COURSE STRUCTURE (R19)

I Year I Semester						
S.No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	HS01	Communicative English (Common to ALL)	3	1	0	3
2	BS01	Mathematics – I (Common to ALL)	3	1	0	3
3	BS02	Applied Physics	3	1	0	3
4	ES01	Programming for Problem Solving using C (Common to ALL)	3	1	0	3
5	ES02	Engineering Graphics	1	0	0	2.5
6	HS01L	Communicative English Lab-I (Common to ALL)	0	0	0	1.5
7	BS02L	Applied Physics Lab	0	0	0	1.5
8	ES01L	Programming for Problem Solving Using C Lab (Common to ALL)	0	0	0	1.5
9	MC01	Constitution of India	3	0	0	0
Total Credits						**19**

I Year II Semester						
S.No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	BS03	Mathematics - II (Common to ALL)	2	1	0	3
2	BS04	Mathematics - III (Common to ALL)	2	1	0	3
3	BS05	Applied Chemistry	3	0	0	3
4	ES03	Data Structures	3	0	0	3
5	ES04	Basic Circuit Analysis	2	1	0	3
6	HS02L	Communicative English Lab - II (Common to ALL)	0	0	3	1.5
7	BS05L	Applied Chemistry Lab	0	0	3	1.5
8	ES03L	Data Structures Lab	0	0	3	1.5
9	ES05	Engineering Workshop	**0**	**0**	**3**	**1.5**
10	MC02	Environmental Studies	3	0	0	0
Total Credits						21

II Year I Semester						
S.No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	BS06	Complex Variables and Statistical Methods	2	1	0	3
2	ES06	Python Programming	2	0	0	2
3	ES07	Basic Electronic Devices and Circuits	3	1	0	3
4	PC01	Electrical machines -I	3	1	0	3
5	PC02	Electrical Circuit Analysis	2	1	0	3
6	PC03	Electromagnetic Fields	2	1	0	3
7	ES06L	Python Programming Lab	0	0	2	1
8	ES07L	Basic Electronic Devices and Circuits Lab	0	0	3	1.5
9	PC02L	Electrical Circuit Analysis Lab	0	0	3	1.5
10	MC03	Essence of Indian Traditional Knowledge	2	0	0	0
Total Credits						**21**

II Year II Semester						
S.No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	ES09	Thermal and Hydro Prime Movers	2	1	0	2
2	PC04	Linear IC Applications	2	1	0	2
3	PC05	Electrical Machines - II	2	1	0	3
4	PC06	Control Systems	2	1	0	3
5	PC07	Power systems-I	3	1	0	3
6	PC08	Digital Electronics	2	1	0	3
7	ES09L	Thermal and Hydro Prime Movers Lab	0	0	2	1
8	PC05L	Electrical Machines - I Lab	0	0	3	1.5
9	PC06L	Control Systems Lab	0	0	3	1.5
10	PR01	Social Relevant Project	0	0	2	1
Total Credits						**21**

III Year I Semester						
S.No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	PC09	Power Systems - II	2	1	0	3
2	PC10	Special Electrical Machines	3	0	0	3
3	PC011	Power Electronics	3	0	0	3
4	OE01	Open Elective I	2	0	0	2
5	OE02	Open Elective II	3	0	0	3
6	PE01	Professional Elective I 1. Utilization of Electrical Energy 2. Signals and Systems 3. Energy Conservation & Auditing 4. High Voltage Engineering	3	0	0	3
7	PC05L	Electrical Machines –II Lab	0	0	3	1.5
8	PC011L	Power Electronics Lab	0	0	3	1.5
9	OE01L	IoT Lab	0	0	2	1
Total Credits						**21**

III Year II Semester						
S.No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	HS03	Managerial Economics & Financial Analysis	3	0	0	3
2	PC012	Microprocessors & Microcontrollers	2	0	0	2
3	PC013	Electrical Measurements and Instrumentation	3	0	0	3
4	PC014	Power System-III	2	1	0	3
5	OE03	Open Elective III	2	0	0	2
6	PE02	Professional Elective II 1. HVAC & DC Transmission 2. Advanced Control Systems 3. Electrical Machine Design 4. Renewable Energy Sources	3	0	0	3
7	PC012L	Microprocessors & Microcontrollers Lab	0	0	3	1.5
8	PC013L	Electrical Measurements and Instrumentation Lab	0	0	3	1.5
9	PR02	Mini Project	0	0	4	2
Total Credits						**21**

IV Year I Semester						
S.No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	HS04	Management Science	3	0	0	3
2	PC015	Switch Gear and Protection	3	0	0	3
3	PC016	FACTS	3	0	0	3
4	OE04	Open Elective IV	3	0	0	3
5	PE03	Professional Elective III 1. Electric Drives 2. PLC (Programmable Logic controller) 3. Power System Reliability 4. Reactive Power Compensation & Management	3	0	0	3
6	PC015L	Power systems Lab	0	0	3	1.5
7	OE04L	Big Data Analytics lab	0	0	3	1.5
8	PR03	Project stage- I	0	0	6	3
Total Credits						**21**

IV Year II Semester						
S.No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	PE04	Professional Elective IV 1. Digital Control Systems 2. Advanced Linear Continuous Control Systems 3. Electric Power Quality 4. SCADA Systems and Applications	3	0	0	3
2	PE05	Professional Elective V 1. Electric Vehicles 2. Advanced in UHV Transmission and Distribution 3. Introduction to smart Grid 4. NPTEL/ MOOC Course	3	0	0	3
3	OE05	Open Elective V 1. Digital Signal Processing 2. Sensors and Actuators 3. Introduction to coding theory 4. NPTEL/MOOC Course	3	0	0	3
4	PR04	Project stage -II	**0**	0	12	6
Total Credits						**15**

OPEN ELECTIVES

Open Elective-I	Open Elective-II	Open Elective-III	Open Elective-IV
1. Internet of Things	1. Neural Networks & Fuzzy Logic	1. Machine Learning	1. Cyber Security
2.Electrical Machines Modelling and Analysis	2.Advanced Python Programming	2. Big Data Analytics	2. Deep Learning
3.MEMS	3.BlockChain Technology	3. Nano-Technology	3. Object-Oriented Software Engineering
4.Cyber Security	4. Digital Systems Design with VHDL	4. Digital Signal Processing	4.E-Wast Management

List of Open Elective Subjects offered by EEE Branch

Open Elective-I

1.Neural Networks
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 / NPTELcourses for 04 credits (02 courses @02 credits each)

I Year – I Semester

L	T	P	C
3	0	0	3

COMMUNICATIVE ENGLISH
(Common to All Branches)

Course Objectives

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

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 (L3)

CO2. formulate sentences using proper grammatical structures and correct word forms (L3)

CO3. speak clearly on a specific topic using suitable discourse markers in informal discussions (L3)

CO4. write summaries based on global comprehension of reading/listening texts (L3)

CO5. produce a coherent paragraph interpreting a figure/graph/chart/table (L4)

CO6. take notes while listening to a talk/lecture to answer questions (L3)

Syllabus Blueprint

Contents	**Learning Outcomes**	**Bloom's Level**	**No of Hrs**
Unit-1 **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.	1. Identify the context, topic, and pieces of specific information from social or transactional dialogues spoken by native speakers of English 2. ask &answer general questions on familiar topics 3. employ suitable strategies for skimming &scanning to get	L3 L2 L3	10

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: countables and uncountables; singular and plural; basic sentence structures; simple question form - wh-questions; word order in sentences.	the general idea of a text and specific information 4. recognize paragraph structure with beginnings/endings 5. form sentences using proper grammatical structures and correct word forms	 L3 L3	
Unit-2 **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, sign posts and transition signals; use of articles and zero article; prepositions.	1. comprehend short talks on general topics 2. speak clearly on a specific topic using suitable discourse markers in informal discussions 3. understand the use of cohesive devices for better reading comprehension 4. write well-structured paragraphs on specific topics 5. make necessary grammatical corrections in short texts	L2 L3 L2 L3 L3	10
Unit-3 **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 -	1. summarize the content with clarity &precision from short talks 2. report what is discussed in informal discussions 3. infer meanings of unfamiliar words using contextual clues 4. write summaries based on global comprehension of	L3 L3 L3 L3	10

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.	reading/ listening texts 5. use correct tense forms, appropriate structures and a range of reporting verbs in speech and writing	L3	
Unit-4 **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	1. infer &predict about content of spoken discourse 2. engage in formal/informal conversationsunderstanding verbal &non-verbal features of communication 3. interpret graphic elements used in academic texts 4. produce a coherent paragraph interpreting a figure / graph / chart / table 5. use language appropriate for description and interpretation of graphical elements	L4 L3 L2 L4 L4	10
Unit-5 **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	1. take notes while listening to a talk/lecture to answer questions 2. make formal oral presentations using effective strategies 3. produce a well-organized essay with adequate details 4. edit short texts by correcting	L3 L3 L3 L4	10

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)	common errors		

<u>Detailed Syllabus</u>

Unit 1 A Proposal to Girdle the Earth (Excerpt) by Nellie Bly
Theme: Exploration
1. "How to Fashion Your Own Brand of Success" by Howard Whitman
2. "How to Recognize Your Failure Symptoms" by Dorothea Brande

Listening

- identifying thetopic, the context and specific pieces of information

Speaking

- introducing oneself and others

Reading

- skimming for main ideas
- scanning for specific pieces of information

Writing/ Reading for Writing

- paragraphs, beginnings, introducing the topic, key words, main idea

Grammar and Vocabulary

- content words and function words
- word forms: verbs, nouns, adjectives and adverbs
- nouns: countable and uncountable; singular and plural forms
- basic sentence structures; simple question form: why-questions; word order in sentences

Learning Outcomes

- understand social or transactional dialogues spoken by native and non-native speakers of English and identify the context, topic, and pieces of specific information.
- ask and answer general questions on familiar topics and introduce oneself/others
- employ suitable strategies for skimming and scanning to get the general idea of a text and locate specific information
- recognize paragraph structure and be able to match headings/main ideas with paragraphs
- form sentences using proper grammatical structures and correct word forms

Unit 2 An excerpt from The District School As It Was by One Who Went to It by Warren Burton
Theme: On Campus

3. **"How to Conquer the Ten Most Common Causes of Failure" by Lois Binstock**
4. **"How to Develop Your Strength to Seize Opportunities" by Maxwell Maltz**

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; preparing and delivering short structured talks using suitable cohesive devices

Reading

- identifying sequence of ideas
- recognizing verbal techniques that help link the ideas in a paragraph

Writing/ Reading for Writing

- paragraph writing (specific topics) using suitable cohesive devices; using key words/phrases and organizing points in a coherent manner
- mechanics of writing: punctuation, capital letters

Grammar and Vocabulary

- cohesive devices-linkers, sign posts and transition signals
- use of articles and zero articles
- prepositions

Learning Outcomes

- comprehend short talks on general topics
- participate in informal discussions and speak clearly on a specific topic using suitable discourse markers
- understand the use of cohesive devices for better reading comprehension
- write well-structured paragraphs on specific topics using suitable cohesive devices
- identify basic errors of grammar/usage and make necessary corrections in short texts

Unit 3 The Future of Work?

Theme: Working Together

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**

Listening

- listening for global comprehension
- summarizing what is listened to

Speaking

- discussing specific topics in pairs/ small groups
- 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/ Reading for Writing

- summarizing-identifying main idea/s
- 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

Learning Outcomes

- comprehend short talks and summarize the content with clarity and precision
- participate in informal discussions and report what discussed
- infer meanings of unfamiliar words using contextual clues
- write summaries based on global comprehension of reading/listening texts
- use correct tense forms, appropriate structure and a range of reporting verbs in speech and writing.

Unit 4 H.G Wells and the Uncertainties of Progress by Peter J. Bowler

Theme: Fabric of Change

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 Reed**

Listening

- making predictions while listening to conversations/transactional dialogues without video
- listening with video

Speaking

- role plays for practice of conversational English in social and academic contexts (formal & informal)
- asking for and giving information/directions/instructions/suggestions

Reading

- understand and interpret graphic elements used in texts (convey information, reveal trends/patterns/relationships, communicate processes or display data)

Writing/ Reading for 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

Learning Outcomes

- make inferences and predictions while listening to spoken discourse
- understand verbal and non-verbal features of communication and hold formal / informal conversations
- interpret graphic elements used in academic texts
- produce a coherent paragraph interpreting a figure/graph/chart/table
- use language appropriate for description and interpretation of graphical elements

Unit 5 Leaves from the Mental Portfolio of a Eurasian by Sui Sin Far

Theme: Tools for Life

9.“How to Become a Self-Motivator” by Charles T Jones
10. “How to Eliminate Your Bad Habits”byOgMandino

Listening

- identifying the key terms
- understanding concepts
- 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/ Reading for Writing

- writing structured essays on specific topics using suitable claims and evidences

Grammar and Vocabulary

- reinforcing learning: articles, prepositions, tenses, subject-verb agreement

Learning Outcomes

- take notes while listening to a talk/lecture and make use of them to answer questions
- make formal oral presentations using effective strategies
- comprehend, discuss and respond to academic texts oral and in writing
- produce a well-organized essay with adequate support and detail
- edit short texts by correcting common errors

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

L	T	P	C
3	0	0	3

MATHEMATICS – I
(Common to ALL branches)

Course Objectives:

1. This course will illuminate the students in the concepts of calculus.
2. To enlighten the learners in the concept of differential equations and multivariable calculus.
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: 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: 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-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-4: 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: 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.

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.

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

- solve the differential equations related to various engineering fields.
- utilize mean value theorems to real life problems.
- familiarize with functions of several variables which is useful in optimization.

- apply double integration techniques in evaluating areas bounded by region.
- learn important tools of calculus in higher dimensions. Students will become familiar with 2-dimensional and 3 – dimensional coordinate systems.

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 $f_1(xy)\,y\,dx + f_2(xy)\,x\,dy = 0$
		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 $'\sin ax'$ (or) $'\cos ax'$
		Particular integral of the type x^n
		Particular integral of the type $'e^{ax}\,\mathrm{V(x)}'$
		Particular integral of the type $'\mathrm{x}^n\mathrm{v(x)}'$
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	**Partial Differentiation**	Euler’s theorem
		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

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I Year – I Semester

L	T	P	C
3	0	0	3

APPLIED PHYSICS
(Common to ECE and EEE)

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 of Physical Optics phenomena 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-I: Wave Optics:

Interference: Principle of Superposition-Interference of light – Conditions for sustained Interference-Interference in 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– 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-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– 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– V: Semiconductor Physics

Originofenergybands(qualitative) -Classificationofsolidsbasedonenergybands–Intrinsicsemiconductors-densityof charge carriers –Electrical conductivity-Fermi level -extrinsicsemiconductors-P-type&N-type-Densityof chargecarriers-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 Ajoy Ghatak, 6th Edition McGraw Hill Education, 2017.
3. "Solid State Physics" by A.J.Dekker, Mc Millan Publishers (2011).

Course Outcomes:

The students will be able to

1. **Understand** the principles such as interference and diffraction to design and enhance the resolving power of various optical instruments.
2. **Learn** the basic concepts of LASER light Sources and Apply them to holography
3. **Study** the magnetic and dielectric materials to enhance the utility aspects of materials.
4. **Learn** the fundamental concepts of Quantum behaviour of matter.
5. **Identify** the type of semiconductors using Hall Effect.

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	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 - Diffraction due to single slit	Differences between Fresnel’s and Fraunhofer’s 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	**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	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
		HysteresisCurve (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	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 inone dimensionalbox

Unit– V: Semiconductor Physics

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

Unit	Module	Micro content
V.Semiconductor Physics	Origin of energy bands	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 &Halleffect	Drift and Diffusion in semiconductors
		Einstein's Equation
		Hall Effect and it's applications

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

L	T	P	C
3	**0**	**0**	**3**

Programming for Problem Solving using C

(Common to All Branches)

Course Objectives:

1. To familiarize to notion of an algorithm, editing and executing programs in Linux.
2. To Understanding branching, iteration.
3. To represent Data using arrays.
4. To use Modular programming and recursive solution formulation.
5. To familiarize pointers and dynamic memory allocation.
6. To handle data through files

UNIT-I: Introduction to C

Introduction to Computers: hardware, Memory hierarchy, Types of Computers, Types of Software – Operating Systems, Translators, Device drivers and packages. Algorithms and its characteristics, Program development steps. Structure of a C program, Features of C, The main () Function, Standard I/O functions.

