions**{ Analyze level, KL4}**
CO5	**Analyze** Hurwitz polynomials and Positive Real Functions. **{Apply level, KL4}**

Learning Resources

Text books:

1. Network Analysis and Synthesis – UmeshSinha- SatyaPrakashan Publications
2. Linear System Analysis – A N Tripathi, New Age International.

Reference books:

1. Network and Systems – D Roy Chowdhary, New Age International.
2. Engineering Network Analysis and Filter Desgin- Gopal G Bhisk&Umesh.
3. Linear system anlysis by A.Cheng, Oxford publishers.
4. Signals, Systems and Communications by B.P. Lathi, BS Publications 2003.

e- Resources & other digital material

1. https://nptel.ac.in/courses/108/106/108106150/

2.	https://onlinecourses.nptel.ac.in/noc20_ee15/preview
3.	https://nptel.ac.in/courses/108/104/108104100/
4.	https://ocw.mit.edu/courses/mechanical-engineering/2-017j-design-of-electromechanical-robotic-systems-fall-2009/course-text/MIT2_017JF09_ch02.pdf
5.	https://www.researchgate.net/publication/301078132_Linear_Systems_Analysis_in_the_Time_Domain

Micro-Syllabus

Unit – 1: State Variable Analysis (10 hrs)

Choice of state variables in Electrical networks-Formulation of state equations for Electrical networks-Equivalent source method. Network topological method - Solution of state equations-Analysis of simple networks with state variable approach.

Unit No	Module	Micro content
1a.State Variable Analysis	Formulation of state equations	Choice of state variables in Electrical networks,
		Formulation of state equations for Electrical networks,
		Equivalent source method,
1b. State Variable Analysis	Solution of state equations-for simple networks	Network topological method,
		Solution of state equations,
		Analysis of simple networks with state variable approach,

Unit – 2: Fourier Series &Fourier Transform Representation (15hrs)

Introduction, Trigonometric form of Fourier series, Exponential form of Fourier series, Wave symmetry, Fourier integrals and transforms, Fourier transform of a periodic function , Properties of Fourier Transform , Parseval's theorem , Fourier transform of some common signals, Fourier transform relationship with Laplace Transform.

Unit No	Module	Micro content
2a. Fourier Series & Fourier Transform Representation	Fourier series	Introduction Fourier series,
		Trigonometric form of Fourier series,
		Exponential form of Fourier series,
		Wave symmetry,
2b. Fourier Series & Fourier Transform Representation	Fourier integrals and Transforms	Fourier transform of a periodic function,
		Properties of Fourier Transform,
		Parseval's theorem
		Fourier transform of some common signals,
		Fourier transforms relationship with Laplace Transform.

Unit – 3: Applications of Fourier Series And Fourier Transform Representation (15hrs)
Introduction, Effective value and average values of non-sinusoidal periodic waves, currents, Power Factor, Effects of harmonics, Application in Circuit Analysis, Circuit Analysis using Fourier Series.

Unit No	Module	Micro content
3a. Applications of Fourier Series And Fourier Transform Representation	Applications of Fourier Series	Introduction applications of Fourier series,
		Computation of Effective value of non-sinusoidal periodic waves,
		Computation of Average value of non-sinusoidal periodic waves,
		Computation of Effective current value of non-sinusoidal periodic waves,
		Computation of Effective voltage value of non-sinusoidal periodic waves,
		Computation of Effective current value of non-sinusoidal periodic waves,
		Computation of Power Factor value of non-sinusoidal periodic waves,
3b.Applications of Fourier Series And Fourier Transform Representation	Applications of Fourier Transforms	Effects of harmonics,
		Application in Circuit Analysis,
		Circuit Analysis using Fourier Series.

Unit-4:Laplace Transform Applications(15hrs)
Applications of Laplace transform Methods of Analysis – Response of RL, RC, RLC Networks to Step, Ramp, and impulse functions, Shifting Theorem – Convolution Integral – Applications.

Unit No	Module	Micro content
4a. Laplace Transform Applications	Application of Laplace transform	Application of Laplace transform Methods of Analysis,
		Response of RL Networks to Step, Ramp, and impulse functions,
		Response of RC Networks to Step, Ramp, and impulse functions,
		Response of RLC Networks to Step, Ramp, and impulse functions.
4b.Distribution Systems	Application of Laplace transform	Shifting Theorem,
		Convolution Integral,
		Applications of Convolution Integral.

Unit-5:Testing of Polynomials (10hrs) Elements of reliability-Hurwitz polynomials, Properties of Hurwitz polynomials -positive real functions-Properties-Testing-Sturm's Test, examples.		
Unit No	**Module**	**Micro content**
5a.Testing of Polynomials	Hurwitz polynomials	Elements of reliability,
		Introduction to Hurwitz polynomials,
		Properties of Hurwitz polynomials
		problems to check Hurwitz polynomials
5b.Testing of Polynomials	Positive Real Functions	Introduction to Positive Real Functions,
		Properties of Positive Real Functions,
		Testing-Sturm's Test,
		Simple Problems on Positive real Functions

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

CO1	**Understand** the Formulation of state equations for Electrical networks **{Understand level, KL2}**
CO2	**Analyze** Fourier series and Fourier transform of a periodic function.**{ Understand &Analyze level, KL2&KL4}**
CO3	**Analyze** Effective value and average values of non-sinusoidal periodic waves **{Analyze level, KL4}**
CO4	**Analyze** Response of RL, RC, RLC Networks to Step, Ramp, and impulse functions**{ Analyze level, KL4}**
CO5	**Analyze** Hurwitz polynomials and Positive Real Functions. **{Apply level, KL4}**

Text books:

1. Network Analysis and Synthesis – Umesh Sinha- Satya Prakashan Publications.
2. Linear System Analysis – A N Tripathi, New Age International.

Reference books:

1. Network and Systems – D Roy Chowdhary, New Age International.
2. Engineering Network Analysis and Filter Desgin- Gopal G Bhisk&Umesh.
3. Linear system anlysis by A.Cheng, Oxford publishers.
4. Signals, Systems and Communications by B.P. Lathi, BS Publications 2003.

CO-PO Mapping:

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

CO5	2	1											1	

II-Year-II Semester	ENERGY STORAGE SYSTEMS	L	T	P	C
HO2201		3	0	2	4

PRE-REQUISITES: 1) Chemistry

Course objectives: The student should be able to

1. Study the types of various energy storage systems.
2. Study the principle of electro chemical energy storage system and accumulators.
3. Understand flywheel mechanism and energy storage system.
4. Know the production of hydrogen gas, its storage and generation of electricity from hydrogen
5. study the use of super capacitors, its charging and discharging phenomenon and energy storage.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Generalities On Energy Storage: (10hrs)** Energy, Power, Capacity, Depth Of Discharge, State Of Discharge, Round Trip Efficiency, Charge And Discharge Losses, Types Of Energy Storage Systems: Physical And Electrical Storage(Types Only)	**CO1**
II	**Electro Chemical Energy Storage:(10hrs)** Introduction, System Structure, Elementary Principle, Different Types Of Accumulators-Accumulators With Aqueous Electrolyte: Lead–Acid Accumulator, Alkaline Accumulators, The Nickel-Iron , Nickel–Cadmium Accumulator, Ni-MH Accumulator, Accumulators With Non-aqueous Electrolyte: Lithium-Metal Accumulator, Lithium-Ion Accumulator.	**CO2**
III	**Flywheel storage System**:**(8hrs)** Introduction, Rotor Dynamics, Moment Of Inertia, Specific Energy, Aerodynamic Drag Of A Flywheel, Efficiency, Design Of Flywheel.	**CO3**
IV	**Energy Storage Based On Hydrogen:(12hrs)** Introduction, Structure Of Energy storage system, Electrolysis Of Water, Alkaline Electrolysis, High-Temperature Steam Electrolysis. Storage Of Hydrogen: Liquid Hydrogen Storage, Storage Of Hydrogen By Compression, Formic Acid For Hydrogen Storage, Conversion From Hydrogen To Electricity, Efficiency.	**CO4**
V	**Super Capacitors:(8hrs)** Introduction, types of super capacitors, Electrodes used for super capacitors, Electrical parameters, Life time, Applications of super capacitors, General Characteristics, Modelling, behaviour of super capacitors, charging and discharging of super capacitors.	**CO5**
List of Experiments : **1.** Performance characteristics of battery storage system		

2.	Determination of moment of inertia of wheel
3.	Performance characteristics of hydrogen fuel cell
4.	Determination of capacitance of a super capacitor
5.	Determination of Equivalent series resistance of a super capacitor
6.	Determination of leakage current of a super capacitor

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the various forms of energy and types of energy storage system **{Understand level, KL2}**
CO2	**Analyze**the working of electro chemical energy storage system and various accumulators**{Analyze level, KL3}**
CO3	**Explain** the performance of flywheel storage mechanism **{Explain level, KL4}**
CO4	**Understand** the Generation phenomenon of electricity from hydrogen gas and storage system**{Understand level, KL2}**
CO5	**Analyze** the working of super capacitors and its performance **{Apply level, KL4}**

Learning Resources

Text books:

1. Energy storage systems and components by Alfred Rufer , CRC press.
2. Electro Chemical Energy Storage for Renewable sources and Grid balancing, by Patrick T. Mosely, Jurgen Garche, Elsevier.

Reference books:

1. Energy storage: Fundamentals, materials and applications by RobbertA Huggins, Springer, Second Edition.
2. Supercapacitors: Materials, Systems, and Applications by Max Lu, Francois Beguin, ElzbietaFrackowiak, Wiley VCH.
3. Super capacitors Alternative Energy Storage System by Tripati SK, Jain Amrita, Lambert Academic publishing.
4. Engineering Energy storage by OdnestokkeBurhiem, Elsevier Academic press.

e- Resources & other digital material

1. https://nptel.ac.in/content/storage2/courses/108103009/download/M9.pdf
2. https://www.youtube.com/watch?v=EakRe6ICM-Q&t=54s
3. https://energystorage.org/why-energy-storage/technologies/flywheel-energy-storage-systems-fess/

4. https://en.wikipedia.org/wiki/Supercapacitor
5. https://en.wikipedia.org/wiki/Flywheel_energy_storage

Micro-Syllabus

Unit – 1: Generalities On Energy Storage: (10hrs)
Need of energy and energy storage**,** Energy, Power, Capacity, Depth Of Discharge, State Of Discharge, Round Trip Efficiency, Charge And Discharge Losses, Types Of Energy Storage Systems: Physical And Electrical Storage(Types Only)

Unit	Module	Micro content
1a. Basic definitions of energy storage	Basic definitions of energy storage	Need of energy and energy storage
		Energy, Power, Capacity
		Depth Of Discharge
		State Of Discharge,
1b. Performance parameters & types of Energy storage systems	Performance parameters & types of Energy storage systems	Round Trip Efficiency
		Charge And Discharge Losses
		Physical energy storage systems
		Electrical energy storage systems

Unit-2: Electro Chemical Energy Storage:(10hrs)
Introduction, System Structure, Elementary Principle, Different Types Of Accumulators- Accumulators With Aqueous Electrolyte: Lead–Acid Accumulator, Alkaline Accumulators, Nickel-Iron , Nickel–Cadmium Accumulator, Ni-MH Accumulator, Accumulators With Non-aqueous Electrolyte: Lithium-Metal Accumulator, Lithium-Ion Accumulator.

Unit	Module	Micro content
2a. Electro chemical energy storage& Accumulators with aqueous electrolyte	Electro chemical energy storage& Accumulators with aqueous electrolyte	**Electro Chemical Energy Storage introduction**
		Principle of electro chemical energy storage
		Accumulators with aqueous electrolyte: Lead–Acid Accumulator
		Alkaline Accumulators
		Nickel-Iron Accumulators
		Ni-MH Accumulator
		Ni-MH Accumulator
2b. Non-aqueous Electrolyte	Non-aqueous Electrolyte	Non-aqueous Electrolyte: Lithium-Metal Accumulator
		Lithium-Ion Accumulator.

Unit-3: **Flywheel storage System**:**(8hrs)**

Introduction, working of flywheel, Rotor Dynamics, Moment Of Inertia, Specific Energy, Aerodynamic Drag Of A Flywheel, Efficiency, Design Of Flywheel.

Unit	Module	Micro content
3a. Basic terms of flywheel	Flywheel basic terms analysis	Introduction
		working of flywheel
		Rotor Dynamics
		Moment Of Inertia
		Specific Energy
3b. performance analysis of flywheel	Performance analysis of flywheel	Aerodynamic Drag Of A Flywheel
		Efficiency
		Design Of Flywheel

Unit-4: Energy Storage Based On Hydrogen:(12hrs)

Introduction, Structure Of Energy storage system, Electrolysis Of Water, Alkaline Electrolysis, High-Temperature Steam Electrolysis.

Storage Of Hydrogen: Liquid Hydrogen Storage, Storage Of Hydrogen By Compression, Formic Acid For Hydrogen Storage, Conversion From Hydrogen To Electricity, Efficiency.

Unit	Module	Micro content
4a. Production of Hydrogen gas through Electrolysis	Production of Hydrogen gas through Electrolysis	Introduction
		Structure Of Energy storage system
		Phenomenon of Electrolysis Of Water
		Alkaline Electrolysis
		High-Temperature Steam Electrolysis
4b. Storage of Hydrogen and electricity generation	Storage of Hydrogen and electricity generation	Liquid Hydrogen Storage
		Storage Of Hydrogen By Compression
		Formic Acid For Hydrogen Storage
		Conversion From Hydrogen To Electricity
		Efficiency.

Unit-5: Super Capacitors:(8hrs)

Introduction, types of super capacitors, Electrodes used for super capacitors, Electrical parameters, Life time, Applications of super capacitors, General Characteristics, Modelling, behaviour of super capacitors, charging and discharging of super capacitors.

Unit	Module	Micro content
5a. Physical properties of super capacitors, Applications	Physical properties of super capacitors, Applications	Introduction
		types of super capacitors
		Electrodes used for super capacitors
		Electrical parameters, Life time
		Applications of super capacitors

5b. Analysis of super capacitor	Analysis of super capacitor	General Characteristics
		Modelling of super capacitor
		behaviour of super capacitors
		charging and discharging of super capacitors

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

CO1	**Understand** the various forms of energy and types of energy storage system **{Understand level, KL2}**
CO2	**Analyze**the working of electro chemical energy storage system and various accumulators**{Analyze level, KL3}**
CO3	**Explain** the performance of flywheel storage mechanism **{Explain level, KL4}**
CO4	**Understand** the Generation phenomenon of electricity from hydrogen gas and storage system**{Understand level, KL2}**
CO5	**Analyze** the working of super capacitors and its performance **{Apply level, KL4}**

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

CO1	**Understand** the working of hydro and thermal power plants **{Understand level, KL2}**
CO2	**Explain** the working of nuclear, gas, diesel power plants and non-conventional energy sources.**{Apply level, KL3}**
CO3	**Analyze** transmission lines parameters **{Analyze level, KL4}**
CO4	**Evaluate** the performance of AC and DC distribution systems. **{Evaluate level, KL5}**
CO5	**Analyze** the different load curves and tariff methods. **{Apply level, KL4}**

Text books:

1.Energy storage systems and components by Alfred Rufer , CRC press.

2.Electro Chemical Energy Storage for Renewable sources and Grid balancing, by Patrick T. Mosely, Jurgen Garche, Elsevier.

Reference books:

1. Energy storage: Fundamentals, materials and applications by RobbertA Huggins, Springer, Second Edition.
2. Supercapacitors: Materials, Systems, and Applications by Max Lu, Francois Beguin, ElzbietaFrackowiak, Wiley VCH.
3. Super capacitors Alternative Energy Storage System by Tripati SK, Jain Amrita, Lambert Academic publishing.
4. Engineering Energy storage by OdnestokkeBurhiem, Elsevier Academic press.

CO-PO Mapping::

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

II-Year-II Semester	SEMICONDUCTOR DEVICES MODELLING	L	T	P	C
HO2201		3	0	2	4

Pre-Requisites: knowledge of basic Devices

Course objectives: This subject gives knowledge of semiconductor devices

1. The main objectives are Study the principle of operation of basic devices and physics
2. Study the principle of operation of MOSFET and classification of MOSFET
3. Compute the performance factors of CMOS
4. Know the different types of Bipolar devices and its working
5. Design the different modes of Bipolar devices

Syllabus

Unit No	Content	Mapped CO
I	**Unit–1: Basic Devices And Physics(15hrs)** Electrons And Holes In Silicon And Germanium -P-N Junction Diode :Operation, &Its Working,-MOS –Capacitor: Structure And Principle Of Operation-High Field Effects	CO1
II	**Unit–2: MOSFET DEVICES(15hrs)** Long-channel MOSFETs-Short-channel MOSFETs- CMOS Device Design : MOSFET Scaling-Threshold voltage-MOSFET channel length	CO2
III	**Unit–3: CMOS PERFORMANCE FACTORS(15hrs)** Basic CMOS circuit elements- Parasitic elements-Sensitivity of CMOS delay to device parameters-Performance factors of advanced CMOS devices	CO3
IV	**Unit–4: BIPOLAR DEVICES(15hrs)** n-p-n Transistors-Ideal current-voltage characteristics-Characteristics of a typical n-p-n transistor-Bipolar device models for circuit and time-dependent analyses- Breakdown voltages	CO4
V	**Unit–5: BIPOLAR DEVICE DESIGN (15hrs)** Design of the emitter design- Design of the base region-Design of the collector design- Modern bipolar transistor structures.	CO5

List of experiments:

1. V-I Characteristics Of P-N Junction Diode in both forward &reverse bias condition
2. Study Of Characteristics Of MOSFET
3. To Study Triggering Of MOSFET
4. To Study Operation Of MOSFET Chopper Circuit
5. To Study MOSFET Based Single-Phase Series-Resonant Inverter.
6. To Study MOSFET Based Single-Phase Bridge Inverter.
7. NPN BJT Common Emitter Characteristics

8. NPN BJT Common Base Characteristics 9. NPN BJT Common Collector Characteristics

Course Outcomes:

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

No	Description	POs, PSOs	KL
CO1	**Understand** the working of basic devices and physics**{Understand level, KL2}**	PO1, PSO2	1,3
CO2	**Know**the principle of operation of MOSFET and classification of MOSFET**{Apply level, KL3}**	PO1, PSO2	2,3
CO3	**Compute** the performance factors of CMOS**{Analyze level, KL4}**	PO1, PSO2	1,2
CO4	**Know**the different types of Bipolar devices and its working{**Understand Level,KL2**}	PO1, PSO2	2,3
CO5	**Design** the different modes of bipoardevices.**{Apply level, KL4}**	PO1, PSO2	1,2

Text books:
1. **"Solid State Electronic Devices "**,B. G. Streetman and S. Banerjee, PHI. 2. "**Physics of Semiconductor Devices"** S. M. Sze, , John Wiley & Sons.. **3.** **"Semiconductor Devices: Physics and Technology "**S. M. Sze, , John Wiley & Sons**.** 4. **"Physics of Semiconductor Devices**" Michael Shur, PHI.
Reference books:
1. **"Semiconductor Devices** "NanditaDasGupta and AmitavaDasGupta, , PHI. 2. "**Fundamentals of Solid State Electronics**" C. T. Sah, World Scientific. 3. **"Advanced Theory of Semiconductor Devices",**Karl Hess, , IEEE Press. 4. **"Fundamentals of Semiconductor Devices ".**J.Lindmayer and C. Y. Wringley, , Affiliated East-West Press Pvt. Ltd
e-resource:
1. https://nptel.ac.in/courses/117/106/117106033/ 2. https://www.researchgate.net/publication/267261216_Semiconductor_Device_Modeling 3. https://en.wikipedia.org/wiki/Semiconductor_device_modeling 4. https://iitk.ac.in/new/ee616a

Micro-Syllabus

Unit–1:Basic Devices And Physics (15hrs) Electrons And Holes In Silicon And Germanium -P-N Junction Diode :Operation, &Its Working,-MOS –Capacitor: Structure And Principle Of Operation-High Field Effects		
Unit No	**Module Name**	**Micro content**
1a.	Electrons and holes concept in Ge& Si,	Semiconductors/Types OfSemi Conductors
		Semiconductors/EM Field And Transport Equations

	P-N junction diode	Semi Conductors/Drift, Diffusion, Transport Model
		Semiconductors/Energy Band Diagram
		p-n junction diode/construction working, Nine step device modelling
1b.	MOS-Capacitor	MOS capacitor/types of devices
		MOS capacitor/structure
		MOS Capacitor/Modes of operation
		MOS Capacitor/C-V characteristics

Unit–2: MOSFET DEVICES(15hrs)

Long-channel MOSFETs-Short-channel MOSFETs- CMOS Device Design : MOSFET Scaling-Threshold voltage-MOSFET channel length

Unit No	Module Name	Micro content
2a.	MOSFET	MOSFET/device structure, characteristics
		MOSFET /Types Of MOSFET,
		Long Channel MOSFET/DC model
		DC Model of bulk MOSFET
2b.	CMOS DEVICE DESIGN	MOSFET scaling
		Threshold voltage
		MOSFET channel length
		Static dissipation
		Dynamic dissipation

Unit–3: CMOS PERFORMANCE FACTORS(15hrs)

Basic CMOS circuit elements- Parasitic elements-Sensitivity of CMOS delay to device parameters-Performance factors of advanced CMOS devices

Unit No	Module Name	Micro content
3a.	CMOS	Basic circuit elements
		Parasitic elements
		Types of CMOS
3b.	CMOS Devices	Sensitivity of CMOS delay to device parameters
		Performance factors of advanced CMOS devices

Unit–4: BIPOLAR DEVICES(15hrs)

n-p-n Transistors-Ideal current-voltage characteristics-Characteristics of a typical n-p-n transistor-Bipolar device models for circuit and time-dependent analyses- Breakdown voltages

Unit No	Module Name	Micro content
4a.	Bipolar Devices	Bipolar devices/types
		n-p-n transistor/ideal c-v characteristics
		n-p-n transistor/typical c-v characteristics
4b.	Bipolar device models	Bipolar device model /time dependent analysis

		Bipolar device model/breakdown voltages

Unit–5: BIPOLAR DEVICE DESIGN (15hrs)

Design of the emitter design- Design of the base region-Design of the collector design- Modern bipolar transistor structures

Unit No	Module Name	Micro content
5a.	Bipolar device design	Basic bipolar devices
		Different modes of operation of transistor
		Common emitter transistor circuit design
		Common base transistor circuit design
		Common collector transistor circuit design
5b	Bipolar device designing applications	Modern bipolar devices& its structures
		Advantages of modern bipolar devices

Course Outcomes:

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

No	Description	POs, PSOs	KL
CO1	**Understand** the working of basic devices and physics**{Understand level, KL2}**	PO1, PSO2	1,3
CO2	**Know** the principle of operation of MOSFET and classification of MOSFET**{Apply level, KL3}**	PO1, PSO2	2,3
CO3	**Compute** the performance factors of CMOS**{Analyze level, KL4}**	PO1, PSO2	1,2
CO4	**Know**the different types of Bipolar devices and its working{**Understand Level,KL2**}	PO1, PSO2	2,3
CO5	**Design** the different modes of bipolar devices.**{Apply level, KL4}**	PO1, PSO2	1,2

Text books:

1. **“Solid State Electronic Devices “**,B. G. Streetman and S. Banerjee, PHI.
2. “**Physics of Semiconductor Devices”** S. M. Sze, , John Wiley & Sons..
3. **“Semiconductor Devices: Physics and Technology “**S. M. Sze, , John Wiley & Sons**.**
4. **“Physics of Semiconductor Devices**” Michael Shur, PHI.