Programming Style - Indentation, Comments, Identifiers, Data Types**,** Operators, Precedence and Associativity. Variables and Declarations, Format Modifiers, Escape Sequences, Types of Statements

Casting - Implicit Type Conversions, Explicit Type Conversions, Mathematical Library Functions

UNIT-II: Control Flow & Modules

Selection: if-else Statement, nested if, examples, Multi-way selection: switch, else-if, examples.

Repetition: Basic Loop Structures, Pre-test and Post-test Loops, Counter-Controlled andCondition-Controlled Loops, for, while and do while.

Branching: break & continue.

Modular Programming: Function and Parameter Declarations, Returning a Value, Types of parameters. Parameter – scalar data as argument.

Recursion: Definition, Base condition for recursion, Mathematical Recursion, Recursion versus Iteration.

UNIT-III Arrays & Strings

Arrays: Introduction to Arrays, Input and Output of Array Values, Array Initialization, Arrays as Function Arguments, Two-Dimensional Arrays, Larger Dimensional Arrays- Matrices, 1D & 2D arrays as arguments.

Strings: String Fundamentals, String Input and Output, String Processing, Library Functions, Strings as arguments.

Unit – IV Pointers & Structures

Pointers: Concept of a Pointer, Initialization of Pointer variables, Pointers as function arguments, Passing by address, Dangling memory, Pointer Arithmetic, Character pointers, Pointers to Pointers, Array of pointers & Pointer to array, Dynamic memory management functions, Command line Arguments.

Structures: Derived types, Structure's declaration, Initialization of structures, accessing structures, nested structures, arrays of structures, structures and functions, pointers to structures, self-referential structures, unions, typedef, enum, bit-fields.

UNIT-V: Files

Storage classes – auto, static, extern, register. Pre-processor statements

Data Files: Declaring, Opening, and Closing File Streams, File handling functions, Reading from and Writing to Text Files, File copy, merge, Writing and reading records, Random File Access.

Text Books:

1. ANSI C Programming, E Balaguruswamy, Mc-GrawHill, 5th Edition
2. ANSI C Programming, Gary J. Bronson, Cengage Learning.
3. Programming in C, ReemaThareja, OXFORD Publications

Reference Books:

1. C Programming-A Problem Solving Approach, Forouzan, Gilberg, Cengage.
2. Let us C, YashwantKanetkar, BPB Publications
3. Mastering in C, KR Venu Gopal, TMH

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

CO 1: Understand algorithms and basic terminology of C

CO 2: Solve problems using control structures and modular approach

CO 3: Make use of 1D and 2D arrays along with strings for linear data handling

CO 4: Determine the use of pointers and structures

CO 5: Implement various operations on data files.

Correlation of Course Outcomes with Program Outcomes

	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

Micro-Syllabus of Problem Solving and Programming in C

UNIT I: Introduction to Computers: Hardware, Memory hierarchy, Types of Computers, Types of Software – Operating Systems, Translators, Device drivers and packages. Algorithms and its characteristics, Program development steps. Structure of a C program, Features of C, The main () Function, Standard I/O functions.

Programming Style - Indentation, Comments, Identifiers, Data Types**,** Operators, Precedence and Associativity. Variables and Declarations, Format Modifiers, Escape Sequences, Types of Statements

Casting - Implicit Type Conversions, Explicit Type Conversions, Mathematical Library Functions

Unit	Module	Micro content
Introduction to C	Introduction to Computers	Components of Computer: Hardware & Software
		Algorithm and its characteristics
		Program development steps
		Structure of a C Program
		Features of C
		The main () function and standard I/O functions

	Programming Style	Indentation, Comments, Identifiers, Data Types
		Operators, Precedence and Associativity. Variables and Declarations
		Format Modifiers, Escape Sequences
		Types of Statements
	Casting	Implicit Type Conversions
		Explicit Type Conversions
		Mathematical Library Functions

UNIT II: Selection: if-else Statement, nested if, examples, Multi-way selection: switch, else-if, examples. **Repetition**: Basic Loop Structures, Pre-test and Post-test Loops, Counter-Controlled andCondition-Controlled Loops, for, while and do while.
Branching: break & continue.
Modular Programming: Function and Parameter Declarations, Returning a Value, Types of parameters. Parameter – scalar data as argument.
Recursion: Definition, Base condition for recursion, Mathematical Recursion, Recursion versus Iteration.

Unit	**Module**	**Micro content**
Control Flow & Modular Programming	Selection Statements	if else, nested if examples
		Multi Way Selection: switch, else if examples
	Iterative Statements	Counter Controlled Loops
		Logic Controlled Loops
	Unconditional Branching	Break & Continue
	Modular Programming	Function and Parameter Declarations
		Returning a Value
		Types of parameters. Parameter – scalar data as argument.
	Recursion	Definition, Base condition for recursion
		Mathematical Recursion
		Recursion versus Iteration

UNIT III: Arrays: Introduction to Arrays, Input and Output of Array Values, Array Initialization, Arraysas Function Arguments, Two-Dimensional Arrays, Larger Dimensional Arrays- Matrices, 1D & 2D arrays as arguments.
Strings: String Fundamentals, String Input and Output, String Processing, Library Functions, Strings as arguments.

Unit	**Module**	**Micro content**
Arrays & Strings	Arrays	Introduction to Arrays, Input and Output of Array Values, Array Initialization
		Arraysas Function Arguments
		Two-Dimensional Arrays, Larger Dimensional Arrays
		Matrices, 1D & 2D arrays as arguments
	Strings	String Fundamentals, String Input and

		Output
		String Processing, Library Functions
		Strings as arguments

UNIT IV: Pointers: Concept of a Pointer, Initialization of Pointer variables, Pointers as function arguments,Passing by address, Dangling memory, Pointer Arithmetic, Character pointers, Pointers to Pointers, Array of pointers & Pointer to array, Dynamic memory management functions, Command line Arguments.

Structures: Derived types, Structures declaration, Initialization of structures, accessing structures,nested structures, arrays of structures, structures and functions, pointers to structures, self-referential structures, unions, typedef, enum, bit-fields.

Unit	Module	Micro content
Pointers and Structures	Pointers	Concept of a Pointer, Initialization of Pointer variables
		Pointers as function arguments,Passing by address
		Dangling memory, Pointer Arithmetic, Character pointers
		Pointers to Pointers
		Dynamic Memory Allocation
		Pointer to Arrays and Array of Pointers
	Command line Arguments	Command line Arguments
	Structures	Derived types, Structures declaration, Initialization of structures
		Accessing structures,nested structures, arrays of structures
		structures and functions, pointers to structures, self-referential structures
		Unions, typedef, enum, bit-fields.

UNIT V: Storage classes – auto, static, extern, register. Preproessor statements

Data Files: Declaring, Opening, and Closing File Streams, File handling functions, Reading from and Writing to TextFiles, File copy, merge, Writing and reading records, Random File Access.

Unit	Module	Micro content
Storage Classes and Files	Storage Classes	auto, static, extern and register
	Preprocessor Statements	Preprocessor Statements
	Data Files	Declaring, Opening, and Closing File Streams
		File handling functions, Reading from and Writing to TextFiles
		File copy, merge, Writing and reading records
		Random File Access

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I Year – I Semester

L	T	P	C
1	0	3	2.5

ENGINEERING GRAPHICS

Course Objectives:

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

UNIT-I: INTRODUCTION TO AUTOCAD:

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:

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:

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

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

UNIT V: ISOMETRIC PROJECTIONS

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

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

Websites
1 .https://www.autodesk.com.au/campaigns/autocad-tutorials
2. https://nptel.ac.in/courses/112104172

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}**

CO-PO Matrix:

	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

CO-PSO Matrix:

	PSO1	**PSO2**
CO1	–	1
CO2	–	1
CO3	–	1
CO4	–	1
CO5	–	1
CO6	–	1

1 – Slight (Low)	**2 – Moderate (Medium)**	**3 – Substantial (High)**	**"-" – No relation**

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I Year – I Semester

L	T	P	C
0	0	3	1.5

COMMUNICATIVE ENGLISH LAB I
(Common to All branches)

Course Objectives

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. identify the context, topic, and pieces of specific information from social or transactional dialogues spoken by native speakers of English and speak clearly on a specific topic using suitable discourse markers in informal discussions (L3)

CO2. take notes while listening to a talk/lecture; to answer questions in English; formulate sentences using proper grammatical structures and correct word forms; and use language effectively in competitive examinations (L3)

CO3. write summaries based on global comprehension of reading/listening texts; produce a coherent write-up interpreting a figure/graph/chart/table; and use English as a successful medium of communication. (L3)

Detailed Syllabus

CALL based activity. English course books selected for classroom teaching will be used for practice in the computer-based language labs. However, a brief introduction to the English Phonetics will be given to the students. Activities that encourage individual learning of the students based on the suggested texts and web resources will be used in the practical sessions.

Introduction to Sound System of English

Articulation - Airstream mechanism, Manners of Articulation, Places of Articulation, English phonetic symbols.

Accent - Syllabification, word stress and accent, stress rules and stress shift, exceptions to rules.

Intonation - Stress and accent in connected speech. Types and functions of Intonation in English.

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

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

2. “How to Recognize Your Failure Symptoms” by Dorthea Brand

3. “How to Conquer the Ten Most Common Causes of Failure” by Lois Binstock

4. **“**How to Develop Your Strength to Seize Opportunities” by Maxwell Maltz
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
7. “How to Win Your War Against Negative Feelings” by Dr Maxwell Maltz
8. “How to Find the Courage to Take Risks” by Tom Rust and Randy Reed
9. “How to Become a Self-Motivator” by Charles T Jones
10. “How to Eliminate Your Bad Habits” by OgMandino

Text Books

1. English All Round: Communication Skills for Undergraduate Learners-Volume 1, Orient Black Swan, 2019 (to be released)
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

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/shortstories.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/	

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

I Year – I Semester

L	T	P	C
0	0	3	1.5

APPLIED PHYSICS LAB

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.

Course Outcomes:

The students will be able to:

1. Operate optical instruments like microscope and spectrometer
2. Determine thickness of a paper with the concept of interference
3. Estimate the wavelength of different colours using diffraction grating and resolving power
4. Plot the intensity of the magnetic field of circular coil carrying current with distance
5. Calculate the band gap of a given semiconductor

<u>LIST OF EXPERIMENTS</u>

(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.

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

Strong: 3 **Moderate: 2** **Weak: 1**

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I Year – I Semester

L	T	P	C
0	**0**	**3**	**1.5**

Programming for Problem Solving Using C **LAB**

(Common to All Branches)

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 Control Flow - I

a) Write a C Program to Find Whether the Given Year is a Leap Year or not.

b) Write a C Program to find second biggest of three numbers (Assume that all the numbers are unique).

Exercise – 2 Control Flow - II

b) Write a C Program to Find Whether the Given Number is

i) Prime Number

ii) Armstrong Number

Exercise – 3 Control Flow - III

a) Write a C program to print Floyd Triangle

b) Write a C Program to print Pascal Triangle

c) Write a C program to display a Pyramid

Exercise – 4 Arrays - Demonstration of arrays

a) Search-Linear.

b) Sorting-Bubble

c) Operations on Matrix. - Add, Subtract, Multiply

Exercise – 5 Strings

a) Implementation of string manipulation operations **with** library function: Copy, length, compare

b) Implementation of string manipulation operations **without** library function: copy, length, compare

Exercise – 6 Functions

a) Write a C Program demonstrating of parameter passing in Functions and returning values.

b) Write a C Program illustrating Fibonacci, Factorial with Recursion without Recursion

Exercise – 7 Functions - Continued

Write a C Program to compute the values of sin x and cos x and ex values using Series expansion. (Use factorial function)

Exercise - 8 Arrays, Strings and Pointers

a) Write a C Program to find min and max of an array of elements using pointers

b) Write a C Program to concatenate one string to another using pointer.

Exercise – 9 Dynamic Memory Allocations

Write a C program to represent 1D and 2D arrays using malloc () function.

Exercises - 10 Structures

a) Write a C Program to Store Information of a Movie Using Structure

b) Write a C Program to sort a set of student records in ascending order.

c) Write a C Program to Add, subtract & multiply Two Complex Numbers.

Exercise -11 Files

a) Write a C programming code to open a file and to print it contents on screen.

b) Write a C program to copy the content of one file to another.

C) Write a C program merges two files and stores their contents in another file

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

1. **Comprehend** the various concepts of a C language
2. **Develop** algorithms and flowcharts
3. **Design** and development of C problem solving skills.
4. **Acquire** modular programming skills.

Correlation of Course Outcomes with Program Outcomes and Program Specific Outcomes

	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

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I Year – I Semester

L	T	P	C
3	0	0	0

CONSTITUTION OF INDIA

Course Objectives:

- To Enable the student to understand the importance of constitution
- To understand the structure of executive, legislature and judiciary
- To understand philosophy of fundamental rights and duties
- 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.
- 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.

LEARNING OUTCOMES:

After completion of this unit student will

- Understand the concept of Indian constitution
- Apply the knowledge on directive principle of state policy
- Analyze the History, features of Indian constitution
- Evaluate Preamble Fundamental Rights and Duties

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;

LEARNING OUTCOMES: - After completion of this unit student will

- Understand the structure of Indian government
- Differentiate between the state and central government
- Explain the role of President and Prime Minister
- Know the Structure of supreme court and High court

UNIT-III

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

LEARNING OUTCOMES: - After completion of this unit student will

- Understand the structure of state government
- Analyze the role Governor and Chief Minister
- Explain the role of state Secretariat
- Differentiate between structure and functions of state secretariate

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

LEARNING OUTCOMES: -After completion of this unit student will

- Understand the local Administration
- Compare and contrast district administration role and importance
- Analyze the role of Myer and elected representatives of Municipalities
- Evaluate Zilla panchayat block level organisation

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

LEARNING OUTCOMES: -After completion of this unit student will

- Know the role of Election Commission apply knowledge
- Contrast and compare the role of Chief Election commissioner and Commissionerate
- Analyze role of state election commission
- Evaluate various commissions of viz SC/ST/OBC and women

REFERENCES:

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

E-RESOURCES:

1. nptel.ac.in/courses/109104074/8
2. nptel.ac.in/courses/109104045/
3. nptel.ac.in/courses/101104065/
4. www.hss.iitb.ac.in/en/lecture-details
5. www.iitb.ac.in/en/event/2nd-lecture-institute-lecture-series-indian-constitution

Course Outcomes: At the end of the semester/course, the student will be able to have a clear knowledge on the following:

- Understand historical background of the constitution making and its importance for building a democratic India.
- Understand the functioning of three wings of the government ie., executive, legislative and judiciary.
- Understand the value of the fundamental rights and duties for becoming good citizen of India.
- Analyze the decentralization of power between central, state and local self-government.
- Apply the knowledge in strengthening of the constitutional institutions like CAG, Election Commission and UPSC for sustaining democracy.

Course Outcomes:

CO-1	Know the sources, features and principles of Indian Constitution.
CO-2	Learn about Union Government, State government and its administration.
CO-3	Get acquainted with Local administration and Pachayati Raj.
CO-4	Be aware of basic concepts and developments of Human Rights.
CO-5	Gain knowledge on roles and functioning of Election Commission

CO-PO Matrix:

	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

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I Year – II Semester

L	T	P	C
2	1	0	3

MATHEMATICS-II
(Common to All)

Course Objectives:

- To elucidate the different numerical methods to solve nonlinear algebraic equations
- To disseminate the use of different numerical techniques for carrying out numerical integration
- 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: (10 hrs)

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: (12 hrs)

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: (10 hrs)

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 hrs)

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 hrs)

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.

Text Books:

1. **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.

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

- Evaluate approximate in the roots of polynomial and transcendental equations by different algorithms (EVALUATE)
- 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)
- 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)
- Find or compute the Fourier series of periodic signals (SOLVE ,APPLY, FIND, ANALYSE)
- Know and be able to apply integral expressions for the forwards and inverse Fourier transform to range of non-periodic waveforms (SOLVE , APPLY, FIND)

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 & relation between various operators	Unequal spaced data & relation between various operators	Lagrange's interpolation formula
		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
	Numerical solution of ordinary differential equations for single variable	Taylors series method
3b. Numerical solution of ordinary differential equations for single variable		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

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I Year – II Semester

L	T	P	C
2	1	0	3

MATHEMATICS – III
(Common to ALL branches)

Course Objectives:

1. To instruct the concept of Matrices in solving linear algebraic equations
2. To familiarize the techniques in partial differential equations
3. To furnish the learners with basic concepts and techniques at plus two level to lead them into advanced level by handling various real-world applications

UNIT-I: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

UNIT-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.

UNIT – 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.

UNIT– IV: Vector Integration: (12 hrs)

Line integral – Work done – Circulation- Surface integral- Volume integral Vector integral theorems (without proof): Greens theorem in a plane- Stokes theorem- Gauss Divergence theorem.

UNIT– 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 $e^{ax+by}, \sin(ax+by), \cos(ax+by), x^m y^n$.

Text Books:

2. **B.S. Grewal,** Higher Engineering Mathematics, 44th Edition, Khanna Publishers.

Reference Books:

4. **B.V. Ramana,** Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.
5. **H.K.Das,** Advanced Engineering Mathematics, 22nd Edition, S. Chand & Company Ltd.
6. **Erwin Kreyszig**, Advanced Engineering Mathematics, 10th Edition, Wiley-India.

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

- develop the use of matrix algebra techniques that is needed by engineers for practical applications (L6)
- solve system of linear algebraic equations using Gauss elimination, Gauss Jordan (L3)

- to interpret the physical meaning of different operators such as gradient, curl and divergence (L5)
- estimate the work done against a field, circulation and flux using vector calculus (L5)
- identify the solution methods for partial differential equation that model physical processes (L3)

Micro-Syllabus of MATHEMATICS – III

UNIT-I: Solving system of linear equations, Eigen values and Eigen Vectors

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

Unit	**Module**	**Micro content**
1a. Solving system of linear equations	Rank of the given matrix	Find rank of the given matrix by reducing into Echelon form.
		Find rank of the given matrix by reducing into Normal form.(Canonical form)
	System of linear equations	Solve the system of homogeneous linear equations.
		Solve the system of Non- homogeneous linear equations.
		Solve the given system of linear equations using Gauss Elimination method.
		Solve the given system of linear equations using Gauss Jordan method.
1b.Applications	Eigen values and Eigen vectors	Find eigen values and Eigen vectors of given matrix.
	Properties of Eigen values and Eigen vectors	If λ is an eigen value of Matrix A then find eigen values of A^m or A^{-1} or $B = A^2+k_1A+K_2I$ or ….
		The eigen vectors corresponding to distinct eigen values of real symmetric matrix are orthogonal.

UNIT-II: Cayley-Hamilton theorem and quadratic forms:

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.

Unit	**Module**	**Micro content**
	Cayley-Hamilton theorem	Verify Cayley-Hamilton theorem for given matrix A and hence find A^{-1} or A^4.
	Quadratic Forms	Reduce the given matrix into diagonal form.
		Reduce the quadratic form into canonical form using orthogonal transformation method.

UNIT – III: Vector Differentiation:

Scalar and Vector point functions-Vector Differential operator- Gradient – Directional derivatives Divergence – Curl – Laplacian second order operator- Vector identities- Scalar Potential.

Unit	**Module**	**Micro content**
3a.	Divergent, Curl	Find Gradient of given scalar function.

Vector Differential operator	and Gradient	Find Unit normal vector at given point on given surface.
		Find divergent or Curl of given vector function.
3b. Vector identities	Vector identities	Find Scalar potential function.
		Problems on Laplacian second order operator.
		Prove the given vector identity.

UNIT– IV: Vector Integration:
Line integral – Work done – Circulation- Surface integral- Volume integral Vector integral theorems (without proof): Greens theorem in a plane- Stokes theorem- Gauss Divergence theorem.

Unit	Module	Micro content
4a. Vector integration	Line integraton, surface integration & volume integration	Evaluate given line integration along the given curve.
		Find work done by force in moving a particle from A to B along curve C.
		Find surface integral of vector function.
		Find volume integral of vector function.
4b. Vector integration theorems	Green's theorem ,Stoke's theorem and Gauss Divergence throem.	Verify Green's theorem.
		Evaluate using stoke's theorem.
		Evaluate using Divergence theorem.

UNIT– V: Solutions of Partial differential Equations: 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 $e^{ax+by}, \sin(ax+by), \cos(ax+by), x^m y^n$.

Unit	Module	Micro content
5a. First order PDE	Formation of PDE	Form PDE by eliminating arbitrary constants.
		Form PDE by eliminating arbitrary functions.
	Solve First order PDE	Solve first order linear PDE.
		Solve first order non linear PDE.
5b. Higher order PDE	Solve Second order PDE.	Solve Second order linear PDE with constant coefficients with RHS terms $e^{ax+by}, \sin(ax+by), \cos(ax+by), x^m y^n$.

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

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I Year – II Semester

	L	T	P	C
	3	**0**	**0**	**3**

APPLIED CHEMISTRY

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.

Learning 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-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-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-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)

Insulators, Ferro, Ferri Magnetic Materials, Hall Efect

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

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-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.

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.

Course Outcomes:

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

1. explain the preparation, properties and applications of thermoplastics, thermosettings, elastomers and conducting polymers.
2. know the importance of various materials and their uses in the construction of batteries and fuel cells.
3. know the applications of advanced materials in various industries.
4. apply the principles of supramolecular chemistry in the applications of molecular machines, need of green chemistry.
5. 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					

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I Year – II Semester

L	T	P	C
3	0	0	3

DATA STRUCTURES

Course Objectives:

1) To solve problems using data structures such as linear lists, stacks, queues.
2) To explore advanced data structures such as balanced search trees.
3) To be familiar with Graphs and their applications.
4) To analyze various sorting techniques.

UNIT-I: Arrays (12 hrs)

Introduction to data structures – Definition, types of data structures. Introduction to lists – operations: insert, delete, Searching- Linear Search, Binary Search. Sorting - Selection sort, Insertion Sort, Quick Sort, Merge Sort, and Heap Sort.

UNIT-II: Stack & Queue (10 hrs)

Introduction to Stack, Stack Applications- Evaluation of Expressions, Expression- Postfix Notation- Infix to Postfix, Decimal to binary conversion. Introduction to Queue and its operations – Enqueue, Dequeue. Circular queue operations, Applications.

Unit – III: Linked Lists (10 hrs)

Introduction to Single Linked List and its representation. Defining a Node in C – Implementation of operation: Insert, delete, search and sort. Circular Lists, Linked Stacks and Queues, Polynomials, Polynomial Representation- Adding Polynomials- Subtracting and multiplying two polynomials, Doubly Linked list – create, insert, delete, and view.

UNIT-IV: TREES (8 hrs)

Introduction, Terminology, Representation of Trees, Binary Trees, Properties of Binary Tress, Binary Tree Representations, Binary Tree Traversal, Introduction, Inorder Traversal Preorder Traversal, Postorder Traversal, Thread Binary Trees, Binary Search Trees, Definition, Searching a Binary Search Tree, Insertion into a Binary Search Tree.

UNIT-V: GRAPHS (12 hrs)

Introduction to Graphs, Definition, Graph Representation- adjacency matrix & adjacency list, Degree of vertex, Types of graphs, Elementary Graph Operation, Depth First Search, Breadth First Search, Spanning Trees - Minimum Cost Spanning Trees, Kruskal’s Algorithm, Prims Algorithm and Warshall’s algorithm.

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

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

CO1: Implement various operations on linear lists.

CO2: Apply data structure strategies like stacks and queues for exploring complex data structures.

CO3: Analyze performance and trade-offs of static and dynamic data structures..

CO4: Incorporate data structures into the applications such as binary trees, binary search trees.
CO5: Identify appropriate data structure algorithms for graphs.

Micro-Syllabus of Data Structures

Unit-1: Introduction to Data Structures, Definition, Need & Types of Data Structures
Introduction to lists – operations: insert, delete, Searching- Linear Search, Binary Search. Sorting - Selection sort, Insertion Sort, Quick Sort, Merge Sort, and Heap Sort

Unit	Module	Micro content
1a. Introduction to Data Structures	Introduction to Data Structures	Introduction to Data Structure
		Types of Data Structures
		Need of Data Structures
1b. Linear lists (Arrays)	Introduction to Linear Lists	Introduction to Arrays
		Operations on Arrays
		Searching-binary search and Fibonacci Search
1c.Sorting	Introduction to Sorting	Insertion Sort
		Quick Sort
		Merge Sort
		Radix Sort

UNIT-2
Stack & Queue
Stacks: Introduction, Operations – push, pop, underflow, overflow, peek and implementation, Applications – Infix to Postfix Conversion, Postfix evaluation.
Queues: Introduction, Operations – enqueue, dequeue, underflow, overflow and implementation, Applications – Circular Queue (operations), FIFO, Hot Potato Problem Simulation.

Unit	Module	Micro content
2.a Stack and queue	Stack	Introduction
		Operations-push,pop,underflow,overflow and peak
		Stack Implementation
		Applications- Decimal to binary.
		Infix to pre and postfix conversion, prefix to postfix conversion.
		Post fix Evaluation
	Queue	Introduction
		Operations- en-queue, dequeue, overflow,underflow
		Implementation
		Applications – Round robin Algorithm
		Circular queue
		Hot potato problem Simulation

Unit-3: Linked Lists
Single Linked List: Introduction, Differences between arrays & linked lists. Representation, Operations – insert, delete, concat, count and search, Applications – Polynomial representation, addition, multiplication.

Circular Lists: Introduction, Representation and implementation.
Doubly Linked list: Representation, Operations – insert, delete and search.

Unit	Module	Micro content
3.a.Linked Lists	Single Linked Lists	Introduction to Linked Lists
		Differences Between Arrays and Linked Lists
		Operations on Linked Lists
		Implementation
		Polynomial Representation
		Addition
		Multiplication
		Linked List Using Stack
		Linked List Using Queue
		Sparse matrix representation.
	Double Linked List	Introduction
		Differences Between Single Linked list and Double Linked List
		Operations
		Implementation
	Circular Linked List	Introduction
		Comparison of Circular and non circular Linked Lists
		Operations and Implementation
		Advantages and Disadvantages

Unit-4: TREES
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.
Binary Search Trees: Definition, Operations – insertion, deletion and findmin, findmax, count, leaf and Searching.

Unit	Module	Micro content
4a. Trees	Tree Terminology	Introduction to Trees
		Representation and Terminologies
4b.Binary Trees	Binary Trees	Introduction
		Tree Representation and Properties
		Conversion of General to binary tree, Construction of a binary tree from the tree traversals.
		Tree Traversal Recursive and non-Recursive approaches
		Types of Trees-Complete Binary Tree, Full Binary Tree,Thread Binary Tree
		Expression Trees
	Binary Search Trees	Introduction and Definition
		Operations on Binary Search Trees – insert,

		delete, height, count, counting leaf nodes, search.
		Advantages over Binary Trees
		Binary Search Tree Implementation

Unit-5: GRAPHS

Graphs: Introduction to graphs, Definition, Types of graphs, Degree of vertex

Representation **-** Adjacency matrix &Adjacency list

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.

Unit	**Module**	**Micro content**
5. a. Graphs	**Introduction and Representation**	Introduction
		Types of Graphs
		Graph Operations
		Memory representation-Matrix Representation and Linked list Representation
		Graph implementation
5.b. Graph Traversal	**Traversal Techniques and Minimum Spanning Trees**	Depth First Search
		Breadth First Search
		Prim's Algorithm
		Krushkal's Algorithm

CO – PO Mapping:

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

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

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I Year – II Semester

L	T	P	C
2	1	0	3

BASIC CIRCUIT ANALYSIS

Pre-Requisites: Integrations,
Laplace transforms and
Differential equations

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 No	Contents	Mapped CO
I	**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.	CO1
II	**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.	CO2
III	**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.	CO3
IV	**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.	CO4
V	**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.	CO5

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}**

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.Chakrabarti Danapat 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

<table>
<tr><td></td><td>2a,2b</td><td>Network reduction techniques</td><td>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)</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td rowspan="5">II</td><td rowspan="3">3a,3b</td><td rowspan="3">Introduction to Single phase ac systems</td><td>1. Introduction to single phase AC quantities different forms of representing periodic quantities.</td></tr>
<tr><td>2. Basic definitions and Calculation of Average, RMS, peak and form factor using Integration method- numerical problems.</td></tr>
<tr><td>3. Concept of phase, phase angle, phasor representation, phasor relation between quantities and j operator significance.</td></tr>
<tr><td rowspan="2">4a,4b</td><td rowspan="2">Steady state analysis of RLC circuits with AC excitation</td><td>4. Steady state analysis with AC excitation - Concept of impedence, admittance in RLC series and parallel networks - numerical problems.</td></tr>
<tr><td>5. Basic terms and definitions- real, reactive power, apparent power and power triangle.- numerical problems</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td rowspan="5">III</td><td rowspan="2">5a,5b</td><td rowspan="2">Analysis of circuit with AC excitation and resonance</td><td>1. Nodal analysis with AC excitation - numerical problems (Independent sources only)</td></tr>
<tr><td>2. Mesh analysis with AC excitation - numerical problems (Independent sources only)</td></tr>
<tr><td rowspan="3">6a,6b</td><td rowspan="3">Locus Diagrams of RLC networks</td><td>3. Concept of resonance and anti-resonance</td></tr>
<tr><td>4. Definition and derivations of selectivity, band width and Quality factor, voltage and current magnification factor- numerical problems</td></tr>
<tr><td>5. RL and RC locus diagrams with individual parameter variation- simple numerical problems</td></tr>
<tr><td colspan="4">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</td></tr>
</table>

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’s theorem - 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

CO-PO Matrix:

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

CO-PSO Matrix:

Course	**PSO1**	**PSO2**	**PSO3**
CO 1	2		
CO 2	2	2	
CO 3	2	2	
CO 4	1	1	
CO 5	1		
Average	1.6	1.7	

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

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I Year – II Semester

L	T	P	C
0	**0**	**3**	**1.5**

COMMUNICATIVE ENGLISH LAB - II
(Common to All Branches)

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 RebecaDuriga.
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/ http://l	

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 – II Semester

L	T	P	C
0	0	3	1.5

APPLIED CHEMISTRY LAB

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

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)

Note: Choice of any 10 experiments from the above.

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

- To estimate the amount of metal ions present in different solutions (L4 & L3)
- To analyze the quality parameters of water (L4)
- To determine the strength of different solutions by using different instrumentation techniques (L3)

Reference Books:

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

Learning 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.

Course Outcomes:

At the end of the course, the students will be able

- To estimate the amount of metal ions present in different solutions (L4 & L3)
- To analyze the quality parameters of water (L4)

- 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			

****

I Year – II Semester

L	T	P	C
0	0	3	1.5

DATA STRUCTURES LAB

Course Objectives:

1. To develop skills to design and analyze simple linear and nonlinear data structures.
2. To Strengthen the ability to identify and apply the suitable data structure for the given real world problem.
3. To Gain knowledge in practical applications of data structures.