Reference books:

1. **“Semiconductor Devices** “NanditaDasGupta and AmitavaDasGupta, , PHI.
2. “**Fundamentals of Solid State Electronics**” C. T. Sah, World Scientific.
3. **“Advanced Theory of Semiconductor Devices”,**Karl Hess, , IEEE Press.
4. **“Fundamentals of Semiconductor Devices “.**J.Lindmayer and C. Y. Wringley, , Affiliated East-West Press Pvt. Ltd

e-resource:

1. https://nptel.ac.in/courses/117/106/117106033/
2. https://www.researchgate.net/publication/267261216_Semiconductor_Device_Modeli

ng
3. https://en.wikipedia.org/wiki/Semiconductor_device_modeling
4. https://iitk.ac.in/new/ee616a

CO–POs& PSOs Mapping:

CO No.	PO Number												PSO Number		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3		3									3	3	
CO2	3	3											3	2	
CO3	3			3									2		1
CO4				3									3		
CO5	3		3		3	2									

II-Year-II Semester HO2201	RENEWABLE ENERGY SOURCES	L	T	P	C
		3	0	2	4

PRE-REQUISITES: 1) Basics of Solar Energy

Preamble: This course gives a flavor of renewable sources and systems to the students. It introduces solar energy its radiation, collection, storage and its applications. This covers generation, design, efficiency and characteristics of various renewable energy sources including solar, wind, hydro, and biomass. Fuel cells and geothermal systems.

Course objectives: The main objectives are

1. To study the solar radiation data, extraterrestrial radiation. Radiation on earth's surface.
2. To study solar thermal collections.
3. To study solar photo voltaic systems.
4. To study maximum power point techniques in solar pv and wind energy
5. To study wind energy conversion systems Betz coefficient systems tip speed ratio.
6. To study basic principle and working of hydro, tidal, biomass, fuel cell and geothermal systems

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Fundamentals of Energy Systems And Solar Energy (11 hrs)** **Fundamentals of Energy Systems:** Energy conversion principle, Energy Scenario, various forms of renewable energy, solar radiation, outside earth's atmosphere, earth surface, analysis of solar radiation data. **(05 hrs)** **Solar Energy:** Geometry – radiation of tilted surface, numerical problems. Liquid plate plate collectors, performance analysis – Transmissivity – Absorptivity product collector efficiency factor, collector heat remove factor. **(06 hrs)**	**CO1**
II	**Solar Thermal Systems (13 hrs)** Introduction to solar Air heaters, concentrating collectors, solar pond and solar till, Solar thermal plant, numerical problems, solar photovoltaic systems, photovoltaic cell, module, array – construction – efficiency of solar cells, developing technologies cells – I- V characteristics, equivalent circuit of solar cells, series resistance, shunt resistance, applications and systems, balance of system components, maximum power point techniques, pertube and observe technique, hill climbing technique.	**CO2**
III	**Wind Energy (12 hrs)** Sources of wind energy – wind patterns, types of turbines, horizontal axis	**CO3**

	and vertical axis machines, kinetic energy of wind, Betz coefficient, tip speed ratio, Efficiency, power output of wind turbine, selection of generators (synchronous, induction), maximum power point tracking, wind forms, power generators for utility grids.	
IV	**Hydro And Tidal Power Systems (12 hrs) HydroPower Systems:** Basic working principle, Classification of hydro systems, large, small, micro measurement of head and flow - energy equation - types of turbines , numerical problems. **(06 hrs)** **Tidal Power Systems:** Tidal power, basics, kinetic energy equation- turbines for tidal power, numerical problems, wave power basics, kinetic energy equation, wave power devices, linear generators. **(06 hrs)**	**CO4**
V	**Biomass, Fuel Cells And Geothermal Systems (10 hrs)** Energy, Fuel classification – Pyrolysis- direct combustion of heat, different digesters and sizing	**CO5**

Content Beyond the syllabus:

Application of non-conventional and renewable energy sources, Estimation of solar radiation.

List of Experiments

1. To conduct the solar retardation test.
2. To conduct its performance and analysis of solar thermal systems.
3. To draw the I-V characteristics of solar photovoltaic system.
4. To draw the equivalent circuit of solar cell.
5. To find the tip – speed – ratio of wind energy and its efficiency.
6. To write the Kinetic Energy Equation for tidal power systems.
7. To write the Kinetic Energy Equation for Hydro power systems.
8. To draw the V-I characteristics of Fuel cell.

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Analyze solar radiation data,** extraterrestrial radiation. radiation on earth's surface.**{Apply level, KL4}**
CO2	Design solar thermal collectors, solar thermal plants. **{Evaluate level, KL5}**
CO3	Design solar photo voltaic systems. **{Evaluate level, KL5}**
CO4	Develop maximum power point techniques in solar PV and wind energy systems.{**Understand level, KL2}**
CO5	**Explain** wind energy conversion systems, wind generators, power generations.**{Explain level, KL3}**

Learning Resources
Text books:

3. "Solar Energy" Principles of thermal collections and storage, S. P. Sukhatme, and J.K. Nayak, TMH ,New Delhi, 3rd edition. 4. "Renewable Energy Resources" Johan Twidell and Tony Weir, Taylor and Fancies 2rd edition, 2013.	
Reference books:	
3. "Renewable Energy" Edited by Godfrey, Boyle-Oxford University press 3rd edition, 2013. 4. "Renewable Energy Technologies/Ramesh and Kumar Narosa 5. "Renewable Energy Technologies" A Practical Guide For Beginners	
e- Resources & other digital material	
7. https://nptel.ac.in/courses/112105051	
8. https://www.tatapower.com/bussiness/renewable-energy.aspx	
9. https://www.cleanlineenergy.com/technology/wind-and-solar	
10. https://www. youtube.com/watch?=xokHLFE96h8	
11. https://www.youtube.com/watch?v=GZKKWz_tX1c	

Micro-Syllabus

Unit – 1:Fundamentals of Energy Systems And Solar Energy (13hrs)

Fundamentals of Energy Systems And Solar Energy: Energy conversion principle, Energy Scenario, various forms of renewable energy ,solar radiation, outside earth's atmosphere, earth surface, analysis of solar radiation data, Geometry – radiation of tilted surface, numerical problems. Liquid plate plate collectors, performance analysis – transmissivity – absorptive product collector efficiency factor, collector heat remove factor.

Unit No	Module	Micro content
1.Fundamentals of Energy Systems And Solar Energy	Fundamentals of Energy Systems And Solar Energy	Energy conversion principle
		Energy Scenario
		Various forms of renewable energy
		Solar radiation, outside earth's atmosphere
		Earth surface, analysis of solar radiation data
		Geometry – radiation of tilted surface
		Liquid plate plate collectors, performance analysis
		Transmissivity – Absorptive product collector
		Efficiency factor
		Collector heat remove factor
		Numerical problems.

Unit-2:Solar Thermal Systems (13 hrs)

Solar Thermal Systems: Introduction to solar Air heaters, concentrating collectors, solar pond and solar till, Solar thermal plant, numerical problems, solar photovoltaic systems, photovoltaic cell, module, array – construction – efficiency of solar cells, developing technologies cells - I- V characteristics, equivalent circuit of solar cells, series resistance, shunt resistance, applications and systems, balance of system components, maximum power point, techniques, pertube and

observe technique, hill climbing technique.		
Unit No	**Module**	**Micro content**
2. Solar Thermal Systems	Solar Thermal Systems	Introduction to solar Air heaters
		Concentrating collectors, solar pond and solar till
		Solar thermal plant (Working)
		Solar photovoltaic systems, photovoltaic cell, module
		Array – construction – efficiency of solar cells
		Series resistance, shunt resistance, applications
		Balance of system components
		Maximum power point, techniques
		Pertube and observe technique, hill climbing technique.
		Numerical problems.

Unit-3:**Wind Energy (15hrs)**

Wind Energy: Sources of wind energy – wind patterns, types of turbines, horizontal axis and vertical axis machines, kinetic energy of wind, Betz coefficient, tip speed ratio, Efficiency, power output of wind turbine, selection of generators (synchronous, induction), maximum power point tracking, wind forms, power generators for utility grids.

Unit No	Module	Micro content
3.Wind Energy	Wind Energy	Sources of wind energy
		Wind patterns - wind patterns
		Types of turbines
		Horizontal axis and vertical axis machines
		Kinetic energy of wind
		Betz coefficient, tip speed ratio
		Efficiency, power output of wind turbine
		Selection of generators (synchronous, induction)
		Maximum power point tracking, wind forms
		Power generators for utility grids.

Unit-4: Hydro And Tidal Power Systems (13hrs)

Hydro And Tidal Power Systems: Basic working principle, Classification of hydro systems, large, small, micro measurement of head and flow - energy equation - types of turbines , numerical problems, tidal power, basics, kinetic energy equation- turbines for tidal power, wave power basics, kinetic energy equation, wave power devices, linear generators.

Unit No	Module	Micro content
4. Hydro And Tidal Power	Hydro And Tidal Power Systems	Basic working principle

Systems Substations	Substations	Classification of hydro systems, large, small, micro measurement of head and flow
		Energy equation, - types of turbines
		Tidal power, basics
		Basics, kinetic energy equation
		Turbines for tidal power
		Kinetic energy equation
		Turbines for tidal power, wave power basics
		Kinetic energy equation, wave power devices, linear generators
		Numerical problems.

Unit 5:Biomass, Fuel Cells And Geothermal Systems (12 hrs)

Biomass, Fuel Cells And Geothermal Systems: Biomass Energy, Fuel classification – Pyrolysis - direct combustion of heat, different digesters and sizing.

Unit No	Module	Micro content
Biomass, Fuel Cells And Geothermal Systems	Biomass, Fuel Cells And Geothermal Systems	Biomass Energy
		Fuel classification
		Pyrolysis
		Direct combustion of heat
		Different digesters and sizing.

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

CO1	**Understand** Wind energy conversion systems, wind generators, power generation. **{Understand level, KL2}**
CO2	**Explain**. Basic principle and working of hydro, tidal, biomass, fuel cell and geothermal systems. **{Apply level, KL3}**
CO3	**Analyze** Solar photovoltaic systems **{Analyze level, KL4}**
CO4	**Evaluate** Maximum power point technique in solar PV and wind energy systems. **{Evaluate level, KL5}**
CO5	**Analyze** solar radiation data extraterrestrial radiation and radiation on earth's surface. **{Apply level, KL4}**

Text books:

1. "Solar Energy" Principles of thermal collections and storage, S. P. Sukhatme, and J.K. Nayak, TMH New Delhi, 3rd edition.
2. "Renewable Energy Resources" Johan Twidell and Tony Weir, Taylor and Francis 2rd edition, 2013.

Reference books:

1. “Renewable Energy” Edited by Godfrey, Boyle-Oxford University press 3rd edition, 2013.
2. “Renewable Energy Technologies/Ramesh and Kumar Narosa
3. “Renewable Energy Technologies” A Practical Guide For Beginners.

CO-PO Mapping:

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

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III-Year-I Semester	Engineering Economics and Management	L	T	P	C
		3	0	0	3

PRE-REQUISITES: 1) Basic Sciences and Humanities

Course objectives: The student should be able to

CO 1: To understand the concept and nature of Economics and Demand and to familiarize about the Production function, Input Output relationship, Cost-Output relationship and Break Even Analysis.

CO 2: To understand the nature of markets and the concepts of Money and RBI functions.

CO 3: To familiarize with the process of management, principles, and to provide conceptual knowledge on functional management that is on Human resource management and Marketing management.

CO 4: To learn different Accounting Systems, preparation of Financial Statement and to familiarize with the tools of project Management.

CO 5: To understand the concept of Capital, Capital Budgeting and the techniques used to evaluate Capital Budgeting proposals.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction to Economics and Theory of Production** **13 Hrs** Introduction to Economics; Definitions, Nature, Scope, Difference between Microeconomics & Macroeconomics –Concept of Demand, Types of Demand, Determinants of Demand-Law of Demand -Elasticity of Demand, Types of Elasticity of Demand. Theory of production; production function, Law of variable proportions & law of returns to scale, Cost; meaning, short run & long run cost, fixed cost, variable cost, total cost, average cost, marginal cost, opportunity cost. Break even analysis; meaning, explanation, simple problems.	**CO1**
II	**Introduction to Markets and Money** **12 Hrs** Markets: meaning, types of markets & their characteristics (Perfect Competition, Monopoly, Monopolistic Completion, Oligopoly). National Income, GNP, GDP, NNP, NDP, Personal income and GST (Goods & Service Tax). Money: meaning, functions, types, Monetary policy- meaning, objectives, tools, fiscal policy-meaning, objectives, tools, Banking; meaning, types, functions, Central Bank-RBI; its functions, concepts; CRR, bank rate, repo rate, reverse repo rate, SLR.	**CO2**
III	**Introduction to Management** **12 Hrs** Concept –nature and importance of Management Functions of Management, Principles of Management. Human Resource Management: Meaning and difference between Personnel Management and Human Resource Management, Functions of Human Resource	**CO3**

	Management. Marketing Management: Functions of Marketing - Marketing strategies based on product Life Cycle, Channels of distributions.	
IV	**Introduction to Accounting & Project Management** **15 Hrs** Introduction to Double Entry System, Journal, Ledger, Trail Balance and Preparation of Final Accounts with adjustments – Preparation of Financial Statements. Project Management: (PERT/CPM): Development of Network – Difference between PERT and CPM Identifying Critical Path (Simple Problems).	**CO4**
V	**Capital and Capital Budgeting:** **12 Hrs** Capital Budgeting: Meaning of Capital-Capitalization-Meaning of Capital Budgeting-Time value of money- Methods of appraising Project profitability: Traditional Methods (payback period, accounting rate of return) and modern methods (Discounted cash flow method, Net Present Value method, Internal Rate of Return Method and Profitability Index).	**CO5**

Content Beyond the syllabus:

Introduction to Managerial Economics and demand Analysis: Managerial Economics, Nature & Scope, Demand forecasting for new products, Concept of supply**.**

Theory of Production and Cost Analysis: Production Process, Types of production, ISO- Quants, ISO Costs.

Introduction to Markets and Money: Price Output determination, Pricing Methods and Stock Market and inflation influence on industry.

Introduction to Management: Evolution of Management thought, theories of Motivation, Leadership styles.

Project Management: Brief about Project crashing.

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	The Learner is equipped with the knowledge of estimating the Demand and demand elasticity's for a product and Input-Output-Cost relationships.
CO2	The Learner is also ready to understand the nature of different markets and also to have the knowledge of Money & Banking.
CO3	The Learner will acquire the knowledge on management, HRM and Marketing.
CO4	The Learner will acquire the knowledge to prepare Financial Statements and the techniques of project management.
CO5	The Learner can able to evaluate various investment project proposals with the help of capital budgeting techniques for decision making.

Learning Resources
Text books:

1. Dr. A. R. Aryasri – Managerial Economics and Financial Analysis, TMH 2018, 2e.
2. Dr. N. Appa Rao, Dr. P. Vijay Kumar: 'Managerial Economics and Financial Analysis', Cengage Publications, New Delhi – 2012.
3. Management Science, Aryasri, Tata McGraw Hill, 2014.
4. Dr. P. Vijaya Kumar & Dr. N. Appa Rao, 'Introduction to *Management Science'* Cengage, Delhi, 2012.
5. Engineering Economy and Management 1 Edition Pravin Kumar – Wiley Publication.
6. Engineering Economics & Management- Dr. Vilas Kulkarni & HardikBavishi - Vikas Publishing.

Reference books:

1. R. L Varshney, K.L. Maheshwari : Managerial Economics, Sultan Chand&Sons 2014,22e.
2. Suma Damodaran : Managerial Economics, Oxford 2010,2e.
3. Ambrish Gupta: 'Financial Accounting for Management', Pearson 2015,5e.
4. Dr. S.N. Maheswari: Financial Accounting, Vikas Publications 2018.
5. S. A. Siddiqui & A. S. Siddiqui: Managerial Economics and Financial Analysis, New Age International Publishers, 2017.
6. Principles of Marketing: A South Asian Perspective, Kotler Philip, Gary Armstrong, Prafulla Y. Agnihotri, and Eshan ul Haque , 17th Edition, Pearson Education/ Prentice Hall of India, 2018.
7. Human Resource Management: Gary Dessler, 14th Edition, pearson 2015.
8. Project Planning and Control with PERT and CPM: Dr. B. C. Punmia, K. K Khandelwal, Laxmi Publication, 2017, 4th Edition.

e- Resources & other digital material

1. www.managementstudyguide.com
2. www.tutorialspoint.com
3. www.lecturenotes.in

Micro-Syllabus: Engineering Economics and Management

UNIT – I Introduction to Economics and Theory of Production 13 Hrs

Introduction to Economics; Definitions, Nature, Scope, Difference between Microeconomics & Macroeconomics –Concept of Demand, Types of Demand, Determinants of Demand-Law of Demand -Elasticity of Demand, Types of Elasticity of Demand.

Theory of production; production function, Law of variable proportions & law of returns to scale, Cost; meaning, short run & long run cost, fixed cost, variable cost, total cost, average cost, marginal cost, opportunity cost. Break even analysis; meaning, explanation, simple problems.

Unit	Module	Micro Content
Unit I	Concept of Economics	Economics, Definitions of Economics
		Micro economics, Macro economics
		Scope of Micro & Macro Economics
		Difference Between Micro & Macro Economics
		Meaning & Definitions of Managerial Economics
	Basic Economic tools of Managerial	Opportunity cost Principle

	economics	
	Concept of Demand	What is Demand, Demand Analysis & Objectives
	Types of Demand	Demand distinctions, Demand function
		Factors determining demand
	Demand Schedule	Individual demand schedule, Market demand schedule
	Demand Curve	Individual demand curve, Market demand curve
	Law of Demand	Assumption of law of demand, Change in demand, Exceptions of law of demand, why does demand curve slope downwards.
	Elasticity of Demand, Types of Elasticity of Demand & Measurement	Meaning of elasticity of demand, types of Price and income elasticity of demand, factors effecting elasticity of demand, measurements of elasticity of demand, significance of elasticity of demand
	Theory of Production	Production function, Production process, importance of production, assumptions
	Laws of Returns to scale	Schedule and graph
	Cost Analysis	Types of costs, cost & output relationship in short run and long run
	Break even Analysis	Uses, limitations of Break even analysis, Key terminology in Break analysis, Simple problems on BEP, graphical representation of Break even analysis.
UNIT - II Introduction to Markets and Money: 12 Hrs Markets: meaning, types of markets & their characteristics (Perfect Competition, Monopoly, Monopolistic Completion, Oligopoly).National Income, GNP, GDP, NNP, NDP, Personal income and GST (Goods & Service Tax). Money: meaning, functions, types, Monetary policy- meaning, objectives, tools, fiscal policy-meaning, objectives, tools, Banking; meaning, types, functions, Central Bank- RBI; its functions, concepts; CRR, bank rate, repo rate, reverse repo rate, SLR.		
Unit II	Market Structures	Meaning, definitions, types of market
	Perfect Competition	Features
	Monopoly	Features
	Monopolistic competition	Features
	Oligopoly	features
	Macro Economics	National income, ,GNP, GDP, NNP, NDP, Personal Income and GST
	Money	Functions, types
		Monetary Policy

<table>
<tr><td rowspan="4"></td><td></td><td>Fiscal Policy</td></tr>
<tr><td>Banking</td><td>Types, Functions</td></tr>
<tr><td>RBI</td><td>Concept and functions</td></tr>
<tr><td>Bank Rates</td><td>CRR, bank rate, repo rate, reverse repo rate, SLR</td></tr>
<tr><td colspan="3">UNIT – III Introduction to Management: 12 Hrs
Concept –nature and importance of Management Functions of Management, Principles of Management.
Human Resource Management: Meaning and difference between Personnel Management and Human Resource Management, Functions of Human Resource Management.
Marketing Management: Functions of Marketing - Marketing strategies based on product Life Cycle, Channels of distributions.</td></tr>
<tr><td rowspan="9">Unit III</td><td>Management</td><td>Concepts, functions, Principles</td></tr>
<tr><td rowspan="3">HRM</td><td>Concepts of HRM, Personnel Management</td></tr>
<tr><td>Diff B/w HRM & PM</td></tr>
<tr><td>Function of HRM</td></tr>
<tr><td rowspan="5">Marketing Management</td><td>Concepts of Marketing</td></tr>
<tr><td>Functions of Marketing</td></tr>
<tr><td>Product Life Cycle</td></tr>
<tr><td>Marketing strategies based on product Life Cycle</td></tr>
<tr><td>Channels of distributions.</td></tr>
<tr><td colspan="3">UNIT – IV Introduction to Accounting & Project Management 15 Hrs
Introduction to Double Entry System, Journal, Ledger, Trail Balance and Preparation of Final Accounts with adjustments – Preparation of Financial Statements.
Project Management: (PERT/CPM): Development of Network – Difference between PERT and CPM Identifying Critical Path (Simple Problems).</td></tr>
<tr><td rowspan="6">Unit IV</td><td>Financial Accounting</td><td>Meaning, definitions, objectives & significance, users of accounting, accounting cycle, GAAP.</td></tr>
<tr><td>Book Keeping</td><td>Single and double entry book keeping, types of Accounting</td></tr>
<tr><td>Journal</td><td>Features, Pro-forma, Advantages & Limitations, preparation of journal entries, simple problems</td></tr>
<tr><td>ledger</td><td>Features, Pro-forma, Advantages & Limitations, preparation of ledger, simple problems.</td></tr>
<tr><td>Trial Balance</td><td>Features, Pro-forma, Advantages & Limitations, preparation of Trial balance, simple problems.</td></tr>
<tr><td>Final accounts</td><td>Trading account- Pro-forma, Simple problems</td></tr>
</table>

		Profit & Loss account- Pro-forma, Simple problems
		Preparation of balance sheet with simple adjustments
	Project Management	Net work Analysis –Simple Problems
		PERT – Simple Problems
		CPM – Simple Problems
		Diff B/w PERT & CPM

UNIT - V Capital and Capital Budgeting **12 Hrs**

Capital Budgeting: Meaning of Capital-Capitalization-Meaning of Capital Budgeting-Time value of money- Methods of appraising Project profitability: Traditional Methods (payback period, accounting rate of return) and modern methods (Discounted cash flow method, Net Present Value method, Internal Rate of Return Method and Profitability Index).