List of Experiments:

Excercise-1: Implementation of Data Searching (Linear & Binary Search).
Excercise-2: Write C code for implementing sorting techniques: Selection & Insertion.
Excercise-3: Develop C code to demonstrate Merge Sort technique in C.
Excercise-4: Implementation of Quick Sort technique in C.
Excercise-5: Implement Stack operations using arrays –
i) push ii) pop iii) is Stack empty iv) is Stack full, v) peep vi) list.
Excercise-6: Implement Queue operations using arrays –
i) enqueue, ii) dequeue, iii) list, iv) is Queue empty, v) is Queue full
Excercise-7: Create a Circular Queue and its operations using arrays –
i) enqueue, ii) dequeue, iii) list, iv) is Queue empty, v) is Queue full
Excercise-8: Implement singly linked list and its operations:
i) insert, ii) delete, iii) search, iv) count.
Excercise-9: Create a Circular linked list and display the content.
Excercise-10: Implement doubly linked list and its operations:
i) Create ii) List iii) search.
Excercise-11: Develop C code for converting an Infix expression to postfix notation.
Excercise-12: Implementation of Binary Search trees operations: create, Inorder, Preorder, Postorder.
Excercise-13: Implementation of Heaps through C code.
Excercise-14: Develop C code to demonstrate Breadth First Search Techniques.
Excercise-15: Develop C code to demonstrate Depth First Search Techniques.

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

CO 1: Implement the data structures with the basic level knowledge.
CO 2: Design and analyze the time efficiency of the data structure.
CO 3: Design and analyze the Space efficiency of the data structure in the memory.
CO 4: Identifies the appropriate data structure for given problem.
CO 5: Compare and Contrast various data structures and design techniques in the area of Performance.

CO – PO Mapping:

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

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

****

I Year – II Semester

L	T	P	C
0	0	3	1.5

ENGINEERING WORK SHOP

Course Objective: To familiarize students with wood working, sheet metal operations, fitting and electrical house wiring skills

Wood Working: Familiarity with different types of woods and tools used in wood working and make following joints

a) Half – Lap joint
b) Dovetail joint
c) Bridle joint

Sheet Metal Working: Familiarity with different types of tools used in sheet metal working, Developments of following sheet metal job from GI sheets

a) Tapered tray b) Conical funnel c) Elbow pipe d) Brazing

Fitting: Familiarity with different types of tools used in fitting and do the following fitting exercises

a) V-fit b) Dovetail fit c) square fit d) Semi-circular e) Two Wheeler tyre puncture and change of two wheeler tyre

Electrical Wiring: Familiarities with different types of basic electrical circuits and make the following connections

a) Parallel and series b) Two-way switch c) Godown lighting d) Tube light
e) Three phase motor f) Soldering of wires

Course Outcomes: After completion of this lab the student will be able to

1. Apply wood working skills in real world applications. (L3)
2. Build different parts with metal sheets in real world applications. (L3)
3. Apply fitting operations in various applications. (L3)
4. Apply different types of basic electric circuit connections. (L3)
5. Demonstrate soldering and brazing. (L2)

CO-PO MATRIX:

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

CO-PSO Matrix:

	PSO1	PSO2
CO1	2	2
CO2	2	2
CO3	2	2
CO4	2	2
CO5	2	2

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I Year – II Semester

L	T	P	C
3	0	0	0

ENVIRONMENTAL STUDIES
(Common to CE, CSE & IT)

OBJECTIVE:

To make the students to get awareness on environment, to understand the importance of protecting natural resources, ecosystems for future generations and pollution causes due to the day-to-day activities of human life to save earth from the inventions by the engineers.

UNIT – I: MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES

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:

LEARNING OUTCOMES

Students will be able to

1. articulate the basic structure, functions, and processes of key social systems affecting the environment.
2. explain how water resources should be used.
3. articulate basic understanding of effects of modern agriculture on environment.
4. explain how various paradigms or world views and their implicit and explicit assumptions and values shape the viewer's perception of environmental problems and solutions.

UNIT – II: Ecosystems, Biodiversity, and its Conservation

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.

LEARNING OUTCOMES

Students will be able to

1. get a clear picture of structure and functions of ecosystems.
2. explain why renewable and non-renewable energy resources are important.
3. get awareness about land degradation, soil erosion & desertification.
4. gain a rigorous foundation in various scientific disciplines as they apply to environmental science, such as ecology, evolutionary biology, hydrology, and human behaviour.

UNIT – III: Environmental Pollution and Solid Waste Management

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.

LEARNING OUTCOMES UNIT-3

Students will be able to

1. Demonstrate knowledge and understanding of theories in the field of Biodiversity and Systematics in the broad sense.
2. Conduct basic conservation biology research.
3. Explain endangered and endemic species of India.
4. Identify the threats to biodiversity.

UNIT – IV: Social Issues and the Environment

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.

LEARNING OUTCOMES:

Students will be able to

1. Understand Cause, effects and control measures of air pollution.
2. Understand soil, noise & water pollution.
3. Explain the enforcement of Environmental legislation

4. Understand solid waste management.

UNIT – V: Human Population and the Environment

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-Urban/Rural/Industrial/Agricultural Study of common plants, insects, and birds – river, hill slopes, etc.

LEARNING OUTCOMES

Students will have

1. knowledge about watershed management and environmental ethics.
2. explain the reasons for global warming
3. explain principles and impact of disasters on environment.
4. explain disaster management cycle in India.

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

REFERENCES:

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.

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

COURSE OUTCOMES

CO1	Able to U**nderstand** The concepts of the ecosystem
CO2	Able to U**nderstand** The natural resources and their importance
CO3	Able to learn The biodiversity of India and the threats to biodiversity ,and **Apply** conservation practices
CO4	Able to learn Various attributes of the pollution and their impacts
CO5	Able to U**nderstand** Social issues both rural and urban environment
CO6	Able to U**nderstand** About environmental Impact assessment and **Evaluate** the stages involved in EIA

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II Year I Semester

L	T	P	C
2	1	0	3

COMPLEX VARIABLES AND STATISTICAL METHODS

Pre-Requisites:

1. Calculus
2. Partial Differentiation
3. Multiple Integration
4. Set Theory

Course objectives: The student should be able to

1. Familiarize the complex variables.
2. Familiarize the students with the foundations of probability and statistical methods.
3. Equip the students to solve application problems in their disciplines.

Unit No	Contents	Mapped CO
I	**Functions of complex variable and complex integration: (05 hrs)** Introduction – Continuity – Differentiability – Analyticity – Properties – Cauchy-Riemann equations in Cartesian and polar coordinates – Harmonic and conjugate harmonic functions – Milne-Thompson method. **Complex integration: (05 hrs)** Line integral – Cauchy's integral theorem – Cauchy's integral formula. (all without proofs).	**CO1**
II	**Series expansions and Residue Theorem: (05 hrs)** Radius of convergence – Expansion in Taylor's series, Maclaurin's series - Laurent's series. **Types of singularities: (05hrs)** Isolated – pole of order m – Essential – Residues – Residue theorem (without proof)	**CO2**
III	**Probability, Distributions and Sampling Theory: (07 hrs)** Probability-Baye's theorem-Random variables-Discrete and Continuous random variables-Distribution function-Mathematical Expectation and Variance **Application approach: (07 hrs)** Binomial, Poisson and Normal distributions, Population and samples-Sampling distribution of Means -Point and Interval estimations, **Applications: Maximum error of estimate – Bayesian estimate**	**CO3**
IV	**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. **Applications: Chi-square test and F-test on small samples.**	**CO4**
V	**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.	**CO5**

	Multiple regressions	

Advanced topics in this course:

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: Cauchy-Riemann equations to complex function in order to determine whether a given continuous function is analytic (**Apply**)

CO2: The differentiation, integration of complex functions used in engineering problems and make use of Cauchy residue theorem to evaluate certain integrals (**Apply**)

CO3: Discrete and continuous probability distributions and design the components of a classical hypothesis test **(Apply & Create)**

CO4: The statistical inferential methods based on small and large sampling tests. **(Analyze)**

CO5: Interpret the association of characteristics and through correlation and regression tools. **(Analyze)**

Text books:

1. B.S. Grewal, Higher Engineering Mathematics, 44^{th} Edition, Khanna Publishers.
2. S. C. Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, 11/e (Reprint) 2019, Sultan Chand & Sons Publications.

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, 8^{th} Edition, Cengage.

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)

Micro-Syllabus of Complex Variables and Statistical Methods

Unit-1: Functions of a 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.
Complex integration: Line integral – Cauchy’s integral theorem – Cauchy’s integral formula. (all without proofs).

Unit	**Module**	**Micro content**
1a. Analytic functions	Introduction of Analytic function	Cauchy-Riemann equations in cartesian
		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 Milen-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: 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	**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.
2 b) Residue theorem	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: Probability-Baye's theorem-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	**Module**	**Micro content**

3. Probability, Distributions and Sampling Theory	Probability	Find probability using Baye'e theorem
		Write probability distribution for given random variable. And find mean , variance and S.D. of random variable.
	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:
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	**Module**	**Micro content**
4a. Test of Hypothesis	Test significance of large samples	Test significance of single mean or proportions.
		Test significance of two means or proportions.
4b. Test of hypothesis	Test significance of small samples	Test significance of single mean
		Test significance of two means.

Unit 5: Curve fitting and Correlation:
Method of least squares-Straight line -Parabola-Exponential-Power curves -Correlation-Correlation coefficient -Rank correlation -Regression coefficient and properties-Regression lines.

Unit	**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 $y = a\ e^{bx}$
5 b) Correlation and regression	Correlation	Find correlation coefficient
		Find Karl Pearson's coefficient of correlation.
	Regression	Find regression coefficient and lines.

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	P05	P06	P07	P08	P09	P010	P011	P012	PS01	PSO2
C01		2												
C02		2												
C03	2	1												
C04	1	1												
C05	2	3												

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II Year I Semester

L	T	P	C
3	0	0	3

ELECTRICAL MACHINES-1

Pre-Requisites: Basic Electrical Circuits

Course objectives: The student should be able to

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

Uint No	Contents	Mapped CO
I	Electromechanical Energy Conversion :Principles of electromechanical energy conversion – singly excited-concept of co-energy -Force and torque derivation - multi excited system(qualitative treatment) Introduction to DC Generator: Construction and principle of operation of DC machine – EMF equation– 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. (10 hrs)	CO1
II	Performance of D.C. Motor: Torque and back-EMF equation of dc motor– characteristics of shunt, series and compound motors - losses and efficiency- applications of dc motors- Numerical problems. (10 hrs)	CO2
III	Starting, Speed Control of DC Motor: Necessity of starter –3 point and 4 point starters – Speed control of Shunt motor by armature voltage and field control. (04 hrs) Testing of D.C. Machines: Testing methods - Swinburne’s Test –Hopkinson’s Test -Brake Test on Shunt Motor–Load test on shunt generator-Numerical problems. (08 hrs)	CO3
IV	Single-phase Transformers: Principle of operation-Constructional details - EMF equation - operation on no load and on load - phasor diagrams. (04 hrs) Equivalent circuit and performance : Equivalent circuit –Voltage regulation – losses and efficiency –effect of variation of frequency and supply voltage on losses – All day efficiency-Numerical problems. (08 hrs)	CO4
V	Single phase Transformer Testing: 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. (07 hrs)	CO5

	Three Phase Transformers: Poly phase connections - Y/Y, Y/Δ, Δ/Y, Δ/Δ and open Δ-Scott connection. (03 hrs)	
Advanced Topics in this Subject: Load test on DC Shunt Generator, Internal and External characteristics of DC Shunt Generator.		

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. **(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: Empathise parallel operation of transformers and three-phase to two-phase Conversion. **(Understand)**

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, McGrawHill Publications, 4th edition
2. Electrical Machinery by Abijith Chakrabarthi and Sudhipta Debnath, McGraw 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://nptel.ac.in/courses/108/105/108105017/

Micro-Syllabus

Unit-1: **Electromechanical Energy Conversion and introduction to DC machines**

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 – 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	Module	Micro content
1a.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.
1b. 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

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	Module	Micro content
1. 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
	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**

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

Unit	Module	Micro content
3. Starting, Speed Control and Testing 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

	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

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

Equivalent Circuit and Performance:

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

Unit	Module	Micro content
4a. Single-phase Transformers	Principle of operation	principle of operation -Types(core, shell types) and constructional details -
		emf 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.
4b. 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

Single phase Transformer Testing: 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: Poly phase connections - Y/Y, Y/Δ, Δ/Y, Δ/Δ and open Δ-Scott connection.

Unit	Module	Micro content
5. Transformers Testing and Three Phase Transformers	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.

		auto transformer operation(**only theory**)– 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).

CO-PO mapping Table with justification:

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (High: 3, Medium: 2, Low: 1)

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

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II Year I Semester

L	T	P	C
2	0	0	2

PYTHON PROGRAMMING

Pre-Requisites: Nil

Course objectives: The student should be able to

1. To introduce the concepts of Python programming and build scripts using python language constructs, and control structures.
2. To impart knowledge of data structures in python and their application in real-time scenarios.
3. To introduce the concept of reusability using functions.
4. To introduce the concepts of OOPs in python programming.
5. To develop the concepts of interfacing hardware modules and building real-time systems using python and Raspberry Pi.

Unit No	Contents	Mapped CO
I	**Introduction to Python** **(16hrs)** **Introduction**: History of Python, Need of Python Programming, Introduction to Object-oriented Programming, Comparison with Modular Programming, Python Programming Basics, Sample programs, Data types and operators, Strings and Characters, Control statements, Expressions and order of evaluation, Arrays	
II	**OOPS &Data Structures** **(12hrs)** **OOPS:** Introduction, OOPs principles, Classes, Objects, Functions, Arguments & their types. Self variables and static keyword, Constructor Overloading, Lambda functions. **Data Structures**: Lists - Operations, Slicing, Methods; Tuples. Sets, Dictionaries, Sequences, Comprehensions	**CO2**
III	**Inheritance, Exceptions& Modules** **(14hrs)** **Inheritance:** Introduction, Types of Inheritance, Overriding, Access modifiers, Abstract Classes, Interfaces. **Exception Handling:** Error Vs Exception, Exception handling in python, Exception Hierarchy, usage of try, catch, throw. User Defined Exceptions. **Modules:** Creating modules, import statement, from. Import statement, name spacing, Using Python Packages like OS, Math, Date time, Regular Expressions.	**CO3**
IV	**Data & File Handling** **(10hrs)** **Data Handling:** Math, Numpy Library, scipy and Matplotlib - Loading the library and importing the data, How Mat plot lib works, modifying the appearance of a plot, Plotting multiple plots, Modifying the tick marks, Scatter plots, Bar plots. **File Input Output:** Introduction to files, File I/O handling – File Operations, Random Access file**.**	**CO4**
V	**Interfacing with Raspberry Pi** **(14hrs)** **Python programming on Raspberry Pi ::** Basic features, Raspberry Pi2B, Raspberry Pi3B, Raspberry Pi3B+ and Raspberry Pi4B, System setup and booting – Steps involved in making the raspberry pi board ready for use. Introduction to Raspbian Operating system, basic commands – Creating, deleting files,	**CO5**

	directories, listing files and directories, Python IDE on Raspberry Pi, Accessing the board, Basic I/O – Reading analog, digital inputs. **Interfacing with Raspberry Pi:** Purpose of datasheets, Interfacing – LED, 7-segment display, Ultrasonic sensor, Passive Infrared (PIR) sensor, interfacing a camera module with Raspberry Pi. (Programming using Python)	

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

CO1: Identify the basic python constructs with a view of using them in problem solving.**(Remember, Understand, and Apply)**

CO2: Apply control structures and use python lists in examples of problem solving.**(Understand, Apply, Analyze and Evaluate)**

CO3: Explore the utility of functions in modular programming using python. (**Apply, Analyze, valuate, and create)**

CO4: Apply the concepts of Object Oriented Programming to solve the real-time problems. **(Understand, Apply, Analyze)**

CO5: Interface hardware components with Raspberry Pi using Python APIs. **(Understand, Apply, Analyze and create)**

Text books:

1. R. Nageswara Rao, "Core python programming", 2nd Edition, Dreamtech, 2017.
2. Python Programming using problem solving Approach by Reema Thareja, 1st Edition, Oxford University Higher Education, 2017
3. Povel Solin, Martin Novak, "Introduction to Python Programming", NC Lab Public Computing, 2013.
4. Programming the Raspberry Pi: Getting Started with Python, 2nd Edition, Simon Monk, 2015.