Unit V	Capital	What is capital, need of capital types of capital
		Types of fixed capital, types of working capital
	Capital Budgeting	Meaning, Nature & scope of capital budgeting
		Capital budgeting procedure, capital budgeting decisions, method of capital budgeting.
	Payback period	Meaning, formula, advantages & disadvantages, simple problems
	Accounting rate of return(ARR)	Meaning, formula, advantages & disadvantages, simple problems
	Net present value (NPV)	Meaning, formula, advantages & disadvantages, simple problems
	Profitability index (PI)	Meaning, formula, advantages & disadvantages, simple problems
	Internal rate of return (IRR)	Meaning, formula, advantages & disadvantages, simple problems

CO-PO mapping Table

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	1	1	-	-	-	-	1	-	1	1	2	-
CO 2	1	2	-	-	-	1	1	-	1	-	2	-
CO 3	-	-	-	-	-	1	1	1	1	1	2	-
CO 4	1	2	-	3	-	-	1	-	1	2	2	-

III-Year-I Semester	Power Systems-II	L	T	P	C
		3	0	0	3

PRE-Requisites. Electrical circuit Analysis
ii. Power Systems-I

Course objectives: The students should be able to

1. To study the short, medium and long length transmission lines, their models and performance.
2. To study the effect of travelling waves on transmission lines.
3. To study the factors affecting the performance of transmission lines and power factor improvement methods.
4. To discuss sag and tension computation of transmission lines as well as to study the performance of overhead insulators.
5. To discuss computation of Z_{bus} and Y_{bus} of power system

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Performance of Transmission Lines** Classification of Transmission Lines – Short, medium, long line and their model representations –Nominal-T–Nominal-Pie and A, B, C, D Constants for symmetrical and Asymmetrical Networks– Numerical Problems– Mathematical Solutions to estimate regulation and efficiency of all types of lines – Numerical Problems. **Performance of Long Transmission Lines**–Rigorous Solution – Evaluation of A,B,C,D Constants– Interpretation of the Long Line Equations, regulation and efficiency–Representation of Long Lines – Equivalent-T and Equivalent Pie network models (Numerical Problems). **(10 hrs)**	**CO1**
II	**Travelling waves** Incident, Reflected and Refracted Waves –Surge Impedance and SIL of Long Lines–Wavelength and Velocity of Propagation of Waves **Power system Transients** Types of System Transients – Travelling or Propagation of Surges – Attenuation–Distortion– Reflection and Refraction Coefficients – Termination of lines with different types of conditions – Open Circuited Line–Short Circuited Line – T-Junction– Lumped Reactive Junctions. **(10 hrs)**	**CO2**
III	**Various Factors governing the Performance of Transmission line** Skin and Proximity effects – Description and effect on Resistance of Solid Conductors – Ferranti effect – Charging Current –Shunt Compensation –Corona – Description of the phenomenon–Factors affecting corona–Critical voltages and power loss – Radio Interference. **(12 hrs)**	**CO3**

IV	**Sag and Tension Calculations and Overhead Line Insulators** Sag and Tension calculations with equal and unequal heights of towers–Effect of Wind and Ice on weight of Conductor–Numerical Problems – Stringing chart and sag template and its applications–Types of Insulators – String efficiency and Methods for improvement– Numerical Problems – Voltage distribution–Calculation of string efficiency–Capacitance grading and Static Shielding. **(10 hrs)**	**CO4**
V	**Bus Admittance Matrix & Bus Impedance Matrix** **Bus Admittance Matrix (Ybus):** Per Unit systems, Single line diagram, Impedance diagram of a power system, Primitive network representation, Formation of Ybus matrix by direct inspection method. Numerical Problems. **Bus Impedance Matrix (Zbus):** Formation of Zbus matrix by building algorithm, Modification of Zbus for the changes in network, Numerical Problems (3 bus system only). **(12 hrs)**	**CO5**
Content Beyond the syllabus: ➢ Importance of Slack bus, PQ bus and PV bus. ➢ Transients in transmission lines		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** about the performance of various transmission systems**{Understand level, KL2}**
CO2	**Understand**about Travelling waves and transients in power transmission systems **{Understand level, KL2}**
CO3	**Analyze** various factors related to charged transmission lines **{Analyze level, KL4}**
CO4	**Understand**sag/tension of transmission lines and performance of line insulators**{Understand level, KL2}**
CO5	**Analyze** about calculation of Y_{bus} and Z_{bus} matrices **{Apply level, KL4}**

Learning Resources
Textbooks:
1. Electrical power systems – by C.L.Wadhwa, New Age International (P) Limited, Publishers, 1998. 2. Modern Power System Analysis by I.J.Nagarath and D.P.Kothari, Tata McGraw Hill, 2nd Edition.
Reference books:
1. Power system Analysis–by John J Grainger William D Stevenson, TMC Companies, 4th edition 2. Power System Analysis and Design by B.R.Gupta, Wheeler Publishing. 3. A Text Book on Power System Engineering by M.L.Soni, P.V.Gupta, U.S.BhatnagarA.Chakrabarthy, DhanpatRai& Co Pvt. Ltd. 4. Electrical Power Systems by P.S.R. Murthy, B.S.Publications.
e- Resources & other digital material
1. https://nptel.ac.in/courses/108105104
2. https://www.vssut.ac.in/lecture_notes/lecture1424265031.pdf

3. https://www.academia.edu/6923342/LECTURE_NOTES_COURSE_POWER_SYSTEMS_II
4. https://www.powertransmission.com/articles/1702
5. https://www.powertransmissionworld.com/

Micro-Syllabus- Power Systems-II

Unit – 1: Performance of Transmission Lines

Classification of Transmission Lines – Short, medium, long line and their model representations – Nominal-T–Nominal-Pie and A, B, C, D Constants for symmetrical and Asymmetrical Networks–Numerical Problems– Rigorous Solution (for long transmission lines) –Interpretation of the Long Line Equations- Mathematical Solutions to estimate regulation and efficiency of all types of lines – Numerical Problems. (12 Hrs)

Unit	Module	Micro content
Performance of Transmission lines	**Short, Medium and Long transmission lines**	Classification of transmission lines
		Representation of transmission lines
		Nominal-T, Nominal pie representations of medium and long transmission lines
		Regulation, efficiency and ABCD constants of short, medium and long transmission line
		Rigorous solution for long transmission line
		Numerical problems

Unit-2:

Travelling waves

Incident, Reflected and Refracted Waves –Surge Impedance and SIL of Long Lines–Wave Length and Velocity of Propagation of Waves (5 Hrs)

Power system Transients

Types of System Transients – Travelling or Propagation of Surges – Attenuation–Distortion–Reflection and Refraction Coefficients – Termination of lines with different types of conditions – Open Circuited Line–Short Circuited Line – T-Junction– Lumped Reactive Junctions. (5 Hrs)

Unit	Module	Micro content
2 (a) Travelling waves	**Travelling waves**	Incident, Reflected and Refracted voltage and current waves coefficients
		Surge Impedance Loading
		Wavelength and velocity of propagation of waves
		Numerical problems
2(b) Power System transients	**Power System transients**	Types of system transients
		Travelling or Propagation of surges
		Attenuation–Distortion Reflection and Refraction Coefficients (elementary treatment only)
		Termination of lines with different types of conditions ➢ Open circuit

<table>
<tr><td></td><td></td><td>➢ Short circuit
➢ T junction
➢ Lumped reactive junctions
➢ Mathematical calculation
➢ Numerical problems</td></tr>
<tr><td colspan="3">Unit-3: Various Factors governing the Performance of Transmission line
Skin and Proximity effects – Description and effect on Resistance of Solid Conductors – Ferranti effect – Charging Current –Shunt Compensation –Corona – Description of the phenomenon–Factors affecting corona–Critical voltages and power loss – Radio Interference. (12 hrs)</td></tr>
<tr><td>Unit</td><td>Module</td><td>Micro content</td></tr>
<tr><td rowspan="3">Various Factors governing the Performance of Transmission line</td><td rowspan="3">Various Factors governing the Performance of Transmission line</td><td>Skin and Proximity effect
➢ Description and effect on Resistance of Solid Conductors</td></tr>
<tr><td>Ferranti effect
➢ Charging current
➢ shunt compensation
➢ Numerical problems</td></tr>
<tr><td>Corona
➢ Description of the phenomenon
➢ Factors affecting corona
➢ Critical voltages and power loss
➢ Radio Interference
➢ Numerical problems</td></tr>
<tr><td colspan="3">Unit-4:Sag and Tension Calculations and Overhead Line Insulators
Sag and Tension calculations with equal and unequal heights of towers–Effect of Wind and Ice on weight of Conductor–Numerical Problems – Stringing chart and sag template and its applications–Types of Insulators – String efficiency and Methods for improvement– Numerical Problems – Voltage distribution–Calculation of string efficiency–Capacitance grading and Static Shielding.
(12 Hrs)</td></tr>
<tr><td>Unit</td><td>Module</td><td>Micro content</td></tr>
<tr><td>4 (a) Sag and Tension calculations</td><td>Sag and Tension calculations</td><td>Sag and tension calculations
➢ Definition of Sag and Tension of transmission line
➢ Sag and Tension calculations with equal and unequal heights of towers
➢ Effect of Wind and Ice on weight of Conductor
➢ Numerical Problems
➢ Stringing chart and sag template and its applications (Basic idea)</td></tr>
</table>

4 (b) Insulators	**Insulators**	Insulators ➢ Definition and various types ➢ String efficiency ➢ Voltage distributions ➢ Methods for improving string efficiency ➢ Numerical problems ➢ Capacitance grading and static shielding
Unit-5: Bus Admittance Matrix & Bus Impedance Matrix **Bus Admittance Matrix (Ybus):** Per Unit quantities, Single line diagram, Impedance diagram of a power system, Primitive network representation, Formation of Ybus matrix by direct inspection method. Numerical Problems. **Bus Impedance Matrix (Zbus):** Formation of Zbus matrix by building algorithm, Modification of Zbus for the changes in network, Numerical Problems (3 bus system)		
Unit	**Module**	**Micro content**
5(a) Bus Admittance matrix	**Bus Admittance Matrix (Ybus)**	Bus admittance matrix ➢ Per unit quantities ➢ Single line diagram ➢ Impedance diagram of power system ➢ Primitive network representation ➢ Formation of Ybus matrix by direct inspection method. ➢ Numerical Problems.
5(b) Bus Impedance Matri x (Zbus)	**Bus Impedance Matrix (Zbus)**	**Bus Impedance Matrix (Zbus)** ➢ Formation of Zbus matrix by building algorithm ➢ Modification of Zbus for the changes in network ➢ Numerical Problems (upto 3 bus system)

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	2													
CO2	2												1	
CO3	2	1												
CO4	2	2	1											1
CO5	2	1												1

III-Year-I Semester	ELECTRICAL MEASUREMENTS & INSTRUMENTATION	L	T	P	C
		3	0	0	3

PRE-REQUISITES: 1) Basic Circuit Analysis

Course objectives: The student should be able to

1. Study the principle of operation and working of different types of instruments for measurement of electrical quantities.
2. Study the working principle of operation of different types of instruments for measurement of power and power factor, energy and frequency.
3. Understand the principle of operation and working of various types of bridges for measurement of parameters –resistance, inductance, capacitance and frequency.
4. Know the principle of operation and working of transducers.
5. Study the principle of operation and working of DVMs, DMM and other digital instruments

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Measuring Instruments & Instrument Transformers: (12 hrs)**Error analysis; Classification – Deflecting, Controlling and Damping torques – PMMC, MI, Electrodynamometer type instruments – Expression for torque. Extension of ranges using Shunts and Multipliers-numerical problems. Instrument transformers: C.T & P.T: Principle of operation and working.	**CO1**
II	**Measurement of Power, Power factor & frequency: (15 hrs)** **Single phase and three phase dynamometer wattmeter: LPF and UPF; Expression for deflecting and control torques; Measurement of active and reactive powers in balanced and unbalanced systems-Numerical problems. (09 hrs)** **Type of P.F. Meters – Single phase and three phase dynamometer and moving iron type (Elementary treatment only) (02 hrs)** **Electrical resonance type frequency meter and Weston typesynchroscope, Phase sequence indicator (Elementary treatment only) (04 hrs)**	**CO2**
III	**Potentiometers & Bridges (12 hrs)** **Potentiometers:** Principle and operation of D.C. Crompton's potentiometer – Standardization – Measurement of unknown resistance – Current – Voltage. AC Potentiometers: polar and coordinate types – Standardization (Elementary treatment only). **(06 hrs)** **Bridges:** Kelvin's double bridge, Wheat stone's bridge, Measurement of high resistance by loss of charge methods – Megger; Measurement of Inductance & Capacitance: Maxwell' bridge, Anderson's bridge, Hays bridge, Wien's bridge, Schering's bridge, Wagner's earth device. **(06 hrs)**	**CO3**
IV	**Transducers (12 hrs)**	**CO4**

	Transducers: Q-meters, Definition and Classification of Resistive, Inductive and Capacitive Transducer, LVDT, Strain Gauge,Thermistors, Thermocouples, Piezo electric and Photo Diode Transducers, measurement of non-electrical quantities – Pressure- Angular velocity- liquid level.	
V	**Digital Meters: (10 hrs)** Advantages of Digital meters**,** Principle of operation of Ramp, dual–Slope integration continuous balance type DVM's - Successive approximation DVM's, digital multi-meters, digital phase & frequency meters and digital tachometer.	**CO5**
Content Beyond the syllabus: NIL		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Choose suitable instrument for measurement of ac and dc Electrical quantities. **{Understand level, KL2}**
CO2	Understand the concepts used in measurement of power, power factor, and frequency & know the application of synchroscope and sequence indicators. **{Understand level, KL2}**
CO3	Select suitable bridge for measurement of electrical parameters. **{Apply level, KL3}**
CO4	Acquire proper knowledge to use various types of Transducers and able to measure various non-electric quantities. **{Apply level, KL3}**
CO5	Acquire proper knowledge and working principle of various types of digital instruments. **{Understand level, KL2}**

Learning Resources
Text books:
1. Electrical & Electronic Measurement & Instruments by A.K.Sawhney, Dhanpat Rai & Co 17th edition 2000. 2. Electronic Instrumentation by H S Kalsi, 2nd Edition, McGraw-Hill Publishing, 2004. 3. Electrical Measurements and measuring Instruments - by E.W. Golding and F.C. Widdis, 5th Edition, Wheeler Publishing, 1999.
Reference books:
1. Electrical and Electronic Measurements and instrumentation by R.K.Rajput, S.Chand 2. Electrical Measurements by Harris John Wiley. 3. Electrical Measurements: Fundamentals, Concepts, Applications – by Reissland, M.U, New Age International (P) Limited, Publishers.
e- Resources & other digital material
1. https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ee44
2. http://www.facstaff.bucknell.edu/mastascu/elessonshtml/Measurements/MeasIntro.htm
3. http://www.electrical4u.com/electrical-measuring-instruments-types-accuracy-precision-resolutionspeed/

Micro-Syllabus- ELECTRICAL MEASUREMENTS & INSTRUMENTATION

Measuring Instruments & Instrument Transformers: (12 hrs)

Error analysis; Classification – Deflecting, Controlling and Damping torques – PMMC, MI, Electrodynamometer type instruments – Expression for torque. Extension of ranges using Shunts and Multipliers-numerical problems. Instrument transformers: C.T & P.T: Principle of operation and working.

Unit	Module	Micro content
(A) Measuring Instruments	Error analysis	Error analysis: Definitions of true value, static error, accuracy, precision, sensitivity, linearity, hysteresis, threshold, dead time, dead zone, limiting errors, relative limiting errors, simple problems on limiting errors only
	Classification, Torques	Classification of instruments
		Deflecting, Controlling and damping torques
	PMMC, MI, ED, ES type instruments, Expression for torque	PMMC instruments: Torque equation, merits & demerits
		MI instruments: Torque equation, merits & demerits
		ED instruments: torque equation, merits & demerits
(B) Range extension & Instrument transformer	Extension of ranges using Shunts and Multipliers-numerical problems	Extension of range of PMMC and MI instruments
		Simple Numerical problems on extension of range of instruments
	Instrument transformers: C.T & P.T	Use of Instrument transformers, ratios of instrument transformers, burden
		CT: Principle of operation and working, effect of CT secondary open circuit
		PT: Principle of operation and working

Measurement of Power, Power factor & Frequency: (15 hrs)

Single phase and three phase dynamometer wattmeter: LPF and UPF; Expression fordeflecting and control torques; Measurement of active and reactive powers in balanced and unbalancedsystems-Numerical problems. (09 hrs)

Type of P.F. Meters – Single phase and three phase dynamometer and moving irontype (Elementary treatment only) (02 hrs)

Electrical resonance type frequency meter and Weston typesynchroscope, Phase sequence indicator (Elementary treatment only) (04 hrs)

Unit	Module	Micro content
(A) Measurement of Power, Power factor	Measurement of Power and Power factor	Power in DC & AC circuits
		Electrodynamometer type wattmeter construction, theory, shape of scale
		Errors in ED type wattmeter's and compensation
		LPF wattmeter

	Power in Polyphase circuits	Power measurement in polyphase circuits
		Measurement of Reactive power and simple numerical problems on power measurement
	Power factor meters	Principle of operation of ED & MI power factor meter (Elementary treatment only)
(B) Measurement of Frequency & phase sequence	Frequency meters, synchroscope, phase sequence indicators Applications (elementary treatment only)	Electrical resonance type frequency meter Weston type synchroscope Phase sequence indicators: static and rotating

Potentiometers & Bridges (12 hrs)

Potentiometers: Principle and operation of D.C. Crompton's potentiometer – Standardization – Measurement of unknown resistance – Current – Voltage. AC Potentiometers: polar and coordinate types – Standardization (Elementary treatment only). **(06 hrs)**

Bridges: Kelvin's double bridge, Wheat stone's bridge,Measurement of high resistance by loss of charge methods – Megger; Measurement of Inductance & Capacitance: Maxwell' bridge, Anderson's bridge, Hays bridge, Wien's bridge, Schering's bridge, Wagner's earth device. **(06 hrs)**

Unit	**Module**	**Micro content**
(A) Potentiometers	DC Potentiometer	Basic potentiometer circuit, Laboratory type Crompton's potentiometer, multi range potentiometer, standardization procedure
	Applications of potentiometer	Measurement of resistance, Current, voltage, power using potentiometer, Volt ratio box
	AC potentiometers	Polar type potentiometer (elementary treatment only)
		Coordinate type potentiometer (elementary treatment only)
(B) Bridges	Measurement of resistance	Low resistance: Kelvin's double bridge
		Medium resistance: whetstones bridge
		High resistance: Loss of charge method, Megger and simple problems on measurement of high resistance
	Measurement of Inductance	General form & equation for bridge balance, detectors for AC bridges
		Maxwell's bridge, Hays bridge, Andersons bridge and simple problems
	Measurement of capacitance	De Sauty's bridge, Schering bridge, Wien's bridge, Wagner's earth device and simple problems

Transducers (12 hrs)

Transducers: Q-meters, Definition and Classification of Resistive, Inductive and Capacitive Transducer, LVDT, Strain Gauge,Thermistors, Thermocouples, Piezo electric and Photo Diode Transducers, measurement of non-electrical quantities – Pressure- Angular velocity- liquid level.

Unit	Module	Micro content
(A) Transducers	Q-meters	Principle and operation of LCR Q-meters
	Definitions, Classification of Transducers	Transducers, electrical transducers, advantages
		Classification based principle of transduction, primary and secondary; Active & Passive
	Thermistors	Construction, Resistance-Temperature characteristics & application to measurement of temperature
	Thermocouples	Construction, application to measurement of temperature, advantages and disadvantages
	LVDT	Construction, principle of operation, application to measurement of displacement, advantages and disadvantages
	Strain gauge	Theory, gauge factor, gauge sensitivity, strain measurement on cantilever beam
(B) Transducers	Piezo electric transducer & Photo diode transducer	Theory, working, applications of Piezo electric materials
		Semi-conductor photo diode theory and applications
	Measurement of non-electrical quantities	Pressure ((inductive, Capacitive methods), angular velocity (AC and DC Tachometer), Liquid level (Capacitive, Float type and ultrasonic method)

Digital Meters: (10 hrs)

Advantages of Digital meters**,** Principle of operation of Ramp, dual–Slope integration continuous balance type DVM's - Successive approximation DVM's, digital multi-meters, digital phase & frequency meters and digital tachometer.

Unit	Module	Micro content
(A) Voltmeters	Digital meters	Block diagram, Merits & demerits
	Digital voltmeters	Principle and operation of Ramp type DVM
		Principle and operation of Dual slope type DVM
		Principle and operation of integrating type DVM
		Principle and operation of successive approximation type DVM
(B) DMM, DFM	Digital Multimeters	Principle and operation of DMM
	Digital phase &	Principle and operation of digital phase meter

	frequency meter, tachometer	Principle and operation of frequency meter
		Principle and operation of tachometer

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1									
CO2	3	3	1									
CO3	3	2										
CO4	2		1									
CO5	2											

III-Year-I Semester	Power Electronics	L	T	P	C
		3	0	0	3

PRE-REQUISITES: 1. Basic Circuit Analysis
2. Basics of Electronics
3. Concepts of Integrations

Preamble: It is very common to use power converters in all the systems of engineering. So it is compulsory for the students to imbibe the concepts of power electronics. This course covers characteristics of semiconductor devices, AC-DC, DC-DC, AC-AC and DC-AC converters.

Course objectives: The main objectives are

11. To study the characteristics of various power semiconductor devices and to design firing circuits for SCR.
12. To understand the operation of single phase full–wave converters and analyse harmonics in the input current.
13. To study the operation of three phase full–wave converters.
14. To understand the operation of choppers and AC-AC converters.
15. To understand the operation of inverters and application of PWM techniques for voltage control and harmonic mitigation.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Power Semi-Conductor Devices (12 hrs)** Static Characteristics of power MOSFET and power IGBT, Silicon controlled rectifier (SCR): Basic theory of operation of SCR–Static characteristics–Dynamic characteristics of SCR - Turn on and turn off methods– Firing circuits of SCR-Snubber circuit design, Single phase diode bridge rectifier.	**CO1**
II	**Single-Phase AC-DC Converters (12 hrs)** Half wave controlled converter, Full wave controlled converters: Half controlled bridge converter with R and RL loads–continuous and discontinuous conduction, Fully controlled bridge converter with R and RL loads–continuous and discontinuous conduction, Effect of source inductance in fully controlled bridge rectifier with continuous conduction.	**CO2**
III	**Three-Phase AC-DC Converters (12 hrs)** Three-phaseHalf controlled bridge converter with R and RL loads: continuous and discontinuous conduction, Three-phaseFully controlled bridge converter with R and RL loads: continuous and discontinuous conduction, 3-phase semi controlled rectifier with R and RL load, Three-phase Dual converter.	**CO3**

IV	**DC–DC Converters** **(12 hrs)** Introduction to Choppers, Classifications of Choppers, Analysis of Buck, Boost and Buck-Boost converters in Continuous Conduction Mode only. (05 hrs) **AC – AC Regulators.** Integral cycle control, Single phase-controlled AC voltage controller with R and RL loads , Single phase bridge Cycloconverters with R-load only. (07 hrs)	**CO4**
V	**DC–AC Converters** **(12 hrs)** Single- phase full bridge inverters with R and RL loads, Unipolar and Bipolar switching, 3-phase inverters: 120^0 and 180^0 conduction modes, PWM Inverters, Sinusoidal pulse width modulation method, Current Source Inverter (CSI). Real time applications: UPS operation.	**CO5**
Content Beyond the syllabus: Power diode, Series and parallel operation of SCR's, Three phase uncontrolled Rectifiers, Series inverter.		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Design** firing circuits for SCR. **{Apply level, KL4}**
CO2	**Evaluate** the performance of converters and can suggest the converter required for DC drives. **{Evaluate level, KL5}**
CO3	**Analyze** the source current harmonics. **{Analyze level, KL4}**
CO4	**Understand** the operation of different types of DC-DC converters**{Understand level, KL2}**
CO5	**Explain** the operation of inverters and application of PWM techniques for voltage control and harmonic mitigation. **{Explain level, KL3}**

Learning Resources

Text books:

5. "Power Electronics" M.D.Singh, K B Khanchandani, 2nd edition, Tata Mc-Graw Hill publishers,2007.
6. "Power Electronics" P.S.Bhimbra, 3rd edition, Khanna Publishers, 2002.
7. "Power Electronics" Daniel W.Hart, 1st edition, Tata Mc-Graw Hill publishers,2011.

Reference books:

6. "Power Electronics: Circuits, Devices and Applications" M. Harnur Rashid, 3rd edition, Pearson, 2009.
7. "Power Electronics: converters, applications & design" Ned Mohan, Tore M. Undeland, W.P. Riobbins 3rd edition,Wiley India Pvt. Ltd,2009.
8. "Thyristorised Power Controllers" G. K. Dubey, S.R.Doradla, A.Joshi, R. M. K.Sinha, 1st edition, New Age International (P) Limited Publishers, 1996

e- Resources & other digital material

1. https://nptel.ac.in/noc/courses/noc21/SEM1/noc21-ee01/

2.	https://www.coursera.org/learn/power-electronics
3.	https://www.classcentral.com/course/powerelectronics-716
4.	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-334-power-electronics-spring-2007/lecture-notes/

Micro-Syllabus: Power Electronics

Unit-1:Power Semi-Conductor Devices (12 hrs)

Static Characteristics of power MOSFET and power IGBT, Silicon controlled rectifier (SCR): Basic theory of operation of SCR–Static characteristics–Dynamic characteristics of SCR - Turn on and turn off methods– Firing circuits of SCR-Snubber circuit design, Single phase diode bridge rectifier.

Unit	Module	Micro content
1.a static Characteristics of MOSFET, IGBT & SCR	**Operation modes of Devices, Static V-I Characteristics, SCR Operation**	Basics of converter topologies
		Device symbols and I-V characteristics (Ideal)
		Power MOSFET operation
		Power IGBT operation
		Operation of SCR–Static characteristics, Dynamic characteristics of SCR, Two transistor analogy
1.b SCR Switching Characteristics and Protection	**Turn ON and Turn OFF methods, Protection of SCR**	Turn on mechanisms of SCR
		R,RC& UJT firing circuits
		Class A,B,C.D,E & F commutation methods
		Snubber circuit design

Unit-2: Single-Phase AC-DC Converters (12 hrs)

Half wave-controlled converter, Full wave controlled converters: Half controlled bridge converter with R and RL loads–continuous and discontinuous conduction, Fully controlled bridge converter with R and RL loads–continuous and discontinuous conduction, Effect of source inductance in fully controlled bridge rectifier with continuous conduction.

Unit	Module	Micro content
3.a One quadrant converters	**Half wave controlled converter**	Half wave controlled converter with R,RL loads
		Freewheeling diode concept
		Centre tapped configuration
		Bridge configuration
		Discontinuous conduction mode and continuous conduction modes
3.b Two quadrant converters	**Full wave controlled converters,Effect of source inductance**	Half controlled converter with R and RL loads
		Difference between semi and full converters
		Concept overlap angle and it’s impact on rectifier output voltage

Unit-3: Three-Phase AC-DC Converters **(12 hrs)**

Three-phaseHalf controlled bridge converter with R and RL loads: continuous and discontinuous conduction, Three-phaseFully controlled bridge converter with R and RL loads: continuous and discontinuous conduction, 3-phase semi controlled rectifier with R and RL load, Three-phase Dual converter.

Unit	Module	Micro content
5.a Three phase rectifiers	**Three pulse converter, six pulse converter**	Half wave uncontrolled converter
		Half wave-controlled converter
		Full bridge converter
		Half bridge converters
5.b. Four quadrant converter	**1-phase Dual converter**	Circulating current mode
		Non-Circulating current mode

Unit-4: DC–DC Converters **(12 hrs)**

Introduction to Choppers, Classifications of Choppers, Analysis of Buck, Boost and Buck-Boost converters in Continuous Conduction Mode only. (05 hrs)

AC – AC Regulators.

Integral cycle control, Single phase-controlled AC voltage controller with R and RL loads , Single phase bridge Cycloconverters with R-load only. (07 hrs)

Unit	Module	Micro content
7.a DC–DC Converters	**Choppers Operation**	Control strategies of chopper
		Choppers introduction & classifications
		Basic step down chopper Operation
		Buck converter analysis in CCM
		Boost converter analysis in CCM
		Buck-Boost converter analysis in CCM
7.b AC – AC Converters	**Operations of AC Voltage controller, Cyclo Converter**	Integral cycle control Strategy
		Phase angle control Strategy
		Single-Phase Cyclo converter operation with R-Load

Unit-5: DC–AC Converters **(12 hrs)**

Single- Phase full bridge inverters with R and RL loads, Unipolar and Bipolar switching, 3-phase inverters: 120^0 and 180^0 conduction modes, Sinusoidal pulse width modulation method, Current Source Inverter (CSI).Real time applications: UPS operation.

Unit	Module	Micro content
9.a Operation of VSI	**Single phase VSI, Three phase VSI**	Introduction and classification of inverters
		full bridge inverter with R and RL loads
		180^0 conduction mode of operation

		120^0 conduction mode of operation
9.b Operation of PWM & CSI	**Pulse width modulation methods, CSI operation**	Introduction to PWM
		Single Pulse PWM and Fourier series of Output voltage
		Single- Phase Sinusoidal PWM Inverter operation
		Operation of CSI

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**

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

III-Year-I Semester	Object Oriented Programming through JAVA (Open Elective)	L	T	P	C
		2	0	2	3

PRE-Requisites C language and object oriented concepts knowledge

Course objectives: The students should be able to

1. To understand object-oriented programming concepts, and apply them in solving problems.
2. To make the students to learn the principles of inheritance and polymorphism; and to demonstrate how they relate to the design of abstract classes; to introduce the implementation of packages and interfaces.
3. To make the students to learn the concepts of exception handling.
4. To make the students to learn the concepts of multithreading.
5. To make the students to develop GUI applications.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction to OOPS Concepts, Classes and Strings** Introduction to Object Oriented Programming, Java buzzwords, Java Programming Basics, Sample programs, Data types and operators, Control statements. **Classes:** Classes, Objects, Methods, Constructors, this and static keywords, Method and Constructor Overloading, Access modifiers, arrays-One Dimensional and multi-dimensional arrays, Searching, Sorting. **Strings**-Exploring the String class, String buffer class, Command-line arguments.	**CO1**
II	**Inheritance, Interfaces, Packages** **Inheritance :** Need of inheritance, types, super keyword, abstract classes, interfaces, compile time and runtime polymorphism, Packages.	**CO2**
III	**Exception Handling and I/O Streams10 Hrs** **Exception Handling:** Concepts of Exception handling, Built-in exceptions, creating own exception sub classes, Assertions. **Stream based I/O** (java.io) – The Stream Classes-Byte streams and Character streams, reading console Input and Writing Console Output, File class, Reading and writing Files, Random access file operations, Object Serialization, exploring java.nio	**CO3**
IV	**Multithreading** Concepts of Multithreading, differences between process and thread, thread life cycle, Thread class, Runnable interface, creating multiple threads, Synchronization, threadpriorities, inter thread communication, daemon threads, thread groups.	**CO4**
V	**GUI Programming with Swing:** Introduction, limitations of AWT, Various swing components & hierarchy. **Event Handling**- event delegation model, sources of event, Event Listeners,	**CO5**

	adapter classes,inner classes.	
Content Beyond the syllabus: java.util package and GUI using Applets.		

List of Programs

1) Write a JAVA program to display default value of all primitive data types of JAVA
2) Write a JAVA program to display the Fibonacci sequence
3) Write a JAVA program give example for command line arguments.
4) Write a JAVA program to sort given list of numbers.
5) Write a JAVA program to search for an element in a given list of elements (linear search).
6) Write a JAVA program to search for an element in a given list of elements using binary search mechanism.
7) Write a JAVA program to determine the addition of two matrices.
8) Write a JAVA program to determine multiplication of two matrices.
9) Write a JAVA program to sort an array of strings
10) Write a JAVA program to check whether given string is palindrome or not.
11) Write a JAVA program for the following
    a. 1. Example for call by value. 2. Example for call by reference.
12) Write a JAVA program to give the example for ‘this’ operator. And also use the‘this’ keyword as return statement.
13) Write a JAVA program to demonstrate static variables, methods, and blocks.
14) Write a JAVA program to give the example for ‘super’ keyword.
15) Write a JAVA program that illustrates simple inheritance.
16) Write a JAVA program that illustrates multi-level inheritance
17) Write a JAVA program demonstrating the difference between method overloading and method overriding.
18) Write a JAVA program demonstrating the difference between method overloading and constructor overloading.
19) Write a JAVA program that describes exception handling mechanism.
20) Write a JAVA program for creation of user defined exception.
21) Write a JAVA program to illustrate creation of threads using runnable class.(start method start each of the newly created thread. Inside the run method there is sleep() for suspend the thread for 500 milliseconds).
22) Write a JAVA program to create a class MyThread in this class a constructor, call the base class constructor, using super and starts the thread. The run method of the class starts after this. It can be observed that both main thread and created child thread are executed concurrently
23) Write a JAVA program illustrating multiple inheritance using interfaces.
24) Write a JAVA program to create a package named pl, and implement this package in ex1 class.
25) Write a JAVA program to create a package named mypack and import it in circle class.
26) Write a JAVA program to give a simple example for abstract class.
27) Write a JAVA program to create a simple calculator.

28) Write a JAVA program that displays the x and y position of the cursor movement using Mouse.
29) Write a JAVA program that displays number of characters, lines and words in a text file.

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Comprehend** object-oriented programming concepts for problem solving.
CO2	**Build** class hierarchy and packages for real world problems.
CO3	**Develop** thread safe Java programs with appropriate Exception handling.
CO4	**Demonstrate** multithreaded application programs through a language
CO5	**Design** GUI applications using swings and multithreading.

Learning Resources

Textbooks:

1. Java - The Complete Reference, Herbert Schildt, MC GRAW HILL Education, 9th Edition, 2016.

Reference books:

1. Java – How to Program", Paul Deitel, Harvey Deitel, PHI.
2. "Core Java", Nageswar Rao, Wiley Publishers.
3. "Thinking in Java", Bruce Eckel, Pearson Education
4. "A Programmers Guide to Java SCJP", Third Edition, Mughal, Rasmussen, Pearson.

Micro-Syllabus- object oriented programming through JAVA

Unit – I: Introduction to OOPS Concepts, Classes and Strings **12 Hrs**

Introduction to Object Oriented Programming, Java buzzwords, Java Programming Basics, Sample programs, Data types and operators, Control statements.

Classes: Classes, Objects, Methods, Constructors, this and static keywords, Method and Constructor Overloading, Access modifiers, arrays-One Dimensional and multi-dimensional arrays, Searching, Sorting.

Strings-Exploring the String class, String buffer class, Command-line arguments.

Unit	**Module**	**Micro content**
Introduction to OOPS Concepts, Classes and Strings	OOPs	Need of Java, JVM, JDK
		Introduction to Object Oriented Programming
		OOPS Vs structured programming
		Java buzzwords, Sample programs
		Data types & operators
		Control statements
	Classes	Classes, Objects, Methods
		Constructors, this and static keywords
		Method and Constructor Overloading,

		Arrays, searching & sorting
	Strings	String class & methods, problems related
		String buffer & String tokenizer
		Command line arguments

Unit – II: Inheritance, Interfaces, Packages **12 Hrs**

Inheritance: Need of inheritance, types, super keyword, abstract classes, interfaces,compile time and runtime polymorphism, Packages.

Inheritance, Interface & Packages	Inheritance	Need for inheritance
		Types of inheritance
		Super keyword
		Abstract classes
		Calling super class with sub class
	Interface	Introduction
		Dynamic method dispatch
		Compile time & runtime polymorphism
	Packages	Introduction, class path
		Built-in packages
		User defined package,

Unit – III: Exception Handling and I/O Streams 12 Hrs **Exception Handling:** Concepts of Exception handling, Built-in exceptions, creating ownexception sub classes, Assertions.

Stream based I/O (java.io) – The Stream Classes-Byte streams and Character streams, reading console Input and Writing Console Output, File class, Reading and writing Files, Random access file operations, Object Serialization, exploring java.nio

Exceptions & I/o	Exception Handling	Introduction, Concepts of Exceptions - try, catch,throw & throws, finally
		Built-in exceptions

CO-PO mapping Table

Mapping	**P01**	**P02**	**P03**	**P04**	**P05**	**P06**	**P07**	**P08**	**P09**	**P010**	**P011**	**P012**	**PSO1**	**PSO2**
C01	-	2	1	1	-	-	-	-	-	-	-	-		
C02	-	2	2	2	1	-	-	-	-	-	-	-		
C03	-	2	2	2	1	-	-	-	-	-	-	-		
C04	-	2	2	2	1	-	-	-	-	-	-	-		
C05	-	2	2	2	2	-	-	-	-	-	-	-		

III-Year-I Semester	Electrical Measurements and Instrumentation Lab	L	T	P	C
		0	0	3	1.5

PRE-REQUISITES: 1) Basic Circuit Analysis

Preamble:
This course introduces principle of operation of basic analog and digital measuring instruments for measurement of current, voltage, power, energy etc. Measurement of resistance, inductance and capacitance by using bridge circuits will be discussed in detail. It is expected that student will be thorough with various measuring techniques that are required for an electrical engineer.

Course Objectives: The student should be able
1. To study the principle of operation and working of different types of instruments.
Measurement of voltage and current.
2. To study the working principle of operation of different types of instruments for measurement of power and energy
3.To understand the principle of operation and working of dc and ac potentiometers.
4.To understand the principle of operation and working of various types of bridges for measurement of parameters –resistance, inductance, capacitance and frequency.

LIST OF EXPERIMENTS

Any Ten of the following experiments are to be conducted:

1. Calibration and testing of single-phase energy meter.
2. Calibration of dynamo meter type power factor meter.
3. Calibration of PMMC voltmeter and ammeter by dc Crompton's Potentiometer.
4. Measurement of resistance using Kelvin's double bridge.
5. Transformer turns ratio measurement using A.C. bridge.
6. Measurement of capacitance by using Schering bridge.
7. Measurement of inductance by using Anderson's bridge.
8. Measurement of 3 - phase reactive power by using single wattmeter.
9. Measurement of parameters of choke coil using three voltmeter and three ammeter methods.
10. Calibration of LPF wattmeter by phantom testing.
11. Measurement of 3 - phase power by using 1 - phase wattmeter and two current transformers.
12. C.T. testing using mutual inductor – measurement of % ratio error and phase angle of given C.T. by null method.
13. LVDT and capacitance pickup-characteristics and calibration.

List of Additional Experiments: Any of the two experiments are to be conducted

1. Resistance strain gauge- strain measurements and calibration.
2. Dielectric oil testing using h.t. testing kit.

3. Measurement of % ratio error and phase angle of given C.T by comparison.

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

Course Outcomes	
CO1	Able to choose right type of instrument for measurement of voltage and current for ac and dc. (**Analyze**)
CO2	Able to choose right type of instrument for measurement of power and energy – able to calibrate energy meter by suitable method (**Remember and Understand**)
CO3	Able to calibrate ammeter, voltmeter and potentiometer. (**Analyze**)
CO4	Able to select suitable bridge for measurement of electrical parameters. (**Evaluate**)

Learning Resources
Text books:
1. Electrical Measurements and measuring Instruments – by E.W. Golding and F.C.Widdis, fifth Edition, Wheeler Publishing. 2. Modern Electronic Instrumentation and Measurement Techniques – A.D. Helfrick and W.D. Cooper, PHI, 5th Edition, 2002.
Reference books:
11. Electrical & Electronic Measurement & Instruments by A.K.SawhneyDhanpatRai& Co.Publications. 2. Electrical and Electronic Measurements and instrumentation by R.K.Rajput, S.Chand. 3. Electrical Measurements – by Buckingham and Price, Prentice – Hall 4. Electrical Measurements: Fundamentals, Concepts, Applications – by Reissland, M.U, New Age International (P) Limited, Publishers. 5. Electrical and Electronic Measurements by G.K.Banerjee,PHI Learning Private Ltd,New Delhi–2012
e- Resources & other digital material
1.https://nptel.ac.in/courses/108/105/108105017
2.https://nptel.ac.in/courses/103/102/108102146
3.www.nptelvideos.in/2012/11/electrical measurements and instrumentation.html
4.https://www.electrical4u.com/losses-in-dc-machine

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
Mapping	P01	P02	P03	P04	P05	P06	P07	P08	P09	P010	P011	P012	PS01	PSO2
C01	3													
C02	2													

C03	2													
C04	2													

III-Year-I Semester	POWER ELECTRONICS LABORATORY	L	T	P	C
		0	0	3	1.5

PRE-REQUISITES: 1) Power Electronics Theory

Preamble: Introduction to power electronics, Various power electronics devices, Pulse width modulation, AC to DC Converters, AC Voltage Regulator, Buck converter, Boost converter and inverters

Course Objectives: The student should be able to

1.Study the characteristics of various power electronic devices and analyze firing circuits and commutation circuits of SCR.
2. Analyze the performance of single–phase and three–phase full–wave bridge converters with both resistive and inductive loads.
3. Understand the operation of AC voltage regulator with resistive and inductive loads.
4. Understand the working of Buck converter, Boost converter and inverters.

LIST OF EXPERIMENTS

Any Ten of the following experiments are to be conducted:

1. Study of Characteristics of Thyristor, MOSFET & IGBT, SCR.
2. Experimentally study of a firing circuit for Thyristor.
3. Experimentally study of gate drive circuits for IGBT.
4. Single -Phase Half controlled converter with R and RL load
5. Single -Phase fully controlled bridge converter with R and RL loads.
6. Single -Phase AC Voltage Regulator with R and RL Loads
7. Single -Phase square wave bridge inverter with R and RL Loads
8. Three- Phase fully controlled converter with RL–load.
9. Design and verification of voltages gain of Boost converter.
10. Design and verification of voltages gain of Buck-Boost converter.
11. Single -phase PWM inverter with sine PWM technique.
12. 3-phase AC-AC voltage regulator with R-load.

List of Additional Experiments: Any of the two experiments are to be conducted

1. Study of Characteristics of NPN Transistor.
2. Design and verification of voltages gain of Buck converter.
3. Three -phase PWM inverter with sine PWM technique.

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

Course Outcomes	
CO1	Study the characteristics of various power electronic devices and analyze gate drive circuits of IGBT. (**Analyze**)
CO2	Analyze the performance of single phase and three phase full wave bridge converters with both resistive and inductive loads. (**Remember and Understand**)
CO3	Understand the operation of single phase AC voltage regulator with resistive and inductive loads. (**Analyze**)
CO4	Understand the working of Buck converter, Boost converter, single phase square wave inverter and PWM inverter. (**Evaluate**)

Learning Resources
Text books:
1. Elements of Power Electronics–Philip T.Krein.oxford. 2. Power Electronics – by P.S.Bhimbra, Khanna Publishers.
Reference books:
1. Power Electronics by M. D. Singh and K. B. Khanchandani – USA **2.** Power Electronics: Converters, Applications And Design, Media Enhanced (With CD) by Ned Mohan, Tore M. Undeland, and William P. Robbins. 3.Principles Of Power Electronics by John G. Kassakian, Martin F. Schlecht, and George C.
e- Resources & other digital material
1. http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/power_electronics/labs/index.php
2. https://www.vlab.co.in/broad-area-electrical-engineering
3. https://www.vlab.co.in/broad-area-electronics-and-communications

CO-PO mapping Table with Justification:

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**															
Mapping	P0 1	P0 2	P0 3	P0 4	P0 5	P0 6	P0 7	P0 8	P0 9	P010	P01 1	P012	PS01	PSO 2	PS O3
C01	3	-	-	-	-	-	-	-	2	-	-	-	1	-	-
C02	2	-	-	-	-	-	-	-	2	-	-	-	1	-	-
C03	3	-	-	-	-	-	-	-	2	-	-	-	1	-	-
C04	2	-	-	-	-	-	-	-	2	-	-	-	1	-	-

SAC3101	SOFT SKILLS (Employability Skills -II)	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		UG	1	0	2	2	2022

Soft Skills amount to talents for adaptive and optimistic behavior that alter humans to deal effectively with the stress and challenges of life. This notion is additionally termed as psychosocial proficiency. The subject varies greatly reckoning on social norms and community expectations however skills that operate for well-being and aid people to change into active and productive members of their communities' square measure thought-about as Soft Skills.

They exemplify innovativeness, significant thinking, problem-solving, decision-making, the supremacy to speak-up and team-up, in aggregation with personal and social responsibility that contribute to sensible citizenship – all essential skills for achievement within the twenty first century, each for healthy societies and for employable people.

The course of soft skills is introduced to boost the standard of learning and living by complementing scholastic records with skill-based coaching. Realizing that the dual purpose of education i.e. is to foster educational excellence among students and additionally guide them to transform themselves into responsible people and professionals.

Soft Skills are a unit, a crucial facet of having the ability to fulfill the strain of daily & professional lives in a very unendingly dynamical world. The big changes in international economies over the last 5 years have coincided with technological transformations, all of that area unit leaving an impression on education, the geographic point, and our personal lives. Students need dynamically guided soft skills and hands on exposure, like the power to face / tackle stress and frustration, to address the growing pace and alter recent life. Over the course of their careers, today's engineering aspirants can have various new professions, each one with its own set of constraints and necessities, with flexibility & adaptability in demand of learn ability.

Objectives:

By the end of the program students will be able to:

- communicate clearly, confidently, concisely, and persuasively both written as well as orally.
- rediscover and boost self-confidence, to the zenith, and solve issues with ease.
- recognize the results (change) of their behavior / conduct and teach them to take ownership of their acts rather than blaming others.
- build confidence in their speaking / presentation skills and become industry-ready.
- develop a stronger sense of consciousness and appreciation for others by analyzing prospects, and creating choices.
- manage self-competence and self-confidence.

Preamble: Soft skills are character traits and interpersonal skills that portray a person's relationships with other people. In the workplace, soft skills are considered to be a balance to hard skills, which refer to a person's knowledge and professional skills.

Prerequisite: None

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

CO 1	master advanced nuances of both written and oral communication skills that are imperative for any professional to succeed coupled with being emphatic.
CO 2	confidently ace different competitive exams and develop writing skills.
CO 3	gain awareness of the industry expectations and craft CV / Résumé in lieu with desired job profiles.
CO 4	crack behavioral (HR) interview confidently and exhibit professional persona.
CO 5	make presentations effective and develop interview strategies while get rid of interview phobia.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1										
CO 2										
CO 3										
CO 4										
CO 5										

Award of marks

Total Marks	CIE	ESA	ESA Duration
50	25	25	2 Hours

Continuous Internal Evaluation (CIE) Total Marks: 25

Attendance & conduct of attire : 05 marks

Regular assessment (Lecture room demonstrations)

- Brain storming and group activities / case studies : 05 marks
- Presenting experiential learning insights : 05 marks
- Tech & Pep talks : 05 marks
- Simulations on Project(s) Presentation / Idea Garage : 05 marks
  (A range of 4-5 discussions each being 20-25 min.)

End Semester Assessment /Examination (ESA) **Total Marks: 25**

I. Descriptive Questions **- 10 marks** Time: 30 Min.

The students will be given a set of descriptive questions where they can answer any 2 questions carrying 5 marks each.

II. VIVA –Voce by external examiner (Demonstration oriented) **- 15 Marks**

Syllabus (III B. Tech - Soft Skills)

Module 1 **Effective communication skills**

- ✓ Start with self and connect with others.
- ✓ The art of narrating and storytelling.
- ✓ Enhance teamwork and influence change.

Module 2 **Advanced Verbal ability concepts – practice and Professional writing skills**

- ✓ Nurture and enhance the verbal ability strength through practice.
- ✓ Conducting mock verbal (ability) tests and their timely review.
- ✓ List the steps of writing an email effectively & comprehend the importance of structuring an email.
- ✓ Overview of various elements related to accuracy, brevity and correctness in our everyday writing at the workplace (Project proposals / covering letters / blogs / short essays).

Module 3 **Industry sneak and résumé / CV building strategies**

- ✓ Industry & aspirant career expectations and tailoring action learning plan aptly.
- ✓ Crafting winning résumé(s) suiting to different profiles.
- ✓ Framing responses to résumé based interview questions.

Module 4 **Behavioral competency building – Part II and psychometric test (HR Round Preparation)**

- ✓ Listing personal characteristics and preparing blueprint to inculcate them.
- ✓ Assess the students' ability to fit into a specific work environment or with specific personality types.
- ✓ Determine basic characteristics of an individual.

Module 5 **Presentation skills & Mock interviews**

- ✓ Illustration of presentation structure via impromptu / free speech – and essential criteria for an effective presentation
- ✓ Importance of non-verbal communication (signposting)
- ✓ Inciting the interview process by practicing a gamut of behavioral mock interviews.

Module 1 –Tasks

- ✓ Listening & comprehension skills – lessons from the corporate training videos / scenes in films.
- ✓ Role play – story telling & anchoring
- ✓ Extempore – students' experience with college/program.
- ✓ Listening & comprehension skills – lessons from the corporate training videos / scenes in films

Module 2 -Tasks

- ✓ Story paraphrasing, peer introduction and monologue.
- ✓ Assignment on short essay and blog building/digital profile creation.