Reference books:

1. Jacob Fredslund, "Introduction to Python Programming" 2007.
2. Y. Daniel Liang, "Introduction to programming using python", 1st Edition Pearson, 2017.
3. Bill Lubanovic, "Introducing Python - "Modern Computing in Simple Packages", 1st Edition, O'ReillyPublication, 2015.
4. Mark Summerfield, "Programming in Python 3" 2nd Edition, Pearson Education, 2010.
5. Magnus Lie Hetland, "Beginning Python –From Novice to Professional", APress Publication, 2017.

e- Resources & other digital material:

The official Raspberry Pi Beginner's Guide How to use your new computer, Gareth Halfacree. Available Online: https://www.raspberrypi.org/magpi-issues/Beginners_Guide_v1.pdf.

MICRO-SYLLABUS

Unit	Module Name	Micro-Topics
Introduction to Python **Introduction**: History of Python, Need of Python Programming, Introduction to Object-oriented Programming, Comparison with Modular Programming, **Python Programming Basics**, Sample programs, Data types and operators, Strings and Characters, Control statements, Expressions and order of evaluation, Arrays		

IntroductiontoPython	**Introduction to Python**	History of Python,Need of Python Programming, Introduction to Object-oriented Programming, Comparison with Modular Programming,
	Python Programming Basics	Sample programs, Data types and operators, Strings and Characters, Control statements, Expressions and order of evaluation, Arrays

OOPS & Data Structures

OOPS: Introduction, OOPs principles, Classes, Objects, Functions, Arguments & their types. Self variables and static keyword, Constructor Overloading, Lambda functions.

Data Structures: Lists - Operations, Slicing, Methods; Tuples. Sets, Dictionaries, Sequences, Comprehensions

IIOOPS & Data Structures	**OOPS**	Introduction, OOPs principles, Classes, Objects, Functions, Arguments & their types.Self variables and static keyword, Constructor Overloading, Lambda functions.
	Data Structures	Lists - Operations, Slicing, Methods; Tuples. Sets, Dictionaries, Sequences, Comprehensions

Inheritance, Exceptional Modules

Inheritance: Introduction, types of Inheritance, Overriding, Access modifiers, Abstract Classes, Interfaces.

Exception Handling: Error Vs Exception, Exception handling in python, Exception Hierarchy, usage of try, catch, throw. User Defined Exceptions.

Modules: Creating modules, import statement, from. Import statement, name spacing, Using Python Packages like OS, Math, Date time, Regular Expressions.

Inheritance, Exceptional Modules	**Inheritance**	Introduction, Types of Inheritance, Overriding, Access modifiers, Abstract Classes, Interfaces.
	Exception Handling	Error Vs Exception, Exception handling in python, Exception Hierarchy, usage of try, catch, throw. User Defined Exceptions.
	Modules	Creating modules, import statement, from. Import statement, name spacing, Using Python Packages like OS, Math, Date time, Regular Expressions.

Data & File Handling

Data Handling: Math, Numpy Library, scipy and Matplotlib - Loading the library and importing the data, How Mat plot lib works, modifying the appearance of a plot, Plotting multiple plots, Modifying the tick marks, Scatter plots, Bar plots.

File Input Output: Introduction to files, File I/O handling — File Operations, Random Access file.

Data & File Handling	**Data Handling**	Math, Numpy Library, scipy and Matplotlib – Loading the library and importing the data, How Mat plot lib works, modifying the

		appearance of a plot, Plotting multiple plots, Modifying the tick marks, Scatter plots, Bar plots.
	File Input Output	Introduction to files, File I/O handling – File Operations, Random Access file**.**

Interfacing with Raspberry Pi
Python programming on Raspberry Pi :
Basic features, Raspberry Pi2B, Raspberry Pi3B, Raspberry Pi3B+ and Raspberry Pi4B, System setup and booting – Steps involved in making the raspberry pi board ready for use. Introduction to Raspbian Operating system, basic commands – Creating, deleting files, directories, listing files and directories, Python IDE on Raspberry Pi, Accessing the board, Basic I/O – Reading analog, digital inputs.
Interfacing with Raspberry Pi: Purpose of datasheets, Interfacing – LED, 7-segment display, Ultrasonic sensor, Passive Infrared (PIR) sensor, interfacing a camera module with Raspberry Pi. (Programming using Python)

Interfacing with Raspberry Pi	**Python programming on Raspberry Pi**	Basic features, Raspberry Pi2B, Raspberry Pi3B, Raspberry Pi3B+ and Raspberry Pi4B, System setup and booting – Steps involved in making the raspberry pi board ready for use. Introduction to Raspbian Operating system, basic commands – Creating, deleting files, directories, listing files and directories, Python IDE on Raspberry Pi, Accessing the board, Basic I/O – Reading analog, digital inputs.
	Interfacing with Raspberry Pi	Purpose of datasheets, Interfacing – LED, 7-segment display, Ultrasonic sensor, Passive Infrared (PIR) sensor, Interfacing a camera module with Raspberry Pi. (Programming using Python)

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

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II Year I Semester

L	T	P	C
2	0	0	2

ELECTRICAL CIRCUIT ANALYSIS

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

Course Objectives:

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 behavior of electrical circuits with AC excitation.
4. To study the analysis of two port network
5. To understand the concept of Network synthesis.

Unit No	**Contents**	**Mapped CO**
I	Three Phase Systems 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 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 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 Two port network parameters – Z, Y, ABCD and Hybrid parameters and their relations, Cascaded networks	CO4
V	Network Synthesis 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

Advanced Topics in this Subject: Most widely used application of network synthesis in the design of signal processing filters, Radio tuning Medical Electronic Systems, Transient study of power system plays vital role in security and reliability aspects.

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

CO1: Various electrical three phase networks under balanced and unbalanced loads with different methods

CO2: Transient response of various electrical networks with DC excitation.

CO3: Transient response of electrical networks with AC excitation.

CO4: Various Two port network parameters and their mutual relations

CO5: Synthesis procedure for drawing equivalent electrical network for a given transfer functions.

Text books:

1. Circuits & Networks Analysis & Synthesis by A. Sudhakar and Shyammohan S Palli, Tata McGraw- Hill.
2. Circuit Theory by A.Chakrabarti Danapat 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=GasWAlIvvD8&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 of Electrical Circuit Analysis

Unit-1: Balanced Three phase circuits

Types of three phase systems, Introduction to star and delta connected systems, Phase sequence, Relation between line and phase voltages and currents of star and delta connected circuits, Analysis of balanced three phase star connected systems, Analysis of balanced three phase delta connected systems, Analysis of three phase unbalanced delta systems Analysis of three phase unbalanced star connected systems using Loop method, Milliman's method.

Unit	Module	Micro content
1a. Three phase balanced Systems	Analysis of three phase balanced Systems	Types of three phase systems
		Introduction to star and delta connected systems
		Phase sequence
		Relation between line and phase voltages and currents of star and delta connected circuits.
		Analysis of balanced three phase star connected systems.
		Analysis of balanced three phase delta connected systems.
	Analysis of three phase unbalanced Systems	Analysis of three phase unbalanced delta systems

1b. Three phase Unbalanced Systems		Analysis of three phase unbalanced star connected systems using Loop method.
		Loop and Milliman’s method

Unit-2: Transient Analysis in DC circuits

Transient response of R-L Circuit, Transient response of R-C Circuit, Transient response of R-L-C circuits for DC excitations, Solution of R-L,R-C,R-L-C circuits using differential equations Solution of R-L,R-C,R-L-C circuits using Laplace transforms.

Unit	**Module**	**Micro content**
2a. DC Transient response	Transient response of RL, RC Circuits	Transient response of R-L Circuit
		Transient response of R-C Circuit
		Transient response of R-L-C circuits for DC excitations.
2b. DC Transient response	Transient response of RL, RC, RLC Circuits	Solution of R-L, R-C,R-L-C circuits using differential equations
		Solution of R-L,R-C,R-L-C circuits using Laplace transforms

Unit-3: Transient Analysis in AC circuits

Transient response of R-L Circuit, Transient response of R-C Circuit, Transient response of R-L-C circuits for AC excitations, Solution of R-L,R-C,R-L-C circuits using differential equations Solution of R-L,R-C,R-L-C circuits using Laplace transforms.

	Module	**Micro content**
3a. AC Transient response	Transient response of RL, RC Circuits	Transient response of R-L Circuit
		Transient response of R-C Circuit
		Transient response of R-L-C circuits for DC excitations.
3b. AC Transient response	Transient response of RL, RC, RLC Circuits	Solution of R-L, R-C,R-L-C circuits using differential equations
		Solution of R-L,R-C,R-L-C circuits using Laplace transforms

Unit-4: Two Port Networks

Two port network parameters, Z parameters, Y parameters, ABCD parameters, Hybrid parameters and their relations, Cascaded networks, Poles and zeros of network functions.

	Module	**Micro content**
4a. Two port network parameters	Z,Y, ABCD, H Parameters	Introduction Two port network parameters
		Z parameters

		Y parameters
		ABCD parameters
		Hybrid parameters
4b. Cascaded networks	Cascaded networks & Poles and zeros	Parameters and their relations
		Cascaded networks
		Poles and zeros of network functions.

Unit-5: Network synthesis

Introduction to Positive real function, Basic synthesis procedure, Synthesis of LC immittance functions, Synthesis of RC impedance functions, Synthesis of RL admittance function, Synthesis of RL impedance function, Synthesis of RC admittance function - Foster and Cauer methods.

	Module	**Micro content**
5b. Network Synthesis	Synthesis procedure	Introduction to Positive real function
		Basic synthesis procedure
		Synthesis of LC immittance functions
		Synthesis of RC impedance functions
5b. Synthesis methods	Foster and Cauer methods	Synthesis of RL admittance function
		Synthesis of RL impedance function
		Synthesis of RC admittance function
		Foster and Cauer methods.

CO-PO Mapping:

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (High: 3, Medium: 2, Low: 1)

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

CO-PSO Mapping

Course	PSO1	PSO2
CO1	2	1
CO2	2	1
CO3	2	1
CO4	2	1
CO5	1	1

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II Year I Semester

L	T	P	C
3	0	0	3

BASIC ELECTRONIC DEVICES AND CIRCUITS

Pre-Requisites: Engineering Physics

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 No	Contents	Mapped CO
I	**Junction Diode Characteristics (12 Hrs)** Review of semiconductor Physics, P-N Junction Diode Qualitative Theory of P-N Junction, P-N Junction as a Diode, Diode Equation, 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 and Characteristics of Tunnel Diode (with the help of Energy Band Diagram), Varactor Diode, LED and Photo Diode.	CO1
II	Diode Applications **(10 Hrs)** Half wave rectifier, ripple factor, full wave rectifier, Harmonic components in a rectifier circuit, Inductor filter, Capacitor filter, L - section filter, Pi - section filter, Multiple L and pi - section and filter, and comparison of various filter circuits in terms of ripple factors, Simple circuit of a regulator using zener diode, Series and Shunt voltage regulators, Applications of rectifiers and voltage regulators.	CO2
III	**Bi-polar Junction Transistors(BJT) (06 Hrs)** Formation of N-P-N and P-N-P transistors, Transistor current components, Operation of BJT, BJT characteristics (CE, CB, CC configurations), Early effect, Current equations, Relation between Alpha and Beta, typical transistor junction voltage values and Limits of Operation, Transistor as an amplifier. **Junction Field Effect Transistors(JFET) (03 Hrs)** 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. **Metal-Oxide-Semiconductor Field Effect Transistors (MOSFET) (03 Hrs)** Structure of Depletion-MOSFET and Enhancement-MOSFETs, V-I Characteristics of MOSFET, Significance of threshold voltage.	CO3

IV	**Biasing and Stabilisation** **(06 Hrs)** Need for Proper Biasing, Q-point stability, Fixed, Collector to Base bias and Voltage Divider biasing for BJT, Emitter Degeneration, Design of Self Biasing circuit, Thermal Stability considerations. Fixed, Voltage Divider biasing for JFET and MOSFETs. **Small Signal Low frequency analysis of BJT and FET amplifiers** **(06 Hrs)** Small signal low frequency h-parameter model of BJT. Approximate model, Analysis of BJT amplifiers using Approximate model for CB, CE and CC configurations, Analysis of JFET Amplifiers, Analysis of CS, CD JFET Amplifiers.	CO4
V	**Feedback Amplifiers** **(05 Hrs)** 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 **Oscillators** **(05 Hrs)** 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.	CO5
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.		

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

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

CO2: Demonstrate the 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)**

Text books:

1. Jacob Millman and Halkias , ‘ Integrated Electronics’, Tata-Mcgraw Hill International 1991.
2. Donald A. Neaman,”Semiconductor Physics and Devices”, Times Mirror High Education Group, Chicago, 1997.

Reference books:

1. Robert L.Boylestead and Louis Nashelsky,”Electronic Devices and Circuit Theory”,Pearson Education Inc.Eleventh Edition 2013
2. Adel S. Sedra and Kenneth C. Smith, “ Microelectronic Circuits”, Oxford University Press, 2004 Edition.
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

UNIT-1: Junction Diode Characteristics

Review of semiconductor Physics, P-N Junction Diode Qualitative Theory of P-N Junction, P-N Junction as a Diode, Diode Equation, 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 and Characteristics of Tunnel Diode (with the help of Energy Band Diagram), Varactor Diode, LED and Photo Diode.

Unit	Module	Micro content
1a.or 2a. Junction Diode Characteristics	PN Junction Diode Characteristics	P-N Junction Diode Qualitative Theory of P-N Junction, P-N Junction as a Diode, Diode Equation, Volt-Ampere Characteristics, Temperature dependence of VI characteristic, Ideal versus Practical – Resistance levels (Static and Dynamic)
	Diode Resistance and Capacitance	Transition and Diffusion Capacitances, Diode Equivalent Circuits, Load Line Analysis, Breakdown Mechanisms in Semiconductor Diodes.
1b.or 2b. Special Diodes	Zener Diode	Breakdown Mechanism, Zener Diode Characteristics
	Operation and Characteristics	Tunnel Diode (with the help of Energy Band Diagram), Varactor Diode, LED and Photo Diode.

UNIT-2: Diode Applications

Half wave rectifier, ripple factor, full wave rectifier, Harmonic components in a rectifier circuit, Inductor filter, Capacitor filter, L - section filter, Pi - section filter, Multiple L and pi - section and filter, and comparison of various filter circuits in terms of ripple factors, Simple circuit of a regulator using zener diode, Series and Shunt voltage regulators, Applications of rectifiers and voltage regulators.

Unit	Module	Micro content
3a.or 4a. Rectifiers	Working of Rectifiers	HWR, FWCR and FWBR
	Characteristics	RMS Output, DC output, Ripple Factor, Efficiency, PIV, Percentage Regulation, TUF
3b.or 4b. Filters	Working of Rectifiers with Filters	rking of FWR with series inductorfilter andcapacitor filter, L-section and Pi-sectionfilters
	Voltage Regulator	ulator using zener diode, Series and Shuntvoltage regulators

UNIT-3: 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, CC configurations), Early effect, Current equations, Relation between Alpha and Beta, typical transistor junction voltage values and Limits of Operation, Transistor as an amplifier.

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.

Metal-Oxide-Semiconductor Field Effect Transistors (MOSFET)

Structure of Depletion-MOSFET and Enhancement-MOSFETs, V-I Characteristics of MOSFET, Significance of threshold voltage.

Unit	Module	Micro content
5a.or 6a. Bi-polar Junction Transistors	Construction, Operation and Characteristics	Formation of N-P-N and P-N-P transistors, Transistor current components, Operation of BJT, BJT characteristics (CE, CB, CC configurations), Transistor as an amplifier.
5b.or 6b.JFET&MOSFET	Construction, Operation and Characteristics	JFET structure, Drain and Transfer Characteristics, Significance of Pinch-Off Voltage Structure of Depletion-MOSFET and Enhancement-MOSFETs, V-I Characteristics of MOSFET

UNIT-4: Biasing and Stabilisation

Need for Proper Biasing, Q-point stability, Fixed, Collector to Base bias and Voltage Divider biasing for BJT,Emitter Degeneration, Design of Self Biasing circuit, Thermal Stability considerations. Fixed, Voltage Divider biasing for JFET and MOSFETs.