Module 3 -Tasks

- ✓ Overview & analysis of a Job Description(JD) and its reflection in resume / self introduction
- ✓ Crafting of resumes by mapping skills & competences to different profiles offered for engineering graduates.
- ✓ An act on – one day in the life of an HR manager/ Project leader etc.

Module 4 -Tasks

- ✓ Case scenarios – to identify behavioral competencies and personality traits
- ✓ increase self-awareness and improve interactions with others

Module 5 -Tasks

- ✓ Pair & Group work – debating / demonstration of product promotion, etc.
- ✓ Peer mock interview practice on selected profiles.

Reference Books

1. The Ace of Soft Skills: Attitude, Communication and Etiquette for Success, Pearson Education; 1 edition, 2013.
2. Barun K. Mitra, "Personality Development & Soft Skills", Oxford Publishers, Third impression,2017.
3. ICT Academy of Kerala, "Life Skills for Engineers", McGraw Hill Education (India) Private Ltd.,2016.
4. Caruso, D. R. and Salovey P, "The Emotionally Intelligent Manager: How to Develop and Use the Four Key Emotional Skills of Leadership", John Wiley & Sons, 2004.
5. Kalyana, "Soft Skill for Managers"; First Edition; Wiley Publishing Ltd, 2015.
6. Larry James, "The First Book of Life Skills"; First Edition, Embassy Books, 2016.
7. Shalini Verma, "Development of Life Skills and Professional Practice"; First Edition; Sultan Chand (G/L) & Company, 2014.
8. Daniel Goleman, "Emotional Intelligence"; Bantam, 2006.
9. Remesh S., Vishnu R.G., "Life Skills for Engineers", Ridhima Publications, First Edition, 2016.
10. Butterfield Jeff, "Soft Skills for Everyone", Cengage Learning India Pvt. Ltd; 1 edition, 2011.
11. Training in Interpersonal Skills: Tips for Managing People at Work, Pearson Education, India; 6th Edition, 2015.

Digital References

1. Infosys Springboard (https://infyspringboard.uk.onwingspan.com/web/en/login)
2. AICTE Digital Learning Portal (https://free.aicte-india.org/)
3. APSCHE LMS – Bringing Learning to People (https://apschelms.e-pragati.in/#/)
4. Dale Carnegie Academy (https://www.dalecarnegie.com/en)
5. TedX Program (https://www.ted.com/about/programs-initiatives/tedx-program)
6. Toast Masters International (https://www.toastmasters.org/)
7. NPTEL (https://nptel.ac.in/)
8. Coursera / Udemy / Unacademy / Wikipedia (https://en.wikipedia.org/wiki/Main_Page)

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Human Values in the AICTE Model Curriculum for Engineering 2018
In 2018, AICTE included UHV in the Model Curriculum. UHV-II (Understanding Harmony) is to be offered as an essential 3-credit course (H-102) in 3rd/4th semester after an orientation to values in UHV-I, which is a prominent module in the Student Induction Program.

UHV-I: Student Induction Program (mandatory)
Pages related to Induction Program "Guide to Induction Program" pages 31-38 of Volume I (see https://www.aicte-india.org/sites/default/files/Vol.%20I_UG.pdf)

UHV-II: 3-credit Course (H-102) (mandatory)
LTPC 2-1-0-3
Pages related to Course H-102 "Universal Human Values 2: Understanding Harmony" pages 166-170 of Volume II (see https://www.aicte-india.org/sites/default/files/Vol.%20II%20%20AICTE%20UG%20%20Curriculum.pdf)

Please see AICTE Web Page: https://www.aicte-india.org/
Model Curriculum (from Home Page > Education > Model Curriculum & Sugg. Books (UG Engg.)
https://www.aicte-india.org/education/model-syllabus

I. Induction Program

(Please refer **Appendix-A** for guidelines. Details of Induction program also available in the curriculum of Mandatory courses.)
Induction program (mandatory) 3 weeks duration

II. UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY
Course code: HSMC (H-102)
Credits: 2-1-0-3

Curricular Structure
Semester L-T-P-C Course No. & Title
3 or 4 2-1-0-3 H-102 Universal Human Values 2: Understanding Harmony

Human Values Courses

During the Induction Program, students would get an initial exposure to human values through Universal Human Values – I. This exposure is to be augmented by this compulsory full semester foundation course.

Universal Human Values 2: Understanding Harmony
Course code: HSMC (H-102)
Credits: L-T-P-C 2-1-0-3 or 2L:1T:0P 3 credits
Pre-requisites: None. Universal Human Values 1 (desirable)

1. OBJECTIVE:
The objective of the course is four fold:
1.Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

2. COURSE TOPICS:
The course has 28 lectures and 14 practice sessions in 5 modules:

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

1. Purpose and motivation for the course, recapitulation from Universal Human Values-I
2. Self-Exploration–what is it? - Its content and process; ‘Natural Acceptance’ and Experiential Validation- as the process for self-exploration
3. Continuous Happiness and Prosperity- A look at basic Human Aspirations
4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority
5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking

Module 2: Understanding Harmony in the Human Being - Harmony in Myself!
7. Understanding human being as a co-existence of the sentient ‘I’ and the material ‘Body’
8. Understanding the needs of Self (‘I’) and ‘Body’ - happiness and physical facility
9. Understanding the Body as an instrument of ‘I’ (I being the doer, seer and enjoyer)
10. Understanding the characteristics and activities of ‘I’ and harmony in ‘I’
11. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail
12. Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one’s own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease

Module 3: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship

13. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
14. Understanding the meaning of Trust; Difference between intention and competence
15. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
16. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
17. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives

Module 4: Understanding Harmony in the Nature and Existence - Whole existence as Coexistence

18. Understanding the harmony in the Nature
19. Interconnectedness and mutual fulfilment among the four orders of nature-recyclability and selfregulation in nature
20. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space
21. Holistic perception of harmony at all levels of existence.
Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Module 5: Implications of the above Holistic Understanding of Harmony on Professional Ethics

22. Natural acceptance of human values
23. Definitiveness of Ethical Human Conduct
24. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order

25. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
26. Case studies of typical holistic technologies, management models and production systems
27. Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations
28. Sum up.

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist etc.

3. READINGS:

3.1 Text Book

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books,
New Delhi, 2010

3.2 Reference Books

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj - PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)

13. Gandhi - Romain Rolland (English)

4. MODE OF CONDUCT (L-T-P-C 2-1-0-3 or 2L:1T:0P 3 credits)

Lectures hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them.

Tutorial hours are to be used for practice sessions.

While analysing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.

In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection and self-exploration.

Scenarios may be used to initiate discussion. The student is encouraged to take up "ordinary" situations rather than" extra-ordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting.

Tutorials (experiments or practical) are important for the course. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignment and/or activity are included. The practice sessions (tutorials) would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to development of commitment, namely behaving and working based on basic human values.

It is recommended that this content be placed before the student as it is, in the form of a basic foundation course, without including anything else or excluding any part of this content. Additional content may be offered in separate, higher courses.

This course is to be taught by faculty from every teaching department, including HSS faculty.

Teacher preparation with a minimum exposure to at least one 8-day FDP on Universal Human Values is deemed essential.

5. ASSESSMENT:

This is a compulsory credit course. The assessment is to provide a fair state of development of the student, so participation in classroom discussions, self-assessment, peer assessment etc. will be used in evaluation.

Example:

Assessment by faculty mentor: 10 marks

Self-assessment: 10 marks

Assessment by peers: 10 marks

Socially relevant project/Group Activities/Assignments: 20 marks

Semester End Examination: 50 marks

The overall pass percentage is 40%. In case the student fails, he/she must repeat the course.

6. OUTCOME OF THE COURSE:

By the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

They would have better critical ability. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

This is only an introductory foundational input. It would be desirable to follow it up by

a) faculty-student or mentor-mentee programs throughout their time with the institution

b) Higher level courses on human values in every aspect of living. E.g. as a professional

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III-Year-II Semester	MICROPROCESSORS AND MICROCONTROLLERS	L	T	P	C
		3	0	0	3

PRE-REQUISITES: The Purpose of the course is to provide students with the Knowledge of Microprocessors and Microcontroller. To solve real world problems in an efficient manner, this course also emphasis on architecture, Programming and system design used in various day to day gadgets.

Course objectives: The student should be able to

To understand the organization and architecture of Micro Processor

2. To understand addressing modes to access memory and modes of operation
3. To interface different devices to 8086.
4. To understand 8051 micro controller architecture
5. To understand the basics of PIC18 architecture and develop programs using C.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction to Microprocessor Architecture(13h)** Introduction and evolution of Microprocessors,8086 Pin diagram- Architecture of 8086, Register Organization of 8086, Memory organization of 8086– General bus operation of 8086–Introduction to 80286–80386 and 80486 and Pentium [Elementary treatment only]	**CO1**
II	**Minimum and Maximum Mode Operations (10h)** Instruction set- Addressing modes, Minimum and Maximum mode operations of 8086- Read and write cycle timing diagrams, 8086 Control signal interfacing	**CO2**
III	**I/O Interface(20h)** 8255 PPI– Architecture of 8255–Modes of operation–Interfacing A to D converters–Interfacing D to A converters– Stepper motor interfacing, DMA controller (8257)–Architecture– Modes of operations, Programmable Interrupt Controller (8259)–Modes of Operation- Command words of 8259,Keyboard/display controller (8279)–Architecture–Modes of operation[Elementary treatment only]	**CO3**
IV	**Introduction to 8051 Micro Controller (12h)** Introduction to 8051 Micro Controller– Architecture– Register set, I/O ports, Memory Organization– Interrupts, Timers and Counters–Serial Communication.	**CO4**
V	**Introduction to PIC Micro Controller (10h)** Block diagram of basic PIC 18 micro controller, registers I/O ports, Data types, I/O programming, logical operations, data conversion., Numerical problems. **(06 hrs)**	**CO5**
Content Beyond the syllabus: **Powering A Generation:** Generating Electricity using Fossil-fuelled plants, Cogeneration, Combined-cycle and Biomass plants, Geothermal plants, and Decentralized generation. (Elementary treatment only)		

Advanced Transmission Technologies: High-temperature super conducting technology, Advanced composite conductors.(Elementary treatment only) **New Technologies for Electric power Distribution Systems:** Concept of Intelligent Substations (Elementary treatment only). **Tariff structure design process:** Identification of tariff structures, tariff constraints (Elementary treatment only)

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Understand the concepts of 8086 architecture, register and memory organization{Knowledge level, KL1}
CO2	Understand and apply the concepts of the modes of operations and instruction set to develop the Assembly level language programs. {Apply level, KL3}
CO3	Classify the types of interfacing devices and implement to interface with 8086 {Knowledge level, KL1}
CO4	Explain the 8051 architecture and its features. {Knowledge level kL1}
CO5	Understand the PIC18 architecture and Develop the programs using C {Apply level, KL3}

Learning Resources
Text books:
1. "Advanced Micro Processors and Interfacing", Ray and Burchandi, Tata McGraw– Hill 2. "The 8051 Micro Controller Architecture, Programming and Applications", Kenneth J Ayala, Thomson Publishers, 2nd Edition. 3. "PIC Microcontroller and Embedded Systems using Assembly and C for PIC 18", Muhammad Ali Mazidi, RolindD.Mckinay, Danny causey, Pearson Publisher 21st Impression..
Reference books:
1. "A Text book of Microprocessors and Micro Controllers", R.S. Kaler, I.K. International Publishing House Pvt. Ltd. 2. "Microcontrollers – Theory and Applications", Ajay V. Deshmukh, Tata McGraw– Hill Companies –2005 4. "Microcontrollers – Principles and Applications", Ajit Pal, PHI Learning Pvt Ltd, 2011. 5. "Microprocessors and Interfacing", Douglas V Hall, Mc–Graw Hill, 2nd Edition.
e- Resources & other digital material
https://nptel.ac.in/courses/108107029

Micro-Syllabus

Unit 1: Introduction to Microprocessor Architecture (13h)
Introduction and evolution of Microprocessors– 8086 Pin diagram- Architecture of 8086– Register Organization of 8086–Memory organization of 8086– General bus operation of 8086– Introduction to 80286–80386 and 80486 and Pentium [Elementary treatment only

Unit No	Module	Micro content
1.a	Introduction and evolution of Microprocessors–	Evolution and Applications of Microprocessors
		Differences between 8085 and 8086.
		8086 common pins, minimum mode and maximum mode pins.
		Detailed architecture(BIU and EU)
1b.	Register Organization of 8086	General purpose registers, segment registers, Pointer and Index registers, flag register.
		Physical Memory organization (odd bank and evenbank) [Elementary treatment only
		Factors to be considered for selection of site,
	Memory organization of 8086	Efficiency (Formula orientation),
	General bus operation of 8086	General 8086 system bus structure and operation with timing diagram. [Elementary treatment only]
	Introduction to 80286–80386 and 80486 and Pentium	Features of 80286, 80386, 80486 and Pentium. [Elementary treatment only]

Unit 2 Minimum and Maximum Mode Operations:(10h)
Instruction set- Addressing modes– Minimum and Maximum mode operations of 8086–8086 Control signal interfacing–Read and write cycle timing diagrams

Unit No	Module	Micro content
2a	Instruction set- Addressing modes, Control signal interfacing	Arithmetic Instructions- Data Transfer Instructions- Logical Instructions - Branch and loop instructions - String Instructions - Process Control Instructions
		Immediate, Register, Direct, Indirect, Based, Indexed, Based Indexed, Based Relative, Indexed Relative, Based Indexed Relative and I/O port addressing modes
		Control signal (ALE, BHE, M/IO’, DT/R’, RD’, WR’, DEN, READY) interfacing
2b	Minimum and Maximum mode operations- Read and	Block diagram of Minimum mode-Operation
		Read and write cycle timing diagrams
		Block diagram of Maximum mode-Operation

	write cycle timing diagrams	Read and write cycle timing diagrams

Unit 3 I/O Interface: (20h)

8255 PPI– Architecture of 8255–Modes of operation–Interfacing A to D converters– Interfacing D to A converters– Stepper motor interfacing–DMA controller (8257)– Architecture– Modes of operations– Programmable Interrupt Controller (8259)– Modes of Operation-Command words of 8259.Keyboard/display controller (8279)–Architecture -Modes of operations of 8279 [Elementary treatment only]

Unit No	Module	Micro content
3a	8255 Architecture	Features, Pin diagram and Block diagram of 8255
	DMA controller (8257)– Architecture	Features, Pin diagram and Block diagram of 8257
	Programmable Interrupt Controller (8259)	Features, Pin diagram and Block diagram of 8259
	Keyboard/display controller (8279)– Architecture	Features, Pin diagram and Block diagram of 8279.
3b.	Modes of operation of 8255	BSR mode and I/O mode (Mode 0 ,Mode1 and Mode 2)
	Interfacing A to D converters– Interfacing D to A converters– Stepper motor interfacing	Interfacing of 0808/0809 ADC with 8086 Interfacing of 0800 DAC with 8086 ALP to rotate 4 phase stepper motor in clockwise and anti-clock wise direction
	Modes of operations of 8257	Rotating priority mode, Fixed priority mode, Extended write mode, TC stop mode and Auto Load mode
	Modes of Operation of 8259	Fully nested mode, Specially Fully nested mode, Rotating priority mode, Special Masked mode, Polled Mode
	Modes of operations of 8279	Keyboard modes: Scanned keyboard, scanned sensor matrix and strobed input modes.

Unit 4 Introduction to 8051 Micro Controller (12h)

Introduction to 8051 Micro Controller– Architecture– Register set–I/O ports and Memory Organization– Interrupts–Timers and Counters–Serial Communication.

Unit No	Module	Micro content
4	Introduction to 8051 Micro Controller–	Features, Pin diagram and block diagram and applications of 8051

	Architecture– Register set–I/O ports	Registers of 8051
4b.	Memory Organization– Interrupts–Timers and Counters–Serial Communication.	Program memory and Internal memory
		interrupts (IE0, IE1, TF0, TF1 and serial port) – IE register, IP register
		Timers/counters: TMOD register, TCON register and modes of Timers
		Serial Communication: SBUF register, SCON register and PCON register
Unit 5 Introduction to PIC Micro Controller (10h) PIC Architecture: Block diagram of basic PIC 18 micro controller, registers I/O ports. Programming in C for PIC: Data types, I/O programming, logical operations, data conversion		
Unit No	**Module**	**Micro content**
5a.	Block diagram of basic PIC 18 micro controller	Difference between 8051MC and PIC18, Types of PIC microcontrollers. Features and block diagram of PIC18
	Registers, I/O ports	Working Register, File register, Special Function registers, General purpose registers and CCP registers
5b.	Data types, I/O programming, logical operations, data conversion	C-Programs related to Data types, I/O programming, logical operations, data conversion. [Elementary treatment only].

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	2													
CO2	2		1											
CO3	2													
CO4	2													
CO5	2		1											

III-Year-II Semester	POWER SYSTEMS-III	L	T	P	C
		3	0	0	3

Pre-Requisites: Power Systems-I and Power Systems-II

Preamble:

The course is designed to give the required knowledge for the calculation of power flow in a power system network using various techniques, short circuit analysis, power system analysis for steady state and transient stability. It also deals with economic operation of power systems, modelling of speed governing system, turbines and generators including single area and two area load frequency control.

Course Objectives:

- To study the Gauss Seidel, Newton Raphson, Decoupled and Fast Decoupled load flow methods.
- To understand the short circuit calculations for symmetrical and unsymmetrical faults.
- To study the stability analysis of power systems.
- **To understand optimal dispatch of generation with and without losses.**
- **To study the load frequency control for single and two area system.**

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Power Flow Studies (13hrs)** Necessity of power flow studies, Derivation of static power flow equations, Load flow solutions using Gauss Seidel Method, Newton Raphson Method, Decoupled and Fast Decoupled Methods, Numerical problems (3 bus system up to one iteration only).	**CO1**
II	**Short Circuit Analysis** **Symmetrical Fault Analysis: (6hrs)** Symmetrical fault analysis-Short circuit current and MVA calculations, Series reactors-Selection and Advantages of reactors, Numerical problems. **Unsymmetrical Fault Analysis: (7hrs)** Symmetrical component theory-Positive, Negative and Zero sequence components, Sequence impedances and networks, Various types of faults-LG, LL and LLG on unloaded alternator, Numerical problems.	**CO2**
	Stability Analysis **Steady State Stability: (7hrs)** Classification of power system stability,Transfer Reactance, Synchronizing Power Coefficient ,Power Angle Curve , Determination of Steady State Stability, Methods	

III	to improve steady state stability, Numerical Problems. **Transient Stability: (6hrs)** Swing Equation, Determination of Transient Stability by Equal Area Criterion, Application of Equal Area Criterion-Critical Clearing Angle and time,Methods to improve transient stability, Numerical Problems.	**CO3**
IV	**Economical Operation of Power Systems:** **Different Curves: (6hrs)** Optimal operation of Generators in Thermal power stations, Input–output characteristics, Cost Curve, Heat rate curve, Incremental fuel and Production costs. **Mathematical Analysis: (6hrs)** Optimum generation allocation with and without transmission line losses, Loss Coefficients, General transmission line loss formula, Numerical Problems.	**CO4**
V	**Load Frequency Control** **Single Area Control: (7hrs)** Modeling of speed governing system, steam turbine and generator, Control area concept, Single area control-Transfer function and Block diagram representation of an isolated power system, Steady state analysis, Dynamic response, Proportional plus Integral control of single area and its block diagram representation, Numerical Problems. **Two Area Control: (6hrs)** Transfer function and Block diagram representation, Tie-line bias control, Steady state analysis, real time applications of load frequency control and economic load dispatch.	**CO5**
Content Beyond the Syllabus: Power flow solution including convergence characteristics, Case studies of different faults, Swing Equation solution using point by point method, Economic load dispatch including all constraints.		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Find out the load flow solution of a power system network using different load flow methods.
CO2	Evaluate the fault current for different types of faults with a view to provide data for the design of protective devices.
CO3	Analyze the steady state and transient stability concepts of a power system.
CO4	Calculate optimal scheduling for generators **with and without losses**.
CO5	Acquire the knowledge of load frequency control **for various systems**.
Learning Resources	
Textbooks:	

1. Modern Power System Analysis- I.J.Nagrath & D.P.Kothari: Tata McGraw-Hill Publishing Company, 2nd edition.
2. Electrical Power Systems- C.L. Wadhwa, New Age International Publishers, 7th Edition.

Reference books:
1. Power System Analysis–Grainger and Stevenson, Tata McGraw-Hill 2. Power Systems Operation and Control –Chakravarthi, Prentice Hall, Inc. 3. Power System Analysis -Hadi Saadat, TMH Edition . 4. Power System Stability & Control -PrabhaKundur, TMH.
e- Resources & other digital material
1. https://nptel.ac.in/courses/117105140/ 2. https://nptel.ac.in/courses/108/105/108105104 3. https://nptel.ac.in/courses/108/107/108107127/ 4. https://nptel.ac.in/courses/108/105/108105060/ 5. https://www.coursera.org/learn/electric-power-systems 6. https://www.edx.org/ power-systems 7. https://www.classcentral.com/course/electric-power-systems

Micro-Syllabus

Unit-1 Power Flow Studies (13hrs)

Necessity of power flow studies, Derivation of static power flow equations, Load flow solutions using Gauss Seidel Method, Newton Raphson Method, Decoupled and Fast Decoupled Methods, Numerical problems.

Unit No	Module	Micro content
1a.	**Power Flow Studies Introduction andStatic Power Flow Equations**	Introduction and Necessity of power flow studies
		Classification of buses
		Data for power flow studies
		Derivation of static power flow equations
1b.	**Iterative Methods and Problems**	Load flow solutions using iterative methods(in polar coordinates only)
		Gauss Seidel Method with and without PV buses, concept of acceleration factor.
		Newton Raphson Method
		Decoupled and Fast Decoupled Methods
		Line flows and line losses equations
		Algorithm and flow chart of all iterative methods
		Comparison of iterative methods
		Numerical problems (3 bus system up to one iteration only)

Unit-2 Short Circuit Analysis

Symmetrical Fault Analysis: (6hrs)

Symmetrical fault analysis-Short circuit current and MVA calculations, Series reactors-Selection and Advantages of reactors, Numerical problems.

Unsymmetrical Fault Analysis: (7hrs)

Symmetrical component theory-Positive, Negative and Zero sequence components, Sequence impedances and networks, Various types of faults-LG, LL and LLG on unloaded alternator, Numerical problems.

Unit No	Module	Micro content

2a.	**Symmetrical Fault Analysis**	Introduction and Reasons for faults
		Classification of faults
		Concept of synchronous reactance
		Symmetrical fault analysis using Thevenin's theorem
		Symmetrical fault analysis using bus impedance matrix and its advantages
		Concept of Series reactors
		Selection and Advantages of reactors
		Numerical problems-Short circuit current and MVA calculations.
2b.	**Unsymmetrical Fault Analysis**	Symmetrical component theory
		Relation between unbalanced vectors(voltage and current) and symmetrical component
		Sequence impedances and networks
		Sequence networks for power system components
		Fault current expression for LG, LL and LLG fault on unloaded alternator
		Numerical problems.

Unit-3 Stability Analysis

Steady State Stability: (7hrs)

Classification of power system stability,Transfer Reactance, Synchronizing Power Coefficient ,Power Angle Curve , Determination of Steady State Stability, Methods to improve steady state stability, Numerical Problems.

Transient Stability: (6hrs)

Swing Equation, Determination of Transient Stability by Equal Area Criterion, Application of Equal Area Criterion-Critical Clearing Angle and time,Methods to improve transient stability, Numerical Problems.

Unit No	Module	Micro content
3a.	**Steady State Stability**	Introduction to stability studies
		Classification of power system stability
		Concept of steady state stability limit & Transfer Reactance
		Power angle equation derivation
		Power angle curve
		Concept of synchronizing power coefficient
		Determination of Steady State Stability
		Methods to improve steady state stability
		Steady state stability limit in terms of ABCD parameters
		Numerical Problems
3b.	**Transient Stability**	Swing equation derivation
		Concept of Equal Area Criterion
		Application of Equal Area Criterion

		Expressions of Critical Clearing Angle and time for single circuit and double circuit transmission line
		Methods to improve transient stability
		Numerical Problems

Unit-4 Economical Operation of Power Systems:

Different Curves: (6hrs)

Optimal operation of Generators in Thermal power stations, Input–output characteristics, Cost Curve, Heat rate curve, Incremental fuel and Production costs.

Mathematical Analysis: (6hrs)

Optimum generation allocation with and without transmission line losses, Loss Coefficients, General transmission line loss formula, Numerical Problems.

Unit No	Module	Micro content
4a.	**Different Curves**	Introduction and over view of thermal plant operation
		Input–output characteristics
		Cost Curve and equation
		Incremental Cost Curve and equation
		Incremental efficiency
		Heat rate curve
		Incremental fuel and Production costs
		Equality and inequality constraints
4b.	**Mathematical Analysis**	Optimum generation allocation without transmission line losses expression
		Optimum generation allocation with transmission line losses expression
		Concept of exact and approximate penalty factors
		General transmission line loss formula
		Incremental transmission line loss formula
		Loss Coefficients
		Numerical Problems

Unit-5 Load Frequency Control

Single Area Control: (7hrs)

Modelling of speed governing system, steam turbine and generator, Control area concept, Single area control-Transfer function and Block diagram representation of an isolated power system, Steady state analysis, Dynamic response, Proportional plus Integral control of single area and its block diagram representation, Numerical Problems.

Two Area Control: (6hrs)

Transfer function and Block diagram representation, Tie-line bias control, Steady state analysis, real time applications of load frequency control and economic load dispatch.

Unit No	Module	Micro content
5a.	**Single Area Control**	Introduction and Concept of load frequency control

		Necessity of constant frequency
		Control area concept
		Operation of speed governing system
		Modelling of speed governing system(Transfer function and Block diagram representation)
		Modelling of steam turbine (Transfer function and Block diagram representation)
		Modelling of generator(Transfer function and Block diagram representation)
		Transfer function and Block diagram representation of an isolated power system (Single area control)
		Steady state analysis-Controlled and Uncontrolled case
		Dynamic response
		Proportional plus Integral control of single area-steady state frequency error derivation
		Numerical Problems
5b.	**Two Area Control**	Transfer function and Block diagram representation of two area control
		Concept of Tie-line bias control
		Steady state analysis-Controlled and Uncontrolled case
		Real time applications of load frequency and economic dispatch control

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1									1	2	1
CO2	2	2	1										2	1
CO3	3	2											2	1
CO4	3	2									2	1	2	1
CO5	3	2										1	2	1

III-Year-II Semester	Digital Electronics	L	T	P	C
		3	0	0	3

PRE-REQUISITES: NIL

Course objectives: The student should be able to

1. To understand common forms of number representation in digital circuits and Boolean algebra.
2. To learn basic techniques for the design of digital circuits and fundamental concepts used in the design of digital systems and simplify logic expressions using basic theorems, K-map and Tabular methods.
3. To understand the concept of Combinational logic design and realize logic expressions using MUX and Decoder
4. Illustrate the concept of sequential logic design; analyze the operation of flip-flop and conversion from one flip-flop to another, and application of flip-flop.
5. To impart to student the concepts of sequential machines of digital system.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Number Systems and Boolean Algebra** **14 Hours** **Number systems:**Introduction to different number system and their conversions,Complement of number system and subtraction using complement method, Weighted and Non-weighted codes and its Properties, Error detection and correction codes, **Boolean Algebra:**Boolean algebra and logic gates, Basic theorems and properties of Boolean Algebra, Boolean functions, canonical and standard forms, Universal Gates.	**CO1**
II	**Minimization Methods of Boolean functions** **11 Hours** Minimization of logic expressions by algebraic method, Sum of Products (SOP), Product of Sums (POS), K-Map Method, Don't Care Combinations, Prime and essential Prime Implicants, Tabular Method.	**CO2**
III	**Combinational Circuits** **14 Hours** Design procedure,Half/full adders, Half / full subtractors,Carry look ahead adder, Multiplexer/De-Multiplexer, Encoder/Decoder, Priority encoders, Implementation of Higher-Order Device Using Lower Order devices,Implementation of combinational logic using MUX/Decoder, Magnitude Comparator.	**CO3**
IV	**Sequential Circuits** **12 Hours** **Sequential Circuits Fundamentals:** Basic Architectural Distinctions between Combinational and Sequential circuits, SR Latch, Flip Flops: SR, JK, JK Master Slave, D and T Type Flip Flops, Excitation Table of all Flip Flops, Timing and Triggering Consideration, Conversion from one type of Flip-Flop to another.	**CO4**

	Registers and Counters: Shift Registers Left, Right and Bidirectional Shift Registers, Applications of Shift Registers, Design and Operation of Ring and Twisted Ring Counter, Operation of Asynchronous and Synchronous Counters.	
V	**Sequential Machines** **8 Hours** Finite State Machines, Synthesis of Synchronous Sequential Circuits, Mealy and Moore models, Serial Binary Adder, Sequence Detector, Parity-bit Generator Synchronous Modulo N – Counters, Finite state machine capabilities and limitations.	**CO5**

Content Beyond the syllabus:

Programmable Logic Devices,BCD adder

<u>LIST OF EXPERIMENTS</u>

1. Verify the truth tables of Basic Logic gates.
2. Verify the truth tables of universal gates.
3. Realize the half adder and full adders and verify it's function.
4. Realize the half subtractor and full subtractor and verify it's function.
5. Verify the functioning of 2-bit comparator IC.
6. Realize 3-variable function using (8:1MUX) 74151 IC.
7. Realize Mod-N counter using IC7490
8. Realize ring and Johnson counters using IC 7476

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Distinguish the analog and digital systems, apply positional notations, number systems, computer codes in digital systems. **(Remember, Understand, and Apply)**
CO2	Uunderstand the Boolean Algebra theorems, simplify and design logic circuits. **(Understand, Apply, Analyze and valuate)**
CO3	Implement combinational logic circuit design and modular combinational circuits using encoders, decoders, multiplexers and demultiplexers. (**Apply, Analyze, valuate, and create)**
CO4	Understand the basic elements of sequential logic circuits. **(Understand, Apply, Analyze)**
CO5	Design and analyze sequential circuits. **(Apply, Analyze and create)**

Learning Resources
Text books:
1. Digital Design by Mano, PHI 2. Modern Digital Electronics by RP Jain, TMH 3. Switching Theory and Logic Design by A. Anand Kumar, PHI. 4. Switching and Finite Automata Theory- ZviKohavi& Niraj K. Jha, Cambridge.
Reference books:

1. Switching Theory and Logic Design by Hill and Peterson Mc-Graw Hill TMH edition
2. Fundamentals of Logic Design by Charles H. Roth Jr, Jaico Publishers

e- Resources & other digital material

1. https://nptel.ac.in/courses/108/105/108105113/
2. https://www.coursera.org/learn/digital-systems
3. https://swayam.gov.in/nd1_noc20_ee70/preview

Micro-Syllabus

Unit – 1

Number Systems and Boolean Algebra 14 Hours

Number systems: Introduction to different number system and their conversions, Complement of number system and subtraction using complement method, Weighted and Non-weighted codes and its Properties, Error detection and correction codes,

Boolean Algebra: Boolean algebra and logic gates, Basic theorems and properties of Boolean Algebra, Boolean functions, canonical and standard forms, Universal Gates.

Unit No	Module	Micro content
1a.or 2a. Number systems	different number system and their conversions	Importance of radix or base and numerical
		Different number systems: binary, decimal, octal&hexa decimal.
		Binary addition, subtraction, multiplication
	Signed numbers & Binary arithmetic	2's complement arithmetic & 1's complement arithmetic.
1b.or 2b. binary codes & Boolean algebra	Classification of Binary codes	Weighted and Non-weighted codes and self complementing, cyclic codes
		Error detection and correction codes
	Axioms and laws of Boolean algebra Logic Gates	Basic theorems and properties of Boolean Algebra, Boolean functions, canonical and standard forms

Unit-2: Minimization Methods of Boolean functions 11 Hours

Minimization of logic expressions by algebraic method, Sum of Products (SOP), Product of Sums (POS), K-Map Method, Don't Care Combinations, Prime and essential Prime Implicants, Tabular Method.

Unit No	Module	Micro content
3a.or 4a. Minimization of logic expressions by algebraic method & K-Map Method	Minimization of logic expressions by algebraic method K-Map Method	Sum of Products (SOP)), Product of Sums (POS)
		2-variable,3- variable & 4- variable K-maps
		Don't cares
		5-variable K-map
3b.or 4b. prime	Quine McCluskey	Prime implicants and Essential prime implicants

<table>
<tr><td>implicant chart</td><td>method</td><td>prime implicant chart</td></tr>
<tr><td colspan="3">Unit-3:Combinational Circuits 14 Hours
Design procedure, Half/full adders, Half / full subtractors, Carry look ahead adder, Multiplexer/De-Multiplexer, Encoder/Decoder, Priority encoders, Implementation of Higher-Order Device Using Lower Order devices, Implementation of combinational logic using MUX/Decoder, Magnitude Comparator.</td></tr>
<tr><th>Unit No</th><th>Module</th><th>Micro content</th></tr>
<tr><td rowspan="2">5a.or 6a.
Combinational Circuits fundamentals</td><td rowspan="2">Adders/subtractors</td><td>Half/full adders, Half / full subtractors, Carry look ahead adder</td></tr>
<tr><td>Magnitude Comparator.</td></tr>
<tr><td rowspan="2">5b.or 6b.
Implementation of combinational logic using MUX/Decoder</td><td rowspan="2">Mux/Demux
Applications of Mux/Demux</td><td>Multiplexer/De-Multiplexers & Encoder/Decoders</td></tr>
<tr><td>Implementation of Higher Order Device Using Lower Order devices.</td></tr>
<tr><td colspan="3">Unit-4:Sequential Circuits 12 Hours
Sequential Circuits Fundamentals: Basic Architectural Distinctions between Combinational and Sequential circuits, SR Latch, Flip Flops: SR, JK, JK Master Slave, D and T Type Flip Flops, Excitation Table of all Flip Flops, Timing and Triggering Consideration, Conversion from one type of Flip-Flop to another.
Registers and Counters: Shift Registers Left, Right and Bidirectional Shift Registers, Applications of Shift Registers, Design and Operation of Ring and Twisted Ring Counter, Operation of Asynchronous and Synchronous Counters.</td></tr>
<tr><th>Unit No</th><th>Module</th><th>Micro content</th></tr>
<tr><td rowspan="2">7a.or 8a.
Sequential Circuits Fundamentals</td><td rowspan="2">Flip Flops</td><td>Distinctions between Combinational and Sequential circuits; types of triggering, types of flip flops,</td></tr>
<tr><td>Excitation Table of all Flip Flops; Conversion from one type of Flip-Flop to another.</td></tr>
<tr><td rowspan="3">7b. or 8b. Registers and Counters</td><td rowspan="3">Registers and Counters</td><td>Synchronous and asynchronous counters and also their design</td></tr>
<tr><td>Operation of Ring and Twisted Ring Counter</td></tr>
<tr><td>Shift Registers Left, Right and Bidirectional Shift Registers, Applications of Shift Registers</td></tr>
<tr><td colspan="3">Unit-5: Sequential Machines 8 Hours
Finite State Machines, Synthesis of Synchronous Sequential Circuits, Mealy and Moore models, Serial Binary Adder, Sequence Detector, Parity-bit Generator Synchronous Modulo N – Counters, Finite state machine capabilities and limitations.</td></tr>
<tr><th>Unit</th><th>Module</th><th>Micro content</th></tr>
</table>

9a.or 10a. Fundamentals of FSM	Fundamentals of FSM	Finite State Machines, Synthesis of Synchronous Sequential Circuits, Mealy and Moore models
		Finite state machine capabilities and limitations.
9b.or 10b. State Models	State Models and diagrams	Serial Binary Adder, Sequence Detector, Parity-bit Generator Synchronous Modulo N – Counters.

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	3	2	2							1				3
CO2	3	2	2							1				3
CO3	3	2	2							1				3
CO4	3	2	2							1				3
CO5	3	2	2							1				3

III-Year-II Semester	Special Electrical Machines	L	T	P	C
		3	0	0	3

PRE-REQUISITES:1) Electrical Machines-I &II

Course objectives: The student should be able to

1. To explain theory of different permanent magnetic material and applications.
2. To explain the performance and control of stepper motors, and their applications.
3. To describe the operation and characteristics of switched reluctance motor.
4. To explain the operation permanent magnet brushless square wave and sine wave motors
5. To explain the theory of travelling magnetic field and applications of linear motors

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Permanent magnet materials and PMDC motors(15hrs)** Introduction-classification of permanent magnet materials used in electrical machines-minor hysteresis loop and recoil line-Stator frames of conventional dc machines-Development of electronically commutated dc motor from conventional dc motor. **(07hrs)** Permanent-magnet materials and characteristics-B-H loop and demagnetization characteristics-Temperature effects: high temperature effects-reversible losses Irreversible losses -Application of permanent magnets in motors. **(08hrs)**	**CO1**
II	**Stepper Motors (14 hrs)** Classification of stepper motors – Hybrid and Variable Reluctance Motor (VRM) - Construction and principle of hybrid type synchronous stepper motor – Different configuration for switching the phase windings control circuits for stepper motors – Open loop and closed loop control of 2-phase hybrid stepping motor. **(08hrs)** Construction and principle of operation of Variable Reluctance Motor (VRM) – Single stack and multiple stack – Open loop control of 3- phase VR Stepper Motor- Applications**(06hrs)**	**CO2**
III	**Switched Reluctance Motors (10hrs)** Construction – Comparison of conventional and switched reluctance motors – Design of stator and rotor pole arcs – Torque producing principle and torque expression **(5 hrs)** Different converter configurations for SRM – Drive and power circuits for SRM – Position sensing of rotor – Applications of SRM**(5 hrs)**	**CO3**
IV	**Square and Sine Wave Permanent Magnet Brushless DC Motor (15hrs)** Types of constructions – Surface mounted and interior type permanent magnet – Principle of operation of BLDC motor. Torque and EMF equations – Torque speed characteristics – Performance and efficiency- Square wave brushless motors with 120^0 and 180^0 magnetic areas commutation. **(8 hrs)**	**CO4**

	Sine wave Permanent Magnet Brushless Motor Torque and EMF equations – Torque/speed characteristics – Comparison between square wave and sine wave permanent magnet motors - Applications. **(7 hrs)**	
V	**Linear Induction Motors (10hrs)** Construction– principle of operation–Double sided LIM from rotating type Induction Motor **(5 hrs)** Schematic of LIM drive for traction – Development of one sided LIM with back iron equivalent circuit of LIM. **(5 hrs)**	**CO5**
Content Beyond the syllabus: **Powering A Generation:** Reactive Power Requirements in steady state-Conventional control strategies-Alternate control strategies sources of reactive power-AC Filters – shunt capacitors-synchronous condensers. (Elementary treatment only)		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	To understand theory of different permanent magnetic material and applications.**{Understand level, KL2}**
CO2	To explain the performance and control of stepper motors, and their applications.**{Understand level, KL2}**
CO3	To describe the operation and characteristics of switched reluctance motor **{ Understand level, KL2}**
CO4	To explain the operation permanent magnet brushless square wave and sine wave motors .**{Understand level, KL2}**
CO5	To explain the theory of travelling magnetic field and applications of linear motors . **{Understand level, KL2}**

Learning Resources
Text books:
1. Brushless Permanent magnet and reluctance motor drives, Clarenden press, T.J.E. Miller, 1989, Oxford. 2. Special electrical Machines, K.VenkataRatnam, University press, 2009, New Delhi.
Reference books:
1. Special Electrical Machines ,G.Janradhana, PHI Publishers
e- Resources & other digital material
1. https://nptel.ac.in/courses/108/102/108102156/

Micro-Syllabus

UNIT-I: Permanent magnet materials and PMDC motors (15 hrs)

Introduction-classification of permanent magnet materials used in electrical machines-minor hysteresis loop and recoil line-Stator frames of conventional dc machines-Development of electronically commutated dc motor from conventional dc motor. **(07 hrs**

Permanent-magnet materials and characteristics-B-H loop and demagnetization characteristics-Temperature effects: high temperature effects-reversible losses Irreversible losses -Application of permanent magnets in motors. **(08hrs)**

Unit	Module	Micro content
1.a or 2.aIPemanent magnet materials and PMDC motors	Permanent Magnetic Materials introduction	Introduction of Magnetic Materials
		classification of permanent magnet materials used in electrical machines
		minor hysteresis loop
		recoil line
		Stator frames of conventional dc machines
		Development of electronically commutated dc motor from conventional dc motor
1.b or 2.b I Permanent magnet materials and PMDC motors	Permanent Magnetic Materials characteristics	Permanent-magnet materials and characteristics
		Permanent-magnet materials and characteristics-B-H loop
		demagnetization characteristics
		Temperature effects: high temperature effects
		reversible losses Irreversible losses
		Application of permanent magnets in motors

UNIT-II: Stepper Motors (14 hrs)

Classification of stepper motors – Hybrid and Variable Reluctance Motor (VRM) - Construction and principle of hybrid type synchronous stepper motor – Different configuration for switching the phase windings control circuits for stepper motors – Open loop and closed loop control of 2-phase hybrid stepping motor. **(08hrs)**

Construction and principle of operation of Variable Reluctance Motor (VRM) – Single stack and multiple stack – Open loop control of 3- phase VR Stepper Motor- Applications**(06hrs)**

Unit	Module	Micro content
3.aor 4.a Stepper Motors	Hybrid Stepper Motor	Classification of stepper motors
		Construction of Hybrid Stepper Motor
		principle of hybrid type synchronous stepper motor
		Different configuration for switching the phase

		windings control circuits for stepper motors
		Open loop control of 2-phase hybrid stepping motor
		closed loop control of 2-phase hybrid stepping motor
3.b or 4.b Stepper Motors	Vriable Reluctance Motor (VRM)	Construction of Variable Reluctance Motor (VRM)
		principle of operation of Variable Reluctance Motor (VRM)
		Single stack and multiple stackoperation of Variable Reluctance Motor (VRM)
		Open loop control of 3- phase VR Stepper Motor
		Applications of stepper motor

Unit III Switched Reluctance Motors (10 hrs)
Construction – Comparison of conventional and switched reluctance motors – Design of stator and rotor pole arcs – Torque producing principle and torque expression **(5 hrs)**
Different converter configurations for SRM – Drive and power circuits for SRM – Position sensing of rotor – Applications of SRM**(5 hrs)**.

Unit	**Module**	**Micro content**
5.aor 6.aSwitched Reluctance Motors	Construction of Operation VR Motors	Construction of switched reluctance motor
		Comparison of conventional and switched reluctance motors
		Design of stator and rotor pole arcs
		Torque producing principle of switched reluctance motor
		torque expression of switched reluctance motor
5.b o 6.b Switched Reluctance Motors	Control of VR Motors	Different converter configurations for SRM
		Drive and power circuits for SRM
		Position sensing of rotor
		Applications of SRM

Unit IV Square and Sine Wave Permanent Magnet Brushless DC Motor (15 hrs)
Types of constructions – Surface mounted and interior type permanent magnet – Principle of operation of BLDC motor. Torque and EMF equations – Torque speed characteristics – Performance

and efficiency- Square wave brushless motors with 120^0 and 180^0 magnetic areas commutation. **(8 hrs)**Sine wave Permanent Magnet Brushless Motor Torque and EMF equations –Torque/speed characteristics – Comparison between square wave and sine wave permanent magnet motors - Applications. **(7 hrs)**		
Unit	**Module**	**Micro content**
7.a or 8.a Square and Sine Wave Permanent Magnet Brushless DC Motor	**Square Wave Permanent Magnet Brushless DC Motor**	Types of constructions – Surface mounted and interior type permanent magnet,
		Principle of operation of BLDC motor
		Torque and EMF equations
		Torque speed characteristics – Performance and efficiency-
		Square wave brushless motors with 120^0 and 180^0 magnetic areas commutation
7.b or .b Square and Sine Wave Permanent Magnet Brushless DC Motor	**Sine Wave Permanent Magnet Brushless DC Motor**	Construction of Sine wave Permanent Magnet Brushless Motor
		Torque and EMF equations
		Torque/speed characteristics
		Comparison between square wave and sine wave permanent magnet motors
		Applications
Unit V Linear Induction Motors (10 hrs) Construction– principle of operation–Double sided LIM from rotating type Induction Motor **(5 hrs)** Schematic of LIM drive for traction – Development of one sided LIM with back iron equivalent circuit of LIM. **(5 hrs)**		
Unit	**Module**	**Micro content**
9.a or 10.a Linear Induction Motors	Construction of Linear Induction motor	Construction of Linear Induction motor
		principle of operation Linear Induction motor
		Double sided LIM from rotating type Induction Motor
9.b or 10.b Linear Induction Motors	Applications of Linear Induction motor	Schematic of LIM drive for traction
		Development of one sided LIM with back iron
		equivalent circuit of LIM

CO PO MAPPING:

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

III-Year-II Semester	Advance Control Systems	L	T	P	C
		3	0	0	3

PRE-REQUISITES: 1) Control System
2) Analog Circuits -1
3) Engineering Mathematics -1

Course objectives: The student should be able to

1) To study the basic theory required for solving complex control problems.
2) To do analysis and modeling of systems and signals.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Concept of state space**-state space representation of system, solution of time invariant state equation- state transition matrix. Linear time varying System. Discrete system state space representation and solution (7hrs)	**CO1**
II	**Non-linear system**, types of non-linearity, singular point, non-linear system stability analysis- phase plane technique, construction of phase trajectories, isocline method. (8Hrs)	**CO2**
III	**Describing function analysis** : Basic concepts, derivation of describing functions for common non-linearities Describing function analysis of non-linear systems – Conditions for stability – Stability of oscillations. (9Hrs)	**CO3**
IV	**Lyapunov stability analysis**- definition of stability, instability and asymptotic stability. Lyapunov stability theorems. Stability analysis of simple linear systems. (9Hrs)	**CO4**
V	**MIMO systems-controllability**- Observability- Effect of pole-zero cancellation, Practical examples-controllable and uncontrollable systems- observable and unobservable systems. Optimal control system-definition- design using state variable feedback and error squared performance indices. (9Hrs)	**CO5**
Content Beyond the syllabus: Z-transfer function- block diagram- signal flow graph- discrete root locus.		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Graduates will be able to understand different state model of a system, and have the knowledge to find its solution. **{Knowledge & Understand (1 & 2) }**
CO2	Graduates will be able to understand nonlinear system models, and analyse its stability. {**Understand & Analyze (2 & 4)}**

CO3	Graduates will be able to analyse the describing function analysis of various nonlinear systems. {**Analyze (4)**}
CO4	Graduates will be able design different systems and analyse its stability using Lyapunov stability analysis.{ **Analyze & Design (4 & 6)**}
CO5	Graduates will be industry ready by analysis of controllability and observability of the dissimilar system. {**Analyze (4)**}

Learning Resources
Text books:
1. "Discrete Time Control Systems", K. Ogata, PHI, 1996. 2. "Modern Control Engineering", K. Ogata, PHI, 1996. 3. Modern Control Systems, R. C. Dorf and R. H. Bishop, 8th ed., Pearson Education, Delhi, 2004.
Reference books: 1. Process Control Instrumentation Technology, C. D. Johnson, 7th ed., Prentice Hall of India, New Delhi, 2003. 2. "Modern Control System Theory", M. Gopal, New Age International Publishers, 2nd edition,1996. 3. "Digital control and state variables methods", Madangopal, PHI, 1997. 4. Modern control engineering – Katsuhiko Ogata, Pearson Edn.
e- Resources & other digital material
1. http://nptel.iitm.ac.in/courses/108101037/
2. http://nptel.iitm.ac.in/video.php?subjectId=108102043
3. http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-Delhi/Control%20system%20design%20n%20principles/index.htm

Micro-Syllabus

Unit – 1: Concept of state space - state space representation of system, solution of time invariant state equation- state transition matrix. Linear time varying system. Discrete system state space representation and solution (7hrs)

Unit	Module	Micro content
Concept of state space	**Concept of state space**	State space representation of system
		Solution oftime invariant state equation
		State transition matrix
		Linear time varying system
		Discrete system state space representation and solution

Unit-2: Non-linear system, types of non-linearity, singular point, non-linearsystem stability analysis- phase plane technique, construction of phase trajectories, isocline method. (8Hrs)

Unit	Module	Micro content

Non-linear system	**Non-linear system**	Types of non-linearity
		Singular point
		Non-linearsystem stability analysis
		Phase plane technique
		Construction of Phase Trajectories
		Isoline Method.