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, CE and CC configurations, Analysis of JFET Amplifiers, Analysis of CS, CD JFET Amplifiers.

Unit	Module	Micro content
7a.or 8a. Biasing and Stabilisation	Transistor Biasing and Stabilisation	Fixed, Collector to Base bias and Voltage Divider biasing for BJT, Emitter Degeneration, Design of Self Biasing circuit
	JFET and MOSFET Biasing	Fixed, Voltage Divider biasing for JFET and MOSFETs
7b. or 8b. Small Signal Low frequency analysis of BJT and FET amplifiers	h-parameters of BJT and JFET	Analysis of BJT amplifiers using Approximate model for CB, CE and CC configurations, Analysis of JFET Amplifiers, Analysis of CS, CD JFET Amplifiers

UNIT-5: 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

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.

Unit	Module	Micro content
9a.or 10a. Feedback Amplifiers	Circuit Analysis	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
9b.or 10b. Oscillators	Working Principle	RC-phase shift oscillators with Transistor and FET, Hartley and Colpitts oscillators, Wein bridge oscillator, Crystal oscillators, Frequency and amplitude stability of oscillators

CO-PO mapping Table with Justification:

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (High: 3, Medium: 2, Low: 1)

CO/PO	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

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II Year I Semester

L	T	P	C
2	**1**	**0**	**3**

ELECTROMAGNETIC FIELDS

Pre-Requisites:

1. Complex numbers
2. Vector Analysis
3. Co-ordinate Geometry
4. Basic circuit Analysis

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

Unit No	Contents	Mapped CO
I	**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. **(10 hr)**	CO1
II	**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. **(10 hrs)**	CO2
III	**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). **(10 hrs)**	CO3
IV	**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,	CO4

	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. **(10 hrs)**	
V	**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. (05 hrs) 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. **(05 hrs)**	CO5
Advanced Topics in this Subject: List of industrial applications of electrostatics, Concept of Magnetic Levitation, List of applications of electromagnetics in communication systems.		

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

CO2: The student will be able to evaluate capacitance for different configurations

CO3: The student will be able to find magnetic field intensity of different configurations using Biot-Savart's law and Ampere's law

CO4: The student will be able to calculate magnetic forces and torque produced by currents in magnetic fields

CO4: The student will be able to quantify inductance and evaluation of induced EMF in time varying fields

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.
2. "Introduction to Electro Dynamics" by D J Griffiths, PHI Pvt. Ltd, 2nd editon.
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/

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 = $-Q\int_A^B \vec{E}.\vec{d}$
	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) =ρ_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	Magnetic field intensity (MFI)	Concepts and definitions

fields	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
1. (B). Time varying fields	Faraday's laws of electromagnetic induction	Statement
	Integral and point forms, Maxwell's fourth equation	Derivations - Curl (E) = - $\partial B/\partial t$
	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

CO-PO mapping Table with Justification: Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (High: 3, Medium: 2, Low: 1)

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

*****

II Year I Semester

L	T	P	C
0	0	2	1

PYTHON PROGRAMMING LAB

Prerequisites: Knowledge of any programming language

Course Objectives:

1. Experiment with scripting language
2. Evaluate expression evaluation, control statements
3. Use Data structures
4. Model Functions, Modules and packages
5. Outline OOP through Python and Exception Handling
6. Select required Python Standard Library for GUI

Course Outcomes:

CO-1: Demonstrates the use of an interpreted language for problem solving through control statements including loops and conditionals.

CO-2: Practice with data structures for quick programming solutions.

CO-3: Demonstrates software building for real needs through OOPS approach.

CO-4: Comprehend functions and modules & exception handling.

CO-5: Use of python standard libraries to handle IOT based applications.

LIST OF EXPERIMENTS

PART – A: SOFTWARE

(Students must perform Any 15 experiments from the following list)

1. Write a program to compute distance between two points taking input from the user (Using Pythagorean Theorem)
2. Write a program add.py that takes 2 numbers as command line arguments and prints its sum.
3. Write a Program for checking whether the given number is a even number or not.
4. Write a program to identify the quadrant of a given angle using elif control statement.
5. Write a Program to set the password considering string length not less than six characters using for loop within a chance of limit given as 5.
6. Write a program using a while loop that asks the user for a number, and prints a countdown from that number to zero.
7. Find the sum of all the primes below two million.
8. Considering the terms in the Fibonacci sequence whose values do not exceed four million, find the sum of the even-valued terms.
9. Write a program to count the numbers of characters in the string and store them in a dictionary data structure
10. Write a program to use split and join methods in the string and trace a birthday with a dictionary data structure.
11. Write a program to print each line of a file in reverse order.
12. Write a program to compute the number of characters, words and lines in a file.
13. Find mean, median, mode for the given set of numbers in a list.
14. Write a function dups to find all duplicates in the list.
15. Write a function unique to find all the unique elements of a list.

16. Write a function cumulative_product to compute cumulative product of a list of numbers.
17. Write a function reverse to reverse a list. Without using the reverse function.
18. Implement Bank account of a customer with data members: acno, account holder name, account type, balance. Implement necesssary methods like set(), get(), withdraw() and deposit().
19. Implement addition, subtraction operations on a complex number using Python classes.
20. Implement a simple program to demonstrate Exceptions in python.

PART – B: HARDWARE

(Students must perform Any 5 experiments from the following list)

1. Design and implement a system that measures the distance between an object and current position using Raspberry Pi 4B.
2. Design and implement a system that can detect and alert movement of an object/person using Raspberry Pi 4B.
3. Design and implement a system that measures the temperature of the room using Raspberry Pi 4B.
4. Interface an LED and a 7-Segment display to a Raspberry Pi 4B board.
5. Interface a relay switch to Raspberry Pi board and demonstrate its operation.
6. Interface a camera module and store an image/video in a specific location on Raspberry Pi 4B board.

CO-PO Mapping Matrix:

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	P011	PO12
CO1	-	2	2	1	-	-	-	-	-	-	-	-
CO2	-	2	2	2	2	-	-	-	-	-	-	-
CO3	1	2	2	2	2	-	-	-	-	-	-	-
CO4	1	2	2	2	2	-	-	-	-	-	-	-
CO5	1	2	2	2	2	-	-	-	-	-	-	-
CO6	1	2	2	2	2	-	-	-	-	-	-	-

CO-PSO Mapping matrix:

CO/ PSO	PSO-1	PSO-2
CO1	1	1
CO2	2	2
CO3	2	2
CO4	2	2
CO5	2	2

*****

II Year I Semester

L	T	P	C
0	**0**	**3**	**1.5**

ELECTRICAL CIRCUIT ANALYSIS LAB

Prerequisites: Basic Circuit Analysis, Electrical Circuit Analysis

Course Objectives:

1. To analyze different circuits using network theorems.
2. To analyse two port network parameters.
3. To understand the resonance condition of AC circuits
4. To determine the self and mutual inductance of coupled circuit.
5. To acquire skills of electrical circuit studies using MATLAB.

LIST OF EXPERIMENTS

Any ten experiments from the following

1. Verification of Thevenin's and Norton's Theorems.
2. Verification of Superposition theorem and Reciprocity theorem
3. Verification of Maximum Power Transfer Theorem.
4. Verification of Compensation Theorem.
5. Verification of Millmann's Theorem.
6. Verification of series Resonance of AC circuit.
7. Determination of Choke coil parameters
8. Determination of Z and Y Parameters of a network
9. Determination of Transmission and hybrid parameters of a network
10. Determination of self inductance and mutual inductance of coupled circuit
11. Simulation of mesh analysis of electrical network.
12. Simulation of nodal analysis of electrical network.
13. Simulation of determining form factor, peak factor of sinusoidal wave, square wave.
14. Simulation of parallel resonance of AC circuit.
15. Simulation of Verification of Kirchhoff's current law and voltage law

Course Outcomes:

Students are able to

1. Understand network theorems for different circuits.
2. Evaluate the two port network parameters
3. Examine the resonance condition of AC circuits
4. Determine the self and mutual inductance of coupled circuits.
5. Analyse electrical circuits using software.

CO-PO mapping Table with justification

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

*****

II Year I Semester

L	T	P	C
0	**0**	**3**	**1.5**

BASIC ELECTRONIC DEVICES AND CIRCUITS LAB

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 Table with Justification:

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (High: 3, Medium: 2,Low: 1)

CO/PO	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

*****

II Year I Semester

L	T	P	C
2	**0**	**0**	**0**

ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE

Pre-Requisites: Nil

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

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

Unit No	Contents	Mapped CO
I	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	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	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	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	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**

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

CO1: understand the concept of Traditional knowledge and its importance

CO2: Know the need and importance of protecting traditional knowledge.

CO3: Understand legal framework of TK, Contrast and compare the ST and other traditional forest dwellers

CO4: Know the various enactments related to the protection of traditional knowledge.

CO5: Understand the concepts of Intellectual property to protect the traditional knowledge

Text 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. https://www.youtube.com/watch?v=LZP1StpYEPM
2. http://nptel.ac.in/courses/121106003/

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II Year II Semester

L	T	P	C
2	0	0	2

LINEAR IC APPLICATIONS

PRE-REQUISITES: Basics of Electronic Devices, KCL, KVL& Network Theorems

Course objectives:

- To understand the basic operation and performance parameters of differential amplifier and operational amplifier.
- To learn the linear and non-linear applications of operational amplifier.
- To understand the analysis & design of different types of active filters using Op-Amps.
- To learn the internal structure, operation and applications of different IC's.
- To understand the various types of Digital to Analog and Analog to Digital converters

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Differential Amplifier and Operational Amplifier Characteristics: [13 hours]** Analysis of Differential Amplifier using BJTs: DC & AC analysis of all the four configurations, Types of Integrated circuits: packages, temperature ranges and power supplies. Basic block diagram of Operational Amplifier, Symbol of operational amplifier, operational amplifier ideal characteristics and specifications of IC 741, DC&AC characteristics of operational Amplifier: input bias current, input offset current, input offset voltage, Drift, Slew rate, CMRR, PSRR; pin diagram of IC 741,equivalent diagram of operational amplifier.	**CO1**
II	**Linear and Non-Linear applications of Operational Amplifier: [13 hours]** Inverting and Non-inverting amplifier, Integrator and differentiator, Difference amplifier, Instrumentation amplifier, AC amplifier, V to I, I to V converters, Log and Anti log Amplifiers, Precision rectifiers. Comparators, Multivibrators, Triangular and Square wave generators.	**CO2**
III	**Active Filters, AnalogMultipliers and Modulators:** Design & Analysis of Butter worth active filters –1storder, 2ndorder LPF, HPF filters. Band pass, Band reject and all pass filters. Four Quadrant Multiplier, IC 1496, Sample &Hold circuits.	**CO3**
IV	**Timers & Phase Locked Loops:** Introduction to 555 timer, functional diagram, Monostable and Astable operations and applications, Schmitt Trigger. PLL- introduction, block schematic, Principles and description of individual blocks,565 PLL, Applications of PLL-Frequency Multiplication, frequency translation, Applications of VCO (566).	**CO4**
V	**Data Converters and Applications:** Introduction, basic DAC techniques, weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, and IC 1408 DAC, Sample and Hold circuit, Different types of ADCs - parallel comparator type ADC, counter type ADC, successive	**CO5**

	approximation ADC and dual slope ADC. DAC and ADC Specifications, illustrative problems on resolution of ADC and DAC.	

Course Outcomes

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

CO1: Explain the DC and AC analysis of Differential Amplifier, and performance parameters of OP-Amp**{Understand level, KL2}**

CO2: Demonstrate the usage of operational amplifier in various applications **{Apply level, KL3}**

CO3: Explain the working principles of Active filters, Multipliers and Modulators using Op-Amp.**{Understand level, KL2}**

CO4: Learn the internal structure, pin diagrams and operations of different IC's **{Apply level, KL3}**

CO5: Learn the circuits of data converters and **Compare** among them in terms of Parameters**{ Apply level, KL3Analyze level, KL4}**

Learning Resources

Text books:

1. Linear Integrated Circuits – D. Roy Choudhury, New Age International (p) Ltd, 2nd Edition,2003.
2. Op-Amps & Linear ICs - Ramakanth A. Gayakwad, PHI,1987.
3. Linear Integrated Circuits by Salivahan-3rd-Edition, McGrawHill,2018

Reference books

1. Operational Amplifiers & Linear Integrated Circuits –Sanjay Sharma;SKKataria&Sons;2nd Edition,2010
2. Design with Operational Amplifiers & Analog Integrated Circuits – Sergio Franco, McGraw Hill, 1988.
3. Operational Amplifiers & Linear ICs – David A Bell, Oxford Uni. Press, 3rd Edition,2011.
4. J. V. Wait, L. P. Huelsman and G. A. Korn, "Introduction to Operational Amplifier theory and applications", McGraw Hill U. S., 1992

Micro-Syllabus

Unit – 1: Differential Amplifier and Operational Amplifier Characteristics: Analysis of Differential Amplifier using BJTs: DC & AC analysis of all the four configurations, Types of Integrated circuits: packages, temperature ranges and power supplies.

Basic block diagram of Operational Amplifier, Symbol of operational amplifier, operational amplifier ideal characteristics and specifications of IC 741, DC & AC characteristics of operational Amplifier: input bias current, input offset current, input offset voltage, Drift, Slew rate, CMRR, PSRR; pin diagram of IC 741, equivalent diagram of operational amplifier.

Unit	Module	Micro content
1a	Differential Amplifier	Terms and definitions of Differential Amplifier
		Modes of Operation and Types of Differential Amplifiers, DC & AC analysis of all the four configurations.
1b	Integrated circuits	Classification of Integrated circuits –based on inputs, power supply, Temperature range, IC

		package type and no of active devices.
2a	Operational Amplifier	Basic block diagram of Operational Amplifier.
		Ideal and practical Op-amp, Voltage transfers Characteristics.
2b	DC & AC characteristics of operational Amplifier	DC Characteristics of Op Amp (input bias current, input offset current, input offset voltage, Thermal Drift)
		AC Characteristics of Op Amp (Slew Rate) –Simple Numerical problems
	IC 741	Pin diagram of IC 741& its specifications
		Equivalent diagram of operational amplifier.

Unit-2: Linear and Non-Linear applications of Operational Amplifier:
Inverting and Non-inverting amplifier, Integrator and differentiator, Difference amplifier, Instrumentation amplifier, AC amplifier, V to I, I to V converters, Log and Anti log Amplifiers, Precision rectifiers. Comparators, Multivibrators, Triangular and Square wave generators.

Unit	Module	Micro content
3a.	Linear and Non-linear applications of Op-amp	Inverting and Non-inverting amplifier-Simple numerical problems
		Voltage Follower, Summing Amplifier, Difference Amplifier, Simple Numerical problems.
3b	Linear and Non-linear applications of Op-amp	Ideal, Practical Integrator and ideal, partial Differentiator, Simple Numerical problems.
4a	Linear and Non-linear applications of Op-amp	Instrumentation amplifier
		AC amplifier
		V to I, I to V converters,
		Log and Anti log Amplifiers
		Precision rectifiers
4b	Comparators, wave Generators	Multivibrators – Monostable, Astable Multivibrator
		Triangular and Square wave generators
		Inverting Comparators, Non-inverting comparator, Schmitt Trigger

Unit-3: Active Filters, Analog Multipliers and Modulators:
Design & Analysis of Butter worth active filters –1storder, 2ndorder LPF, HPF filters. Band pass, Band reject and all pass filters. Four Quadrant Multiplier, IC 1496, Sample & Hold circuits.