Unit-3: **Describing function analysis**: Basic concepts, derivation of describingfunctions for common non-linearities Describing function analysis of non-linear systems – Conditions for stability – Stability of oscillations. (9Hrs).

Unit	Module	Micro content
Describing function analysis	**Describing function analysis**	Basic concepts
		Derivation of describingfunctions for common non-linearities
		Describing function analysis of non-linear systems
		Conditions for stability
		Stability of oscillations

Unit-4: Lyapunov stability analysis- definition of stability, instability andasymptotic stability. Lyapunov stability theorems. Stability analysis of simple linear systems. (9Hrs)

Unit	Module	Micro content
Lyapunov stability analysis	**Lyapunov stability analysis**	Definition of stability Instability andasymptotic stability Lyapunov stability theorems. Stability analysis of simple linear systems.

Unit-5: MIMO systems-controllability- Observability- Effect of pole-zero cancellation, Practical examples-controllable and uncontrollable systems- observable and unobservable systems. Optimal control system-definition- design using state variable feedback and error squared performance indices. (9Hrs)

Unit	Module	Micro content
MIMO systems-controllability	**MIMO systems-controllability**	Observability
		Effect of pole-zero cancellation
		Practical examples
		Controllable and uncontrollable systems
		Observable and unobservable systems
		Optimal control system-definition
		Design using state variable feedback
		Error squared performance indices.

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**															
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2	PSO-3
CO1	3	2	-	1	-	-	-	-	-	-	-	-	-	2	2
CO2	2	3	-	-	-	-	-	-	-	-	-	-	-	-	3
CO3	-	3	2	-	-	-	-	-	-	-	-	-	2	2	-
CO4	-	2	3	-	-	-	-	-	-	-	-	-	-	-	2
CO5	-	-	-	-	3	-	-	-	-	-	-	2	-	2	-

III-Year-II Semester	Solar and Wind Energy Conversion Systems	L	T	P	C
		3	0	0	3

PRE-REQUISITES:

1) **Power Electronics**

Course objectives: The student should be able to

1. Understand the principles and to study the control of Solar PV system.
2. Model and design the components of Solar PV energy system.
3. Study the principles and the mechanisms of wind energy conversion systems.
4. Obtain the mathematical models for DFIG, PMSG, stand alone and Grid Connected WECS system control.
5. Implement the control principles for PV & wind energy integration.

Syllabus

Unit No	Contents	Mapped CO
I	**Solar PV energy conversion(12 hrs)** Generic Photovoltaic Cell, Equivalent Circuits, Cells to Modules to Arrays, I –V Curve, Impacts of Temperature and Insolation, Shading impacts on I–V curves, I–V Curves for different loads, MPPT, System sizing, System Performance, Economics	CO1
II	**Solar PV System control (12 hrs)** Mathematical models -PV cell, PV Array, Battery pack, dc-dc converter, P&O MPPT technique, DC bus voltage regulation	CO2
III	**Wind Energy Conversion components (12 hrs)** **Basics of wind energy systems:** Components of WECS, Power obtained from the wind, Power Regulation, yaw control, Pitch control, stall control, Schemes for Maximum Power Extraction. **Wind Turbines & Generators:** Fixed-speed Induction Generator (FSIG) based Wind Turbines, Doubly Fed Induction Generator (DFIG) based Wind Turbines, Fully Rated Converter-based (FRC) Wind Turbines	CO3
IV	**Control of Wind Power Conversion (12 hrs)** Mathematical models for DFIG, PMSG, stand alone and Grid Connected WECS system control, Models for MPPT	CO4
V	**Grid Connection of Solar PV and Wind Power (12 hrs)** **PV integration technology:**PV inverter topologies- configurations and control strategies of solar PV integration. **Wind power integration technology:** Wind power and voltage control for synchronous and induction generators-based integration; active and reactive power control.	CO5

Content Beyond the syllabus:

1. Grid codes and technical regulations of Solar PV integration

2. Grid codes and technical regulations of Wind power integration
3. Integrating multiple renewable energy sources

LIST OF EXPERIMENTS

Any Ten of the following experiments are to be conducted:

1. Modelling of PV system
2. Modelling of DFIG based wind power system
3. Simulation of Grid connected PV MPPT (P&O) single stage
4. Simulation of Grid connected PV MPPT (P&O) double stage.
5. Virtual inertia emulation using PV Battery systems and its studies under varying loads
6. Grid connected DFIG wind generation analysis under varying wind, and grid conditions.
7. PV+BESS+Diesel generator simulation with virtual inertia in autonomous mode.
8. Use of ultra-capacitors to improve dynamic performance of PV+BESS+Diesel generator autonomous system
9. Fuel Cell grid integration studies and analysis.
10. Improving dynamic response with Fuel cell and Microturbine combination
11. Forecasting of wind and solar energy for techno-economic analysis

List of Additional Experiments: Any of the two experiments are to be conducted

1. Simulation study on Solar PV Energy System.
2. Modelling and simulation of electric vehicle charging system

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the principles and control of Solar PV Energy system **{Understand level, KL2}**
CO2	**Model** and Select Solar PV energy system components **{Create level, KL6}**
CO3	**Interpret**the principles and control of Wind Energy Conversion **{Apply level, KL3}**
CO4	**Model** and Select Solar Wind energy conversion system components**{Create level, KL6}**
CO5	**Apply** the control principles for PV & wind power - grid integration control**{Apply level, KL3}**

Learning Resources

Text books:

1. H.P. Garg & J. Prakash, "Solar Energy - Fundamentals and Applications", Indian Edition - First Revised Edition, Mc Graw Hill Education.
2. G. D. Rai, “Non-Conventional Energy Sources”, Khanna Publishers, First edition.

Reference books:

1. Solar Photovoltaics, Fundamentals, Technologies and Applications, Second Edition, Chetan Singh Solanki, PHI Learning Private Limited (2012).
2. Ali Keyhani Mohammad Marwali and Min Dai, Integration and Control of Renewable Energy in Electric Power System, John Wiley publishing company, 2nd Edition, 2010.

e- Resources & other digital material

1. https://www.coursera.org/learn/solar-energy-system-design

2.	https://nptel.ac.in/courses/103103206
3.	https://www.coursera.org/lecture/solar-energy-and-electrical-system-design/inverters-and-solar-panels-cgwIm
4.	https://onlinecourses.nptel.ac.in/noc21_ge04/preview
5.	https://link.springer.com/book/10.1007/978-3-319-14941-7

Micro-Syllabus

Unit I: Solar PV energy conversion (12 hrs)

Generic Photovoltaic Cell, Equivalent Circuits, Cells to Modules to Arrays, I –V Curve, Impacts of Temperature and Insolation, Shading impacts on I–V curves, I–V Curves for different loads, MPPT, System sizing, System Performance, Economics.

Unit No	Module	Micro content
1. Solar PV energy conversion	**Solar PV energy conversion**	Generic Photovoltaic Cell
		Equivalent Circuits
		Cells to Modules to Arrays
		I –V Curve
		Impacts of Temperature and Insolation
		Shading impacts on I–V curves
		I–V Curves for different loads
		Maximum power point tracking (MPPT)
		System sizing and Performance
		Economics

Unit-II: Solar PV System control (12 hrs)

Mathematical models -PV cell, PV Array, Battery pack, dc-dc converter, P&O MPPT technique, DC bus voltage regulation.

Unit No	Module	Micro content
2.Solar PV System control	**Solar PV System control**	Introduction to mathematical models
		Model of PV cell
		PV Array
		Battery pack
		Design of dc-dc converter
		Various MPPT techniques for solar PV systems
		P&O MPPT technique
		DC bus voltage regulation.

Unit-III:**Wind Energy Conversion components (12 hrs)**

Basics of wind energy systems: Components of WECS, Power obtained from the wind, Power Regulation, yaw control, Pitch control, stall control, Schemes for Maximum Power Extraction,

Wind Turbines & Generators: Fixed-speed Induction Generator (FSIG) based Wind Turbines, Doubly Fed Induction Generator (DFIG) based Wind Turbines, Fully Rated Converter-based (FRC) Wind Turbines

Unit No	Module	Micro content
9. Wind Energy Conversion components	**Basics of wind energy systems**	Components of WECS
		Power obtained from the wind
		Power Regulation
		yaw control
		Pitch control
		stall control
		Schemes for Maximum Power Extraction
	Wind Turbines & Generators	Fixed-speed Induction Generator (FSIG) based Wind Turbines
		Doubly Fed Induction Generator (DFIG) based Wind Turbines
		Fully Rated Converter-based (FRC) Wind Turbines

Unit-IV Control of Wind Power Conversion (12 hrs)
Mathematical models for DFIG, PMSG, stand alone and Grid Connected WECS system control, Models for MPPT.

Unit No	Module	Micro content
4.Control of Wind Power Conversion	**Control of Wind Power Conversion**	Mathematical models for DFIG
		Mathematical models forPMSG
		Stand-alone and Grid Connected WECS system control.
		Models for MPPT

Unit-V Grid Connection of Solar PV and Wind Power (12 hrs)
PV integration technology:PV inverter topologies- configurations and control strategies of solar PV integration.
Wind power integration technology: Wind power and voltage control for synchronous and induction generators-based integration; active and reactive power control.

Unit No	Module	Micro content
5.Grid Connection of Solar PV and Wind Power	**PV integration technology**	PV inverter topologies
		PV inverter configurations
		control strategies of solar PV integration
	Wind power integration technology	Wind power and voltage control for synchronous generators-based integration
		Wind power and voltage control for induction-generators based integration
		active power control
		Reactive power control

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	3												3	
CO2		3											3	
CO3	3												3	
CO4		3											3	
CO5				2	3								3	

III-Year-II Semester	MICROPROCESSORS AND MICROCONTROLERS LAB	L	T	P	C
		0	0	3	1.5

PRE-REQUISITES: 1) MICROPROCESSORS AND MICROCONTROLERS Theory

Preamble: Microprocessors and Microcontrollers laboratory course helps the students to develop their knowledge on processor architecture and the programming skills. This laboratory course provides hands-on experience to interface I/O devices, perform stepper motor rotation and writing assembly level language programs etc. The skills acquired through the experiments help the students to dotheir projects and enhance their knowledge on the latest trends and technologies.

Course objectives:

The main objectives are

1. To perform arithmetic, logical, string and port operations using 8086 emulator software.
2. To implement timer and serial data operations using 8051microcontroller.
3. To interface 8255 and 8279 using8086Objective.

List of Experiments: Any 10 of the following experiments are to be conducted

1. ARITHMETICOPERATIONS
   a. Multi byte addition and subtraction, multiplication and division
   b. ASCII – addition and subtraction, multiplication and division.
2. LOGICOPERATIONS
   a. Packed BCD to UnpackedBCD
   b. BCD toASCII
   c. Find the number of elements in the array having “1” in their 5^{th}position.
3. STRINGOPERATIONS
   a. Change position of word in a given string
   b. Reverse the given string
   c. Insert a word into given string
   d. Remove a word from given string
   e. Find length of the string.
4. PORTOPERATIONS
   a. Read data from port 1 and increment it by 1 and transfer it to port2.
   b. Transfer 1 to 10 continuously port1.
5. TIMER IN DIFFERENT MODES USING8051
   a. Produce 1khz square wave with 50% duty cycle using timer 0 in mode0.
   b. Produce 1khz square wave with 50% duty cycle using timer 0 in mode1
   c. Produce 1khz triangular wave with 50% duty cycle using timer 0 in mode1
6. SERIAL DATACOMMUNICATION
   a. Receive data serially.

b. Transfer “HELLO” serially at 9600 band, 8 bit data and 1 stopbit.

7. Addition & Subtraction using 8086Kit
8. Interfacing 8279 – Key board Display.
9. Interfacing8255–PPI.
10. Stepper motor control using8253/8255

List of Additional Experiments: Any 2 of the following experiments are to be conducted

1. Interfacing of 8259- Programmable Interrupt Controller.
2. Traffic light control using 8051 micro controller.
3. A/D and D/A converter using8255.

Software(s)/ Hardware(s) used: EMU8086, 8255, 8259 and 8279 interfacing boards.

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Understand and apply the fundamentals of assembly level programming of microprocessor.**{Knowledge level, KL1, KL3}**
CO2	Design and implement 8051 microcontroller based systems **{Knowledge level, KL1, KL2}**
CO3	Design interfacing circuits with 8086. **{Knowledge level, KL1, KL2}**

CO–POs& PSOs Mapping:

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	3	1	1	1	1									
CO2	2	1	1	1	1									
CO3	2	1	1	1	2									

III-Year-II Semester	Power Systems Laboratory	L	T	P	C
		0	0	3	1.5

PRE-REQUISITES:

1. Power generation, Transmission and Protection
2. Power System Analysis

Preamble: To impart the practical knowledge of functioning of various power system components and determination of various parameters and simulation of load flows, transient stability, LFC and Economic dispatch.

Course Objectives: The student should be able to

1. To control the speed of three phase induction motors.
2. To determine /predetermine the performance of three phase induction.
3. To determine /predetermine the performance of single-phase induction.
4. To improve the power factor of single-phase induction motor.
5. To predetermine the regulation of three–phase alternator by various methods, find Xd/ Xq ratio of alternator and asses the performance of three–phase synchronous motor.

LIST OF EXPERIMENTS

Any Ten of the following experiments are to be conducted:

1. Sequence impedances of 3-phase transformer
2. Sequence impedances of 3-phase alternator by fault analysis
3. Calibration of Tong tester
4. ABCD parameters of transmission network
5. Load flow study using Gauss-Seidel method
6. Load flow study using Newton-Raphson method
7. Economic load dispatch without transmission losses
8. Economic load dispatch with transmission losses
9. Load frequency control of single area system without controller
10. Load frequency control of single area system with controller
11. Load frequency control of two area system without controller
12. Load frequency control of two area system without controller

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

CO1	Able to understand affect of various faults in various power system components.
CO2	Students can execute energy management systems functions at load
CO3	Able to determine the parameters of various power system components
CO4	Able to understand the power flows and stability in power system.

Learning Resources
Textbooks:
1. Nagrath I J and Kothari D P , “Modern Power System analysis” Tata McGraw Hill 2. Wadhwa C L “Electrical Power Systems” New Age International 3. Badri Ram and Vishwakarma D N “Power System Protection and Switch Gear” Tata McGraw Hill. 4. Ned Mohan, First Course in Power Systems, Wiley.
Reference books:
1.Power System by V. K. Mehta. 2.“Power systems and analysis” by Hadisaadat, Tata McGraw Hill
e- Resources & other digital material
1.https://nptel.ac.in/courses/108/105/108105017
2.https://nptel.ac.in/courses/103/102/108102146
3.www.nptelvideos.in/2012/11/electrical-power systems-i.html
*4.*https://www.electrical4u.com/power systems

CO-PO mapping Table with Justification:

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
Mapping	P01	P02	P03	P04	P0 5	P0 6	P 07	P08	P09	P010	P01 1	P012	PS01	PSO2
C01	1	1	1	1	1	-	-	-	1	-	-	_	-	2
C02	1	2				-	-	-	1	-	-	_	-	2
C03	2	2	2	2	-	-	-	-	1	-	-	_	-	1
C04	2	2	2	2	-	-	-	-	1	-	-	_	-	1

III-Year-II Semester	Electrical Simulation Laboratory	L	T	P	C
		0	0	3	1.5

PRE-REQUISITES: 1) Electrical circuit analysis 2) Electrical Power systems Theory

Preamble: Electrical Simulation lab provides the essential facilities to the students to augment their concepts about the fundamentals of basic circuits and simulate integrator circuit, differentiator circuit, Boost converter, Buck converter, full convertor and PWM inverter. To perform transient analysis of RLC circuit. The lab covers the determination stability analysis of linear time invariant system using matlab of 8056 microprocessor, 8051 microcontroller.

Course Objectives: The student should be able to

1. To study programming based on 8086 microprocessor and 8051 Microcontroller
2. To study 8056 microprocessor based ALP using arithmetic, logical and shift operations
3. To study modular and Dos/Bios programming using 8086 microprocessor
4. To study to interface 8086 with I/O and other devices. parallel and serial communication using 8051 microcontroller

LIST OF EXPERIMENTS

Any Ten of the following experiments are to be conducted:

1. Transient response of rlc circuits.
2. Analysis of three-phase circuit representing the generator, transmission line and load
3. Modeling of transformer.
4. Integrator & differentiator
5. Single-phase full converter.
6. Single-phase ac voltage converter.
7. Buck & boost converter
8. Single-phase inverter with pwm control.
9. Three-phase full converter.
10. Stability analysis (bode, root locus, nyquist) of linear time invariant system using matlab.

List of Additional Experiments: Any of the two experiments are to be conducted

1. Simulation of three phase full converter using MOSFET and IGBTS.
2. Pspice simulation of Reasonant Pulse Communication Circuit..

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

Course Outcomes	
CO1	Able to write assembly language program using 8086 micro based on arithmetic, logical, and shift operations. (**Analyze**)
CO2	Able to Will be able to do modular and Dos/Bios programming using 8086 micro processor. (**Remember and Understand**)
CO3	Able to interface 8086 with I/O and other devices (**Analyze**)
CO4	Able to do parallel and serial communication using 8051 micro controllers. (**Evaluate**)

Learning Resources
Text books:
1. "Simulation of Power Electronic Circuit", by M.B. Patil, V.Ramanarayan, V.T. Ranganathan. Narosha, 2009. 2. Pspice for circuits and electronics using PSPICE – by M.H.Rashid, M/s PHI Publications. 3. Pspice A/D user`s manual – Microsim, USA.
Reference books:
1. The Art of Simulation using PSPICE- Taylor &Francis 2. A Guide to Circuit Simulation and Analysis using PSPICE- Paul.W.Tuinenga 3. PSpice Simulation of Power Electronics Circuits **-** E. Ramshaw,D.C. Schuurman
e- Resources & other digital material
1.https://archive.nptel.ac.in/courses/108/108/108108166/
2.https://www.youtube.com/watch?v=Ml6_bxXrBGs
3. www.ee.tttb.ac.in/-sequel
4.https://www.eeweb.com/tools/online-spice-simulator/

O-PO mapping Table with Justification:

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
Mapping	P01	P02	P03	P04	P05	P06	P07	P08	P09	P010	P011	P012	PS01	PSO2
C01	2	2								2				
C02			2								1			
C03		1								2				
C04			1								2			

III-Year-II Semester Low Voltage Switchgear(SOC)

L	T	P	C
1	0	2	2

PRE-REQUISITES: 1) Power Systems and Electric Machines

Course objectives: The student should be able to study

6. The fundamentals of Switch gear.
7. The principle of operation of relays and classification
8. The Contactors working and circuit connections.
9. The applications of contactors.
10. The working of MPCB, MCCB, RCCB.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Fundamentals of Switchgear(6 hrs)** Need for switchgear and protection systems **(02 hrs)** Basics of relays and switchgear **(02 hrs)** Basics of fuse, HRC fuse and HRC fuse **(02 hrs)**	**CO1**
II	**Fundamentals of relays (08 hrs)** Relay connection, Principle and operation of electromagnetic relays **(02 hrs)** Classification of relays, I-T characteristics **(02 hrs)** Relay Applications, **(04 hrs)**	**CO2**
III	**Contactors and circuit connections (8hrs)** Construction of contactor.**(02hrs)** Circuit connection, working and characteristics **(02 hrs)** Types and applications (**02 hrs)** Control wiring of contactor .**(02 hrs)**	**CO3**
IV	**Applications of Contactors (08 hrs)** Protection of motors, Power wiring of contactors (**02 hrs)** DOL, RDOL starters using contactors (**03 hrs)** Star-Delta starter using contactors (**03 hrs)**	**CO4**
V	**MPCB, MCCB, RCCB (10 hrs)** Introduction, Principle and Operation of MPCB **(06 hrs)** Introduction, Principle and Operation of MCCB **(02hrs)** Introduction, Principle and Operation of RCCB **(02hrs)**	**CO5**
Content Beyond the syllabus: **Advanced Protection devices:** Super switch, over load relay **Software:** Interfacing of protective devices through online. **<u>LIST OF EXPERIMENTS</u>** 1. To make control wiring and power wiring of contactor for induction motor.		