Unit	Module	Micro content
5a.	Active Filters	Classifications of Filters
		Design procedure for 1st order and 2nd order LPF and HPF, simple numerical problems
5b	Active Filters	Design procedure for Band Pass (WBP, NBP) and Band Reject (WBR,NBR) filters - simple numerical

		problems
		Design of All pass filters
6a	Analog Multipliers and Modulators	Sample & Hold circuits Analysis
		Performance parameters of Sample & Hold circuits, Modulators(IC 1496).
6b	Analog Multipliers and Modulators	Analog voltage Multiplier, Analog voltage Divider Circuits analysis, Four Quadrant Multiplier.

Unit-4:Timers & Phase Locked Loops:

Introduction to 555 timer, functional diagram, Monostable and Astable operations and applications, Schmitt Trigger. PLL- introduction, block schematic, Principles and description of individual blocks,565 PLL, Applications of PLL-Frequency Multiplication, frequency translation, Applications of VCO (566).

Unit	Module	Micro content
7a.	Timers	Introduction to 555 timer, functional diagram
		Monostable multi vibrator using 555 timer and applications.
7b	Timers	Astable multi vibrator using 555 timer and applications.
		Schmitt trigger using 555 timer and applications
8a.	Phase Locked Loops	Block diagram and operation of PLL
		Terms and Derivation of Lock range, Capture Range related to PLL
		Applications of PLL(Frequency multiplier, Frequency translator)
8b	Phase Locked Loops	Operation of Monolithic PLL(IC 565)
		Operation of Voltage controlled Oscillator(IC 566)
		Analog and Digital Phase detectors

Unit-5: Data Converters and Applications:

Introduction, basic DAC techniques, weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, and IC 1408 DAC, Sample and Hold circuit, Different types of ADCs - parallel comparator type ADC, counter type ADC, successive approximation ADC and dual slope ADC. DAC and ADC Specifications, illustrative problems on resolution of ADC and DAC.

Unit	Module	Micro content
9a	DAC techniques	Introduction ,Basic DAC techniques
		Weighted resistor DAC,
		R-2R ladder DAC,
9b	ADC techniques	Parallel comparator type ADC
		Successive approximation ADC
10a.	DAC techniques	Inverted R-2R DAC,
		Counter type ADC,

10b	ADC techniques	IC 1408 DAC,
		Dual slope ADC

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	P05	P06	P07	P08	P09	P010	P011	P012	PS01	PSO2
C01	3	2											3	--
C02		3		2									2	2
C03	2	3											2	--
C04	2			3									3	2
C05	2				2								2	2

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II Year II Semester

L	T	P	C
2	1	0	3

ELECTRICAL MACHINES - II

PRE-REQUISITES: 1) Electrical Machines-I

Course objectives: The student should be able to

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

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**3-phase Induction Motors:** 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. **(10 hrs)**	**CO1**
II	**Characteristics of Induction Motors:** Torque equation -expressions for maximum torque and starting torque - torque slip characteristics - crawling and cogging. **(04 hrs)** **Starting and Testing methods of Induction Motors:** 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. **(10 hrs)**	**CO2**
III	**Single Phase Motors:** Single phase induction motors– Constructional features -Problem of starting–Double revolving field theory–Equivalent circuit. **(04 hrs)** Starting methods of single phase Induction motor - shaded pole motors-A.C Series Motor. **(04 hrs)**	**CO3**
IV	**Synchronous generator:** 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. **(08 hrs)** **Parallel operation of synchronous Generators**: Parallel operation with	**CO4**

	infinite bus and other alternators-Synchronizing power – Load sharing-Numerical problems. **(05 hrs)**	
V	**Synchronous motor operation, starting and performance:** 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. **(08 hrs)**	**CO5**
Advanced topics in this course: 1. Time constants (transient and sub transient) of synchronous machines. 2. Static and dynamic characteristics of synchronous machines.		

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,McGrawHill Publications,4th edition.
2. Electrical Machinery by AbijithChakrabarthi and SudhiptaDebnath,McGraw Hill education 2015.
3. Electrical Machinery Fundamentals by Stephen J Chapman McGraw Hill education 2010.
4. Electric Machinery by A.E.Fitzgerald,Charleskingsley,StephenD.Umans, TMH.

e- Resources & other digital material

1. https://nptel.ac.in/courses/108/105/108105131/
2. https://nptel.ac.in/courses/108/106/108106072/
3. www.nptelvideos.in/2012/11/electrical-machines-ii.html
4. *https://nptel.ac.in/courses/108/106/108106023/*

Micro-Syllabus

Unit-1:3-phase Induction Motors: 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	Module	Micro content
1a.or 2a. 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
1b.or 2b. Losses and equivalent circuitof 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: Torque equation -expressions for maximum torque and starting torque - torque slip characteristics - crawling and cogging.

Starting and Testing methods of Induction Motors:

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	Module	Micro content
3a.or 4a. 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
3b.or 4b. 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:**

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	Module	Micro content
5a.or 6a. Single phase induction motors	Constructional features & Problem of starting	Constructional features- Problem of starting–Double revolving field theory–Equivalent circuit.
5b.or 6b. 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: 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**: Parallel operation with infinite bus and other alternators-Synchronizing power– Load sharing-Numerical problems.		
Unit	**Module**	**Micro content**
7a.or 8a. 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.
7b. or 8b. 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: Principle operation– Phasor diagram –Variation of current andpower factor with excitation – Methods of starting –Hunting and its suppression methods-Synchronous condenser-Applications-Numerical problems.		
Unit	**Module**	**Micro content**
9a.or 10a. Synchronous motor	Principle of operation	Principle operation– Phasor diagram –Variation of current and power factor with excitation
9b.or 10b.Methods of startingSynchronous motor	Methods of starting	Methods of starting –Hunting and its suppression methods-Synchronous condenser-Applications-Numerical problems.

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	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	-

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II Year II Semester

L	T	P	C
2	1	0	3

CONTROL SYSTEMS

Prerequisites: Laplace Transforms, Differential equations, Matrix Algebra, Basic Circuit Analysis

Course Objectives:

1. To learn the mathematical modeling 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 criterion.
5. To formulate state models and the concepts of Controllability and Observability

Unit No	Contents	Mapped CO
I	**Mathematical Modeling of Control Systems:** Introduction to control systems, Classifications - Open Loop and closed loop, transfer function, Mathematical Modelingof electrical networks, Translational and Rotational systems, analogous systems, Transfer Function of DC & AC Servo motor-Synchros, -Block diagram algebra – Signal flow graph - Mason's gain formula. (**15 Hrs**)	**CO1**
II	**Time Response Analysis:** Standard test signals - Time response of first and second order systems - Time domain specifications - Steady state errors and error constants –Effects of Feed-Back-Dominant Closed loop poles- PD - PI-PID controllers . (**10Hrs**)	**CO2**
III	**Stability and Root locus Technique:** The concept of stability – Routh's stability criterion Procedure and problems –limitations of Routh's stability – Root locus concept - construction of root loci –Effect of Adding open loop poles and Zeros on Root Loci . (**10Hrs**)	**CO3**
IV	**Frequency Response Analysis:** Introduction - Frequency domain specifications-Bode diagrams- transfer function from the Bode Diagram-Polar Plots, Nyquist Stability criterion- relative stability analysis- Phase margin and Gain margin- Characteristics of Lag, Lead and Lag-Lead compensators. (**15 Hrs**)	**CO4**
V	**State Space Analysis:** 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 it's Properties - Transfer function from state model (**10Hrs**)	**CO5**

Advanced topics in this course:

1. Dominant Closed loop poles,
2. Effect of Adding open loop poles and Zeros on Root Loci
3. Solution of the state equation
4. Transfer function from state model
5. Concepts of Controllability and Observability

Course Outcomes

The students are able to

CO1: Derive the transfer function using block diagram algebra and signal flow graph.**{Apply level, KL3}**

CO2: Determine time response specifications of second order systems and Error constants.**{Apply level, KL3}**

CO3: Analyze stability using Routh's stability criterion and the root locus method.**{ Analyze level, KL4}**

CO4: Analyze the stability using Bode plot and Nyquist criterion.**{ Analyze level, KL4}**

CO5: Obtain state models and understanding the concepts of Controllability and Observability.**{Apply level, KL3& Understand level, KL2}**

Learning Resources

Text books:

1. ControlSystems Engineering - I.J.Nagarath and M.Gopal, Newage International Publications, 5th Edition.
2. Automatic control systems - Benjamin C.Kuo, Prentice Hall of India,2nd Edition.

Reference books:

1. Control Systems principles and design-M.Gopal, Tata McGraw Hill education Pvt Ltd., 4th Edition.
2. Modern Control Engineering- Kotsuhiko Ogata, Prentice Hall of India.
3. Control Systems - ManikDhanesh N, Cengage publications.
4. Control Systems Engineering - S.Palani,TataMcGraw 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 of Control Systems

Unit-1: Mathematical Modelling of Control Systems

Introduction to control systems, Classifications - Open Loop and closed loop, transfer function, Effects of Feed-Back, Mathematical Modelling of electrical networks, Translational and Rotational systems, analogous systems, Transfer Function of DC & AC Servo motor- Synchros, -Block diagram algebra – Signal flow graph - Mason's gain formula

Unit	Module	Micro content
1. Mathematical Modelling of Control Systems	Introduction to control systems, classifications - Open Loop and closed loop	Concept of system, control system Classification as Open loop and closed loop
		Different examples of control systems

	Effectsof Feed-Back	Effect of feedback on sensitivity, gain, band width, noise, time constant and speed of response
	Mathematical Modelling	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 –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: Time Response Analysis: Standard test signals - Time response of first and second order systems - Time domain specifications - Steady state errors and error constants –Dominant Closed loop poles- P-PD - PI- PID controllers

Unit	Module	Micro content
2. Time Response Analysis	Standard test signals	Impulse, step, ramp and parabolic signals
	Time response of first and second order systems	derivations
	Time domain specifications	Definitions and derivations - problems
	Steady state errors and error constants	Definitions – derivations and problems
	Dominant Closed loop poles-	Explanation on location of closed loop poles
	P- PD - PI- PID controllers	Effects of controllers on time response

Unit-3: Stability and Root locus Technique:
The concept of stability - Routh's stability criterion Procedure and problems – limitations of Routh's stability –Root locus concept - construction of root loci – Effect of Adding open loop poles and Zeros on Root Loci .

Unit	Module	Micro content
3. Stability and Root	The concept of stability	Explanation of BIBO

locus Technique		stability
	Routh's stability criterion	Procedure and problems
		limitations of Routh's stability
	Root locus	concept - construction of root loci – problems- Effect of Adding open loop poles and Zeros on Root Loci

Unit-4: Frequency Response Analysis:
Introduction - Frequency domain specifications- Bode diagrams- transfer function from the Bode Diagram-Polar Plots, Nyquist Stability criterion- relative stability analysis- Phase margin and Gain margin- Characteristics of Lag, Lead and Lag-Lead compensators.

Unit	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 function from the Bode Diagram
	Polar Plots	Procedure - problems
	Nyquist Stability criterion	Procedure – problems – Phase margin and Gain margin
		Relative stability analysis
	Lag, Lead and Lag-Lead compensators.	Characteristics with derivations of transfer functions only

Unit-5: State Space Analysis: 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 it's Properties - Transfer function from state model.

Unit	Module	Micro content
5. State Space Analysis	state, state variables, state equation and state model	Concepts, definitions
	state space modeling of control systems	Problems on finding state model from the given transfer function and electrical circuits

	Solution of the state equation	Derivation - problems
	State TransitionMatrix	Derivation – problems - properties
	Transfer function from state model	Derivation - problems
	Concepts of Controllability and Observability	Problems only

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	P05	P06	P07	P08	P09	P010	P011	P012	PS01	PSO2
C01	3	2	1			1							1	
C02	3	3	2			1							1	
C03	3	2	1			1							1	
C04	2	2	3			1							1	
C05	3	2	3			1							1	

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II Year II Semester

L	T	P	C
3	0	0	3

POWER SYSTEMS-1

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:** Load curve, 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**	**CO5**

	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	Module	Micro content
1a.or 2a. 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.or 2b. 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	Module	Micro content
3a.or 4a. 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)
3b.or 4b. 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	Module	Micro content
5a.or 6a. 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
5b.or 6b. 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)**

Unit	Module	Micro content
7a.or 8a. Substations	Factors & Classification	Factors to be considered for selection of site,
		Classification based on service requirement ➢ Transformer substations ➢ Switching substations ➢ Synchronous substations ➢ Frequency change substations ➢ Converting substations ➢ Industrial substations

		Classification based on design ➢ Indoor substations ➢ Outdoor substations ➢ Underground substations ➢ Pole mounted and plinth mounted substations
	Equipment and Layout	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
		Layout of 33/11 kV substation (Diagram and arrangement of equipment)
7b. or 8b. Distribution Systems	**Distribution Systems**	Classification based on type of current, type of construction, type of service, number of wires, scheme of connection.
		Design features,
		AC distribution (i.e. primary and secondary distribution systems)
		DC distribution (Elementary treatment only)
		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	**Module**	**Micro content**
9a.or 10a. 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
9b.or 10b. 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:
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

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

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II Year II Semester

L	T	P	C
2	1	0	3

DIGITAL ELECTRONICS

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.

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, Floating-Point Representation, 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, Multilevel NAND/NOR realizations, Prime and essential Prime Implicants, Tabular Method, Prime Implicants Chart, Simplification Rules.	**CO2**
III	**Combinational Circuits** **14 Hours** Design procedure, Half/full adders, Half / full substractors, Carry look ahead adder, BCD 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, Programmable logic devices.	**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. 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.	**CO4**

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**
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)**		
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- Zvi Kohavi & 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/117/106/117106086/		
2.	https://nptel.ac.in/courses/108/105/108105113/		
3.	https://www.coursera.org/learn/digital-systems		
4.	https://swayam.gov.in/nd1_noc20_ee70/preview		

Micro Syllabus

Unit-1: Number Systems and Boolean Algebra

Number systems: Introduction to different number system and their conversions, Complement of number system and subtraction using complement method, Floating-Point Representation, 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	Module	Micro content
1a.or 2a. Number systems	different number system and their conversions	Imporatance of radix or base and numericals
		Different number systems:binary,decimal,octal&hexa decimal.
	Signed numbers& Binary arthimetic	Binary addition, subtraction, multiplication
		2’s complement arithmetic & 1’s complement

<table>
<tr><td rowspan="2"></td><td rowspan="2"></td><td>arithmetic</td></tr>
<tr><td>Floating-Point Representation</td></tr>
<tr><td rowspan="4">1b.or 2b.binary codes & Boolean algebra</td><td rowspan="2">Classification of Binary codes</td><td>Weighted and Non-weighted codes and self complementing, cyclic codes</td></tr>
<tr><td>Error detection and correction codes</td></tr>
<tr><td>Axioms and laws of Boolean algebra</td><td>Basic theorems and properties of Boolean Algebra, Boolean functions, canonical and standard forms</td></tr>
<tr><td>Logic Gates</td><td>Realization of expressions using logic gates;
universal Gates</td></tr>
<tr><td colspan="3">Unit-2:Minimization Methods of Boolean functions
Minimization of logic expressions by algebraic method, Sum of Products (SOP), Product of Sums (POS), K-Map Method, Don’t Care Combinations, Multilevel NAND/NOR realizations, Prime and essential Prime Implicants, Tabular Method, Prime Implicants Chart, Simplification Rules.</td></tr>
<tr><td>Unit</td><td>Module</td><td>Micro content</td></tr>
<tr><td rowspan="4">3a.or 4a. Minimization of logic expressions by algebraic method & K-Map Method</td><td>Minimization of logic expressions by algebraic method</td><td>Sum of Products (SOP)), Product of Sums (POS)</td></tr>
<tr><td rowspan="3">K-Map Method</td><td>2-variable,3- variable & 4- variable K-maps</td></tr>
<tr><td>Don’t cares</td></tr>
<tr><td>5-variable K-map</td></tr>
<tr><td rowspan="2">3b.or 4b. prime implicant chart</td><td rowspan="2">Quine McCluskey method</td><td>Prime implicants and Essential prime implicants</td></tr>
<tr><td>prime implicant chart</td></tr>
<tr><td colspan="3">Unit-3:Combinational Circuits
Design procedure, Half/full adders, Half / full subtractors, Carry look ahead adder, BCD adder, Multiplexer/De-Multiplexer, Encoder/Decoder, Priority encoders, Implementation of HigherOrder Device Using Lower Order devices, Implementation of combinational logic using MUX/Decoder, Magnitude Comparator, Programmable logic devices.</td></tr>
<tr><td>Unit</td><td>Module</td><td>Micro content</td></tr>
<tr><td rowspan="2">5a.or 6a.Combinational Circuits fundamentals</td><td>Adders/subtractors</td><td>Half/full adders, Half / full subtractors, Carry look ahead adder, BCD adder</td></tr>
<tr><td>Mux/Demux</td><td>Multiplexer/De-Multiplexers &Encoder/Decoders</td></tr>
<tr><td rowspan="2">5b.or 6b.Implementation of combinational logic using MUX/Decoder</td><td rowspan="2">Applications of Mux/Demux</td><td>Magnitude Comparator, Programmable logic devices.</td></tr>
<tr><td>Implementation of HigherOrder Device Using Lower Order devices</td></tr>
</table>

Unit-4:Sequential Circuits **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.		
Unit	**Module**	**Micro content**
7a.or 8a.Sequential Circuits Fundamentals	Flip Flops	Distinctions between Combinational and Sequential circuits; types of triggering, types of flip flops,
		Excitation Table of all Flip Flops ;Conversion from one type of Flip-Flop to another.
7b. or 8b.Registers and Counters	Registers and Counters	Shift Registers Left, Right and Bidirectional Shift Registers, Applications of Shift Registers
		Synchronous and asynchronous counters and also their design
		Operation of Ring and Twisted Ring Counter
Unit-5:Sequential Machines 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.		
Unit	**Module**	**Micro content**
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 and diagrams	Serial Binary Adder, Sequence Detector, Parity-bit Generator Synchronous Modulo N – Counters.