2. To make control wiring for contactor to work as RDOL starter 3. To make control wiring for contactor to work as STAR-DELTA starter 4. To make control wiring for contactor to work as reverse STAR-DELTA starter 5. To make control wiring for contactor to work as MPCB 6. To simulate the DOL starter through online using SIMOCODE. 7. To simulate the three RDOL starter through online suing SIMOCODE 8. To simulate overload protection through online using SIMOCODE

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the need for protection systems **{Understand level, KL2}**
CO2	**Explain** the principle and operation of various relays.**{Apply level, KL3}**
CO3	**Explain** the working of contactors **{ Apply level, KL3}**
CO4	**Perform** the connections of different types of starters.**{ Apply level, KL3}**
CO5	**Analyze** the need for MPCB, MCCB and RCCB.**{Analyze level, KL4}**

Learning Resources
Text books:
1. A text book on Power System Engineering by M.L. Soni, P.V.Gupta, U.S. Bhatnagar and A. Chakrabarti, Dhanpat Rai& Co Pvt. Ltd. 2. Electrical power systems by C.L.Wadhwa, New Age International (P) Ltd, Publishers, 1998.. 3. Switchgear and protection by Sunil S. Rao Khanna Publications.
Reference books:
1. Fundamentals of Power System Protection by Paithankar Y.G and Bhide S.R. PHI, 2007 2. Handbook of Switchgears by BHEL, TMH, 2005.
e- Resources & other digital material
1. https://nptel.ac.in/courses/108107167
2. https://nptel.ac.in/courses/117107148

Micro-Syllabus

Unit – Fundamentals of Switchgear(6 hrs) Need for switchgear and protection systems **(02 hrs)** Basics of relays and switchgear **(02 hrs)** Basics fuse and HRC fuse **(02 hrs)**		
Unit No	**Module**	**Micro content**
Fundamentals of Switchgear	Protection system	Requirement of protection system
		Characteristics of protection systems
		Basic circuit of protection system
	Fuses	Fuse and fuse element

		Principle of operation of fuse and characteristics
		HV voltage fuses: HRC fuse and characteristics

Unit-2: Fundamentals of relays (08 hrs)
relay construction and operation **(02 hrs)**
Various types of relays **(02 hrs)**
Relay applications **(04 hrs**

Unit No	Module	Micro content
Fundamentals of relays	Relays	Construction and working of relays
		Classification of relays: Electromagnetic, static and numerical relays
		Application of relays different protection schemes
		OC protection, Under voltage protection
		Differential protection using relays
		Distance relays

Unit-3: **Contactors and circuit connections (8hrs)**
Construction of contactor.**(02hrs)**
Circuit connection, working and characteristics **(02 hrs)**
Types and applications (**02 hrs)**
Control wiring of contactor .**(02 hrs)**

Unit No	Module	Micro content
Contactors and circuit connections	Contactors	Switching devices in industries
		Contactors and its construction
		Terminals Working of contactors
	Circuit connections	Control wiring of contactors
		Power wiring of contactors

Unit-4:Applications of Contactors (08 hrs)
Power wiring of contactors (**02 hrs)**
DOL, RDOL starters using contactors (**03 hrs)**
Star-Delta starter using contactors (**03 hrs)**

Unit No	Module	Micro content
Applications of Contactors	Wiring of contactors	Single line diagrams of wiring circuits
		Control wiring with push buttons
	Applications	DOL starter connection using contactors for 3 phase induction motor
		RDOL starter connection using contactors for 3 phase induction motor
		STAR-DELTA starter connection using contactors for 3 phase induction motor

Unit-5: MPCB, MCCB, RCCB (10 hrs) Introduction, Principle and Operation of MPCB **(06 hrs)** Introduction, Principle and Operation of MCCB **(02hrs)** Introduction, Principle and Operation of RCCB **(02hrs)**		
Unit	**Module**	**Micro content**
MPCB, MCCB, RCCB	MPCB	Introduction to MPCB
		Construction and working of MPCB
		Applications of MPCB
	MCCB	Introduction to MCCB
		Construction and working of MCCB
		Applications of MCCB
	RCCB	Introduction to RCCB
		Construction and working of RCCB
		Applications of RCCB

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	2													
CO2	2													
CO3	2													
CO4	2	1	1		1									
CO5	2	1	1		1									

III-Year-II Semester	PLC and SCADA (SOC)	L	T	P	C
		1	0	2	2

PRE-REQUISITES:

Course objectives: The student should be able to

1. Study the fundamentals of PLC.
2. Study the PLC Hardware modules and implementation of PLC.
3. Study the Conceptsof PLC programmingand its applications.
4. Study the fundamentals of SCADA.
5. Study the Design and development of SCADA for various applications.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction to PLC(8hrs)** Identify the specified parts of thegiven PLC along with its function. ldentify different Programmingdevices types. Differentiate different types of PLCs.Explain with sketches the redundancy concept for the given PLC.	**CO1**
II	**PLC Hardware(08 hrs)** Identify and describe the given module of PLC. Describe the given addressing of PLC Use instruction set to perform the given operation.Develop ladder logic programs for the given application.Describe with sketches the steps to interface appropriate Input module with the given input device.	**CO2**
III	**PLC programmingand applications (10 hrs)** Specify the proper I/O addressing format for PLC.Describe the format of different relay type instructions.Describe the format of different Timer and counter Instructions.Describe the format of different Logical and Comparison type instruction. Describe the format of different data handling instructions. Describe the elements of different programming languages used to program PLC Develop PLC ladder program for the given simple example. Develop a PLC ladder program for the given industrial application.	**CO3**
IV	**Introduction to SCADA (06 hrs)** Describe applications of SCADA. Describe the function of the given element of SCADA Describe SCADA configuration. Differentiate SCADA and PLC.	**CO4**
V	**SCADA interfacing and Applications -(8hrs)** Interface the given PLC with the SCADA system using OPC. Describe the steps to develop SCADA system for given industrial application.Describe the steps to screen for a given application. develop a simple SCADA.	**CO5**
Content Beyond the syllabus: Digital electronics and Logic gates SCADA software: I ike Ellipse/FTVSE/Wonder ware etc.		

LIST OF SUGGESTEDEXPERIMENTS

1. Develop/Execute a ladder program to Verify functions of Logic gates.
2. Develop/Execute a ladder program to test the START STOP logic using two inputs and one output.
3. Develop/Execute a ladder program for sequential ON-OFF control of lamps.
4. Develop/ Execute ladder program for sequential control of DC motor.(Conditionl)and Develop/ Execute ladder program for sequential control of DC motor (use T OFF instruction).
5. Develop/ Execute ladder program for temperature ON-OFF control.
6. Develop /test ladder program for air conditioner system.
7. Develop/ Execute ladder program for temperature ON-OFF control.
8. Develop/ Execute ladder program for Traffic light control system.
9. Use various functions of SCADA simulation editors to develop simple project.
10. Develop a SCADA mimic diagram and tag database for conveyor system.
11. Develop a SCADA mimic diagram and tag database for On-Off control of lamp.
12. Develop a SCADA mimic diagram and tag database for Traffic light control system.

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Identify different components of PLC. **{Understand level, KL2}**
CO2	Select appropriate PLC modules for given application. **{Apply level, KL3}**
CO3	Develop PLC ladder program for a given application**{Analyze level, KL4}**
CO4	Test a simple SCADA application. **{Evaluate level, KL5}**
CO5	Test a simple PLC-SCADA application. **{Apply level, KL4}**

Learning Resources

Text books:

1. “Introduction to Programmable logic controllers’’. Dunning, G. Thomson /Delmar learning, 2005, ISBN 13 : 9781401884260
2. ‘’Programmable Logic Controller’’. Jadhav, V. R. Khanna publishers, 2017 ISBN: 9788174092281
3. “Supervisory control and Data acquisition’’. Boyar, S. A, ISA Publication (4th edition) ISBN: 978-1936007
4. ’Practical SCADA for industry’’. Bailey David ; Wright Edwin.Newnes (an imprint of Elsevier), 2003 ISBN:0750658053.

Reference books:

1. ‘’Programmable logic controllers (Fourth edition)’’, Petruzella, F.D, Tata — McGraw Hill India, 201 (),ISBN: 9740071067386.
2. ‘’Programmable logic controllers and Industrial automation An introduction’’, Mitra, Madhuchandra; Sengupta, Samarjit. Penram International Publication, 2015, Fifth reprint, ISBN: 9788187972174

e- Resources & other digital material
Software:- www.fossee.com www.logixpro.com
www.instrumentationengineers.org
www.ellipse.com

Micro-Syllabus

Unit – 1Introduction to PLC (8hrs)

Identify the specified parts of thegiven PLC along with its function. ldentify different Programming devices types. Differentiate different types of PLCs. Explain with sketches the redundancy concept for the given PLC.

Unit No	Module	Micro content
1. **Introduction to PLC(8hrs)**	Describe applications of SCADA. Describe the function of the given element of SCADA Describe SCADA configuration. Differentiate SCADA and PLC	1.1 Need and benefits of Automation. 1.2 Tools of Automation: PLC,SCADA, HMI, DCS, Drives. 1.3 PLC Architecture: Block diagram, workingCPU: function, scanning cycle, speed of executionMemory: organization and function.Input- output modules: discrete and analog, Specialty I/O Modules.Power supply: Block diagram, Working. 1.4 PLC Type: Fixed PLC, Modular PLC. 1.5 Redundancy in PLC system 1 .6 Advantages and Disadvantages of P L C

Unit-2: Introduction to PLC(8hrs)

Identify and describe the given module of PLC. Describe the given addressing of PLC Use instruction set to perform the given operation.Develop ladder logic programs for the given application.Describe with sketches the steps to interface appropriate Input module with the given input device.

Unit No	Module	Micro content
2. **Introduction to PLC(8hrs)**	Identify and describe the given module of PLC. Describe the given addressing of PLC Use instruction set to perform the given operation. Develop ladder logic programs for the given application.Describe with sketches the steps to interface appropriate	2.1 Discrete input modules: AC input modules – blockdiagram, description, wiring details, and specifications. DC input modules - block diagram, description, wiring details, sinking and sourcing concept & specifications 2.2Analog input modules- blockdiagram, description, interfacing ofinput devices & specifications. 2.3Discrete output modules: AC output modules - block diagram, description, wiring, and specifications.

	Input module with the given input device.	DC output modules - block diagram, description, wiring details, sinking and sourcing concept & specifications. Relay and Isolated o/p modules 2.4 Analog output modules- block diagram, description, wiring details& specifications 2.5. I/O module selection criterion.

Unit-3:**PLC programmingand applications(12 hrs)**
Specify the proper I/O addressing format for PLC.Describe the format of different relay type instructions.Describe the format of different Timer and counter Instructions.Describe the format of different Logical and Comparison type instruction.
Describe the format of different data handling instructions. Describe the elements of different programming languages used to program PLC Develop PLC ladder program for the given simple example. Develop a PLC ladder program for the given industrial application

Unit No	Module	Micro content
3. **PLC programmingand applications(10 hrs)**	Specify the proper I/O addressing format for PLC.Describe the format of different relay type instructions.Describe the format of different Timer and counter Instructions.Describe the format of different Logical and Comparison type instruction	3.1 PLC I/O addressing 3.2 PLC programming Instructions: Relay type instructions, timer instructions. On delay, off delay, retentive, Counter instructions: Up, Down, I ugh speed, Logical instructions. ComparisonInstructions, Data handling Instructions, Arithmetic instructions, Sequencer instruction, PID
3b.	Describe the format of different data handling instructions. Describe the elements of different programming languages used to program PLC Develop PLC ladder program for the given simple example. Develop a PLC ladder program for the given industrial application.	3.3 PLC programming language—Functional Block Diagram (FBD), Instruction List. Structured text, Sequential Function Chart SFC), Ladder Programming. 3.4 Simple Programming examples using ladder logic: Based on relay, timer, counter, logical, comparison, arithmetic and datahandling instructions, PID, Sequencer instruction. 3.5 PLC Based Applications: Motor sequence control, Traffic light control, elevator control, Tank Level control, conveyor system, Stepper motor control, Reactor Control

Unit-4:Introduction to SCADA (06 hrs) Describe applications of SCADA. Describe the function of the given element of SCADA Describe SCADA configuration. Differentiate SCADA and PLC.		
Unit No	**Module**	**Micro content**
12. Introduction to SCADA (06 hrs)	Describe applications of SCADA. Describe the function of the given element of SCADA Describe SCADA configuration. Differentiate SCADA and PLC	4.1 Introduction to SCADA, Application area of SCADA 4.2 SCADA architecture/block diagram, Benefits of SCADA 4.3 Types of SCADA: • Single Master Single Remote • Single Master Multiple Remote • Multiple Master Multiple Remote 4.4 SCADA System Hardware, • Remote Terminal Units (RTUs), • Master Terminal Units(MTUs) • Communication system 4.5Differentiate SCADA and PLC

Unit-5: SCADA interfacing and Applications -(8hrs) Interface the given PLC with the SCADA system using OPC. Describe the steps to develop SCADA system for given industrial application.Describe the steps to screen for a given application. develop a simple SCADA.		
Unit	**Module**	**Micro content**
5.SCADA interfacing and Applications -(8hrs)	Interface the given PLC with the SCADA system using OPC. Describe the steps to develop SCADA system for given industrial application.Describe the steps to screen for a given application. develop a simple SCADA	5.1 Interfacing SCADA system with PLC: Connection diagram, object linking and embedding for Process Control (OPC) architecture, 5.2 Steps in Creating SCADA Screen for simple object, Steps for Linking SCA DA object (defining Tags and it ms) with PLC ladder program using OPC, 5.3 Concept of Tag. types of Tagsaddressing of Tags 5.4 Alarm generation, trend types. 5.5 Applications of SCADA: On-Off control of lamp, Traffic light control, level control system, water distribution system, elevator system, conveyor system.

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1			1		1									2
CO2			1		1									2
CO3			1		1									2
CO4			1		1									2
CO5			1		1									2

III-Year-II Semester	PSCAD (SOC)	L	T	P	C
		1	0	2	2

PRE-REQUISITES: Not specific

Course objectives: The student should be able to
1. Study the fundamentals of PSCAD.
2. Study Basic components and Their specifications in PSCAD.
3. Study Various controls used in PSCAD.
4. Study the Modelling of Transformers in PSCAD.
5. Study DC converter configuration in PSCAD.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction to PSCAD(4 hrs)** What is PSCAD, some common models found in PSCAD, who uses PSCAD and for what**(02 hrs)** Classical example to Demonstrate PSCAD (**02 hrs)**	**CO1**
II	**Basic components and Their Specifications in PSCAD Library (08 hrs)** Sources, Transmission line, Transformer, Circuit Breakers, Surge Arresters **(02hrs)** Setting load flow with a generator**(02 hrs)** Fast front study data (Station Layout, Busbar dimensions, Transformer winding capacitance)**(04 hrs)**	**CO2**
III	**Controls (10 hrs)** CSMF components. Use of slider, switch, button and dial **(04hrs)** Applications of CSMF components**(06 hrs)**	**CO3**
IV	**Modelling of Transformers (06 hrs)** Core configuration, Ungrounded windings, saturation (**02hrs.)** Harmonic measurement**(02 hrs)** Load tap changer, phase shifting transformer (**02 hrs)**	**CO4**
V	**DC Transmission(10 hrs)** Why use DC Transmission, DC converter configuration**(06 hrs)** Twelve pulse converter modelling **(04hrs)**	**CO5**

Content Beyond the syllabus:
Modelling of FACTS: STATCOM control strategy.

LIST OF EXPERIMENTS
1. Transient response of RLC circuit using PSCAD.
2. Transformer inrush current using PSCAD.
3. power quality analysis using PSCAD.
4. Analyze symmetrical faults and short circuit studies in a given synchronous machine using PSCAD.

5. Development of PSCAD model to study the distance protection scheme in long transmission line. 6.Obtain the frequency response of single area power system using PSCAD

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the fundamentals of PSCAD Software**{Understand level, KL2}**
CO2	**Explain** the principle and working of Different components in PSCAD. **{Apply level, KL3}**
CO3	**Understand** different controls in PSCAD.**{Understand level, KL2}**
CO4	**Model** Transformer in PSCAD. {
CO5	**Analyze** twelve pulse converters in PSCAD. **{Apply level, KL4}**

Learning Resources
Text books:
1.Atousa Yazdani "Modern Distribution system with PSCAD Analysis", CRC Press.
Reference books:
1. Application Guide 2008 for PSCAD
e- Resources & other digital material
1. https://www.pscad.com/training-events/courses
2. https://elec-engg.com/pscad-training-for-protection-engineers/
3.https://www.powersystemdynamics.com/index.php/cad

Micro-Syllabus

Unit-1: Introduction to PSCAD(4 hrs) What is PSCAD, some common models found in PSCAD, who uses PSCAD and for what **(02 hrs)** Classical example to Demonstrate PSCAD (**02 hrs)**		
Unit No	**Module**	**Micro content**
1a. Introduction to PSCAD	Introduction to PSCAD	What is PSCAD
		some common models found in PSCAD
		who uses PSCAD and for what
1b. Classical example to Demonstrate PSCAD	Classical example to Demonstrate PSCAD	Network containing 3-phase voltage source, line impedance, and Load.
		Network containing 3-phase voltage source, Transmission line, and Load.
Unit-2: Basic components and Their Specifications in PSCAD Library (08 hrs) Sources, Transmission line, Transformer, Circuit Breakers, Surge Arresters **(02hrs)** Setting load flow with a generator**(02 hrs)** Fast front study data (Station Layout, Busbar dimensions, Transformer winding capacitance)**(04 hrs)**		
Unit No	**Module**	**Micro content**

2aBasic components and TheirSpecifications in PSCAD Library	Basic components and Their Specifications in PSCAD Library	Sources
		Transformers
		Transmission lines
		Circuit Breakers, Surge Arresters
2b.Setting load flow with a generator	Fast front study data	Station Layout
		Busbar dimensions
		Transformer winding capacitance
Unit-3:**Controls (10 hrs)** CSMF components. Use of slider, switch, button and dial **(04hrs)** Applications of CSMF components**(06hrs)**		
Unit No	**Module**	**Micro content**
3a.CSMF components	CSMF components	Use of slider
		switch
		button and dial
3b.Applications of CSMF components	Applications of CSMF components	Filtering with a second order function
		Controlling an Source
Unit-4:Modelling of Transformers (06 hrs) Core configuration, Ungrounded windings, saturation (**02 hrs.)** Harmonic measurement **(02hrs)** Load tap changer, phase shifting transformer (**02hrs)**		
Unit No	**Module**	**Micro content**
4.Modelling of Transformers	Modelling of Transformers	Core configuration
		Ungrounded windings
		saturation
		Harmonic measurement
		Load tap changer
		phase shifting transformer
Unit-5: DC Transmission (10 hrs) Why use DC Transmission, DC converter configuration**(06 hrs)** Twelve pulse converter modelling **(04hrs)**		
Unit	**Module**	**Micro content**
5.DC Transmission	DC Transmission	Why use DC Transmission
		DC converter configuration
		Twelve pulse converter modelling

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	3													
CO2	2													
CO3	2													
CO4			3		2									1
CO5			3											

III-Year-II Semester | Process Instrumentation (SOC)

L	T	P	C
1	0	2	2

PRE-REQUISITES:

Course objectives: The student should be able to

1. Selects measurement method for a process parameter by process instruments for temperature level, vibration, force and torque in a process plant.
2. Specify instrumentation for temperature level, vibration, force and torque application.
3. Identify, describe and Calibrate major instruments for temperature, level, vibration, force and torque in a process plant..

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	Introduction: Heat, Temperature, Temperature scales, Expansionthermometer,Solid Expansion Thermometer Bimetallic thermometer, Spiral Bimetal element, Helix Bimetal element.	**CO1**
II	Liquid Expansion Thermometer- Mercury in Glasstype, Filled system thermometer, Class I-Liquid FilledSystems, Class II- VapourSystems, Class III- Gas Filled Systems, Class V- Mercury Filled Systems, Thermocouples Principle: Seebeck,PeltierThomson effect.	**CO2**
III	Thermoelectric laws Cold junction compensation, Thermo well, Thermocouple extensionwires,Thermocouples selection criteria, Resistance Temperature Detector IndustrialRTD, 2-wireRTD, 3-wireRTD, 4-wireRTD, Thermostats, Integrated Circuit(IC) based Temperature sensors, Non-contact type thermometry, Radiation pyrometer, Optical pyrometer, Optical FibreThermometry, Ultrasonic thermometry, LaserthermometryTemperature switches and thermostats	**CO3**
IV	Level measurement: Importance and Units, Level measurement methods, Direct methods, Bob and Tape method, Sight glass method, Indirect methods, Pressure gauge type, Air bellows, Capacitance typelevelmeasurement and Radiation type level measurement.	**CO4**
V	Differential pressure type level measurement, Ultrasonic leveldetector,Laser Level Sensors, Optical Level detector Level switches: Float type level switch, Displacer level switch, conductivity level switch.	**CO5**

LIST OF EXPERIMENTS

1. Use liquid in glass type filled system thermometers
2. Perform temperature measurement using expansion thermometer
3. Measure temperature of given medium using given thermocouple with the helpofcorresponding thermocouple table.(Conversion of millivolt to temperature)
4. Verify the law of intermediate metal for available type of thermocouple.
5. Test the effect of reference junction temperature ongiventhermocouple
6. Convert output of thermocouple (mV) into temperature (˚C)using corresponding thermocouple calibration table.

7. Measure the temperature using RTD and Test. 8. Calculate temperature co-efficient of resistance using RTD. 9. Measure the temperature using Thermostats and Plotthecharacteristic curve. 10. Measure the temperature using IC temperature sensor

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand**. the concept of heat, temperature and temperature concepts**{Understand level, KL2}**
CO2	**Explain**. the different types of thermometers.**{Apply level, KL3}**
CO3	**Analyze** the different types of resistance thermometer detector.**{Analyze level, KL4}**
CO4	**Evaluate** the importance of Level measurement and its methods.**{Evaluate level, KL5}**
CO5	**Analyze the operation of**Differential pressure type level measurement.**{Apply level, KL4}**

Learning Resources
Text books:
1. Liptak, B. G ,Process Measurement andAnalysis.I.S.A publication. 2. Eckman, D. P,Industrial Instrumentation, Wiley Eastern Limited publication. 3. Singh, S.K ,Industrial Instrumentation, Tata Mc Graw Hill Publication
Reference books:
1. Krishnaswamy, K. and S.Vijayachitra, Industrial Instrumentation, New AgeInternational Publication, New Delhi. 2. Jain, R.K Mechanical and Industrial Measurements, Khanna publication, New Delhi
e- Resources & other digital material
1. http://www.pc-education.mcmaster.ca/Instrumentation/temperature.
2. http://www.dugantech.com/Product_Group-Temperature/Technical%20Articles/TE
3. http://www.pc-education.mcmaster.ca/Instrumentation/level.

Micro-Syllabus

Unit–1 Introduction: Heat, Temperature, Temperature scales, Expansionthermometer,Solid Expansion Thermometer Bimetallic thermometer, Spiral Bimetal element, Helix Bimetal element		
Unit No	**Module**	**Micro content**
1.aIntroduction: Heat, Temperature, Temperature scales	Introduction: Heat, Temperature, Temperature scales	Introduction: Heat, Temperature, Temperature scales
		Expansionthermometer,Solid Expansion Thermometer
		Bimetallic thermometer, Spiral Bimetal element, Helix Bimetal element

Unit-2: Liquid Expansion Thermometer- Mercury in Glass type, Filled system thermometer, Class I-Liquid Filled Systems, Class II- VapourSystems, Class III- Gas Filled Systems, Class V- Mercury Filled Systems, Thermocouples Principle: See beck, Pettier Thomson effect.

Unit No	Module	Micro content
2.a. Liquid Expansion Thermometer	Liquid Expansion Thermometer	Liquid Expansion Thermometer
		Mercury in Glass type, Filled system thermometer
		Class I-Liquid Filled Systems
VapourSystems and Gas Filled Systems	VapourSystems and Gas Filled Systems	Class II- VapourSystems, Class III- Gas Filled Systems
		Class V- Mercury Filled Systems
		Thermocouples Principle: See beck, Peltier Thomson effect

Unit-3:Thermoelectriclaws Cold junction compensation, Thermo well, Thermocouple extension wires, Thermocouples selection criteria, Resistance Temperature Detector IndustrialRTD, 2-wireRTD, 3-wireRTD, 4-wireRTD, Thermostats, Integrated Circuit(IC) based Temperature sensors, Non-contact type thermometry, Radiation pyrometer, Optical pyrometer, Optical Fiber Thermometry, Ultrasonic thermometry, Laser thermometry Temperature switches and thermostats

Unit No	Module	Micro content
Thermo-electric laws		Cold junction compensation, Thermo well, Thermocouple extension wires
		Thermocouples selection criteria, Resistance Temperature Detector Industrial RTD
		2-wireRTD, 3-wireRTD, 4-wireRTD, Thermostats, Integrated Circuit(IC) based Temperature sensors
		Non-contact type thermometry, Radiation pyrometer, Optical pyrometer, Optical Fibre Thermometry, Ultrasonic thermometry, Laser thermometry Temperature switches and thermostats

Unit-4: Level measurement: Importance and Units, Level measurement methods, Direct methods, Bob and Tape method, Sight glass method, Indirect methods, Pressure gauge type, Air bellows, Capacitance type level measurement and Radiation type level measurement.

Unit No	Module	Micro content
Level measurement: Importance and Methods		Level measurement: Importance and Units, Level measurement methods
		Direct methods, Bob and Tape method, Sight glass method
		Sight glass method, Indirect methods, Pressure gauge type, Airbellows,

		Capacitance typelevelmeasurement and Radiation type level measurement.
Unit-5: Differential pressure type level measurement, Ultrasonic leveldetector,Laser Level Sensors,OpticalLeveldetectorLevelswitches: Float type level switch, Displacer level switch, conductivity level switch.		
Unit	**Module**	**Micro content**
5aDifferential pressure type level measurement		Differential pressure type level measurement
		Ultrasonic leveldetector,Laser Level Sensors
		Optical LeveldetectorLevelswitches: Float type level switch
		Displacer level switch, conductivity level switch.

CO-PO mapping Table

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	3													
CO2	2													
CO3	3													
CO4	3													
CO5	2													

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