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	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

*****

II Year II Semester

L	T	P	C
2	1	0	3

THERMAL AND HYDRO PRIME MOVERS

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.	**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.	**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, 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).	**CO3**
IV	**FUNDAMENTALS OF FLUID MECHANICS:** Definition of fluid,	**CO4**

	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.	
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.	**CO5**

Advanced topics in this course: Applications of gas turbine, Simple Manometers- Piezometer, U-tube and Differential manometers, Venture meter and Orifice meter, 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 Thermodynamics	Kelvin-Planck & Clausius Statements.
		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.

<table>
<tr><td rowspan="6">3b. or 4b.
I. C. Engines
&
Gas Turbines</td><td rowspan="3">I. C. Engines</td><td>Parameters of performance, Determination of Frictional Power & Indicated Power.</td></tr>
<tr><td>Engine performance evaluation.</td></tr>
<tr><td>Simple problems on performance of IC Engines.</td></tr>
<tr><td rowspan="3">Gas Turbines</td><td>Simple gas turbine plant, Classification.</td></tr>
<tr><td>Analysis of closed and open cycle plants, Applications</td></tr>
<tr><td>Performance parameters, Simple Problems on open cycle.</td></tr>
<tr><td colspan="3">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).</td></tr>
<tr><th>Unit</th><th>Module</th><th>Micro content</th></tr>
<tr><td rowspan="4">5a. or 6a.
Steam Turbines</td><td rowspan="4">Steam Turbines</td><td>Working Principle, Classification, Simple Impulse Turbine.</td></tr>
<tr><td>Vector diagrams of velocities, Combined Velocity diagram.</td></tr>
<tr><td>Work done on the blade, Axial Thrust.</td></tr>
<tr><td>Blade efficiency, stage efficiency, overall efficiency.</td></tr>
<tr><td rowspan="5">5b. or 6b.
Steam Turbines</td><td rowspan="5">Steam Turbines</td><td>Effect of blade friction on velocity diagram.</td></tr>
<tr><td>Simple problems on Impulse turbine.</td></tr>
<tr><td>Compounding of Impulse Turbine.</td></tr>
<tr><td>Reaction Turbine, Velocity Diagram for Reaction Turbine.</td></tr>
<tr><td>Degree of Reaction. (Only theory on Reaction Turbines)</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><th>Unit</th><th>Module</th><th>Micro content</th></tr>
<tr><td rowspan="3">7a. or 8a.
Fundamentals of Fluid Mechanics</td><td rowspan="3">Fundamentals of Fluid Mechanics</td><td>Definition of fluid, Differences between a solid and fluid.</td></tr>
<tr><td>Physical properties of fluids- Density, Specific Weight, Specific gravity, viscosity, Simple Problems.</td></tr>
<tr><td>Types of Fluids and Fluid flows.</td></tr>
</table>

		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.

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	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

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II Year II Semester

L	T	P	C
0	0	3	1.5

CONTROL SYSTEMS LAB

Learning Objectives:

- To impart hands on experience to understand the performance of basic control system components such as magnetic amplifiers, D.C. servo motors, A.C. Servo motors and Synchros.
- To understand time and frequency responses of control system with and without controllers and compensators.

Any 10 of the following experiments are to be conducted:

1. Time response of Second order system
2. Characteristics of Synchros
3. Effect of P, PD, PI, PID Controller on a second order systems
4. Study of characteristics of Lag and lead compensators – Magnitude and phase plot
5. Obtaining the Transfer function of DC motor
6. Bode Plot, Root locus, Nyquist Plots for the transfer functions of systems up to 5^{th} order using Simulation software.
7. Controllability and Observability Test using Simulation software.
8. Temperature controller using PID
9. Characteristics of magnetic amplifiers
10. Characteristics of AC servo motor
11. Characteristics of DC servo motor
12. Block Diagram Representation of Field Controlled DC servo Motor Using Simulink.

Course Outcomes:

After the completion of the course the student should be:

CO1: Able to analyze the time response of a second order system.

CO2: Able to analyze the effect ofP, PI,PD, PID controllers and Lag, Lead compensators.

CO3:Analyze the performance and working of magnetic amplifier, DC, AC servomotors and synchros.

CO4: Able to judge the stability in time and frequency domain.

CO5: Able to test the controllability and observability.

CO-PO mapping Table with justification

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
C04	1	1	-	-	1	-	-	-	-	-	-	1	2	2
C05	1	1	-	-	1	-	-	-	-	-	-	-	2	2

*****

II Year II Semester

L	T	P	C
0	**0**	**3**	**1.5**

ELECTRICAL MACHINES-1 LAB

Course Objectives:

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. Determine the performance of DC machines by direct and indirect loading methods.
4. Predetermine the efficiency and regulation of single-phase transformer and assess their performance.
5. Study the conversion of three phase to two-phase by Scott connection.

LIST OF EXPERIMENTS

Any 10 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.
3. Load test on DC series generator.
4. Load test on DC Compound generator.
5. Brake test on DC Shunt motor.
6. Brake test on DC compound motor.
7. Hopkinson's test on DC shunt machines. Predetermination of efficiency.
8. Swinburne's test on DC shunt motor.
9. Speed control of DC shunt motor.
10. OC& SC test on single phase transformer.
11. Sumpner's test on single phase transformers.
12. Scott connection of transformers
13. Separation of core losses of a single-phase transformer.

Course Outcomes:

Students able to

CO1: Analyze the characteristics and performance of DC generator.
CO2: Investigate the speed control and testing methods of DC motors.
CO3: Determine the performance of DC machines by direct and indirect loading methods.
CO4: Perform various types of tests on transformers for assessing losses.
CO5: Achieve three-phase to two phase transformation.

CO-PO mapping Table with justification

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 II Semester

L	T	P	C
0	0	3	1.5

THERMAL AND HYDRO PRIME MOVERS LAB

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 Table with Justification

	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

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II Year II Semester

L	T	P	C
0	0	3	1.5

SOCIAL RELEVANT PROJECT

Course Objectives:

To enable the student

- Acquire the requisite skills and to apply the same to a given problem in the relevant technical area.
- Independently analyze and discuss complex inquiries/problems within the given constraints and handle larger problems at an advanced level within the technical area.
- Reflect on, evaluate, and critically assess one's own results and correlate it with other scientific results.
- Document and present one's own work for a given target group, with strict requirements on structure, format and language usage.
- Identify one's need for updating skills and knowledge and to continuously develop one's own competencies

Syllabus:

A number of social relevant research projects, e.g., in sectors of defense, medicine environment, energy, health, infrastructure, etc.Some representative activities in these areas are briefly mentioned below.

- **Environment**

In the area of environment, the projects like development of a zero discharge toilet, climate models, development of air quality standards which have been accepted by the Govt. of Indiadevelopment of an air quality index for dissemination of information to the people and for policy making etc

- **Energy**

In the area of energy, development of photovoltaics, solar-hydrogen generation, connection of solar cells to the grid in a smart manner, grid stability are some of the activities.

- **Defense**

In the area of defense, the projects like autonomous vehicles and helicopter, unmanned combat aircraft, materials development for defense applications, technologies for remediation of NBC threats and sensors for detecting explosives, activities with the ordinance factories, networking and communication systems.

- **Healthcare**

In the area of healthcare, the projects like helping devices for specially abled people, neurodegenerative disorders, cancer and bone degeneration etc

- **Other**

Few more socially relevant research projects to solve agricultural related projects like Agriculture Knowledge management systems on the cloud, advisory/alert delivery to the farmers over phones, automatic tagging for agriculture documents.

Course Outcomes:

After completion of the course the student will - be able to

CO1: Acquire the requisite skills and to apply the same to a given problem in the relevant technical area.
CO2: Independently analyze and discuss complex inquiries/problems within the given constraints and handle larger problems at an advanced level within the technical area.
CO3: Reflect on, evaluate, and critically assess one's own results and correlate it with other scientific results.
CO4: Document and present one's own work for a given target group, with strict requirements on structure, format and language usage.
CO5: Identify one's need for updating skills and knowledge and to continuously develop one's own competencies

Text Books:

- Any technical paper publications

References:

- https://csie.iitm.ac.in/SocialProjectsIITM.html

CO-PO mapping Table with justification

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

1 – LOW 2 – MODERATE 3 – HIGH

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III Year I Semester

L	T	P	C
2	1	0	3

POWER SYSTEMS-II

PRE-REQUISITES: 1) Basic Circuit Analysis, Power Systems-I

Course objectives: The student should be able to

1. Study the short, medium and long length transmission lines, their models and performance.
2. Study the effect of travelling waves on transmission lines.
3. Study the factors affecting the performance of transmission lines and power factor improvement methods.
4. Discuss sag and tension computation of transmission lines as well as to study the performance of overhead insulators.
5. discuss computation of Z_{bus} and Y_{bus} of power system

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Performance of Transmission Lines** (15 hrs) 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. **(10hrs)** **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). **(5hrs)**	**CO1**
II	**Travelling waves and Power Systems transients (15 hrs)** **Travelling waves** Incident, Reflected and Refracted Waves –Surge Impedance and SIL of Long Lines–Wave Length and Velocity of Propagation of Waves. (8hrs) **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.(7hrs)	**CO2**
III	**Various Factors governing the Performance of Transmission line (12hrs)** 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.	**CO3**
IV	**Sag and Tension Calculations and Overhead Line Insulators (12hrs)** Sag and Tension calculations with equal and unequal heights of towers–Effect of	**CO4**

	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.	
V	**Bus Admittance Matrix & Bus Impedance Matrix (12hrs)** **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. (6hrs) **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). (6hrs)	**CO5**

Content Beyond the syllabus:
Power transmission system design: Introduction to deregulated power systems, Transmission loss calculation, Power transmission loss allocation, Power transmission cost allocation, Available transfer capability (Elementary treatment only)
Advanced Transmission Technologies: High-temperature super conducting technology, Advanced composite conductors.(Elementary treatment only)

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Evaluate** the performance of transmission lines. **{Evaluate level, KL5}**
CO2	**Understand** the Power systems transients, travelling waves **{Understand level, KL2}**
CO3	**Evaluate** the various factors governing the performance of transmission line. **{Evaluate level, KL5}**
CO4	**Analyze** the sag and tension calculations and overhead line insulators. **{Apply level, KL4}**
CO5	**Evaluate** the bus admittance matrix & bus impedance matrix. **{Evaluate level, KL5}**

Learning Resources

Text books:

1. Electrical power systems by C.L.Wadhwa, New Age International (P) Ltd, Publishers, 1998.
2. Modern Power System Analysis, I.J.Nagarath and D.P.Kothari, Tata McGraw Hill, 2^{nd} Edition
3. A Text Book on Power System Engineering, M.L.Soni, P.V.Gupta, U.S.Bhatnagar A.Chakrabarthy, DhanpatRai& Co Pvt. Ltd.

Reference books:

1. Power system Analysis–by John J Grainger William D Stevenson, TMC Companies, 4^{th}edition
2. Modern Power System Analysis by I.J.Nagarath and D.P.Kothari, Tata McGraw Hill, 2^{nd} Edition

Micro-Syllabus

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. (15 Hrs)

Unit No	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 (8 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. (7 Hrs)

Unit No	Module	Micro content
2 (a) Travelling waves	Travelling waves	Incident, Reflected and Refracted voltage and current waves coefficients
		Surge Impedance Loading
		Wave length 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 ➢ Short circuit ➢ T junction ➢ Lumped reactive junctions ➢ Mathematical calculation ➢ Numerical problems

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)**

Unit No	Module	Micro content
Various Factors governing the Performance of Transmission line	Various Factors governing the Performance of Transmission line	Skin and Proximity effect ➢ Description and effect on Resistance of Solid Conductors
		Ferranti effect ➢ Charging current ➢ shunt compensation ➢ Numerical problems
		Corona ➢ Description of the phenomenon ➢ Factors affecting corona ➢ Critical voltages and power loss ➢ Radio Interference ➢ Numerical problems

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)

Unit No	Module	Micro content
4 (a) Sag and Tension calculations	Sag and Tension calculations	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)
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.(6hrs)

Bus Impedance Matrix (Zbus):

Formation of Zbus matrix by building algorithm, Modification of Zbus for the changes in network, Numerical Problems (3 bus system) (6hrs)

Unit No	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 Matrix (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)

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Evaluate** the performance of transmission lines. **{Evaluate level, KL5}**
CO2	**Understand** the Power systems transients, travelling waves **{Understand level, KL2}**
CO3	**Evaluate** the various factors governing the performance of transmission line. **{Evaluate level, KL5}**
CO4	**Analyze** the sag and tension calculations and overhead line insulators. **{Apply level, KL4}**
CO5	**Evaluate** the bus admittance matrix & bus impedance matrix. **{Evaluate level, KL5}**

Learning Resources

Text books:

1. Electrical power systems by C.L.Wadhwa, New Age International (P) Ltd, Publishers, 1998.
2. Modern Power System Analysis, I.J.Nagarath and D.P.Kothari, Tata McGraw Hill, 2nd Edition
3. A Text Book on Power System Engineering, M.L.Soni, P.V.Gupta, U.S.Bhatnagar A.Chakrabarthy, DhanpatRai& Co Pvt. Ltd.

Reference books:

1. Power system Analysis–by John J Grainger William D Stevenson, TMC Companies, 4thedition
2. Modern Power System Analysis by I.J.Nagarath and D.P.Kothari, Tata McGraw Hill, 2nd Edition

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

III Year I Semester

L	T	P	C
3	0	0	3

SPECIAL ELECTRICAL MACHINES

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 lossesIrreversible losses -Application of permanent magnets in motors-power density-operating temperature range-severity of operation duty. **(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)** 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)**	**CO4**

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 lossesIrreversible losses -Application of permanent magnets in motors-power density-operating temperature range-severity of operation duty. **(08hrs)**

Unit No	Module	Micro content
1.a Permanent magnet	Permanent Magnetic Materials introduction	Introduction of Magnetic Materials
		classification of permanent magnet materials used in

materials and PMDC motors		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 . 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 lossesIrreversible losses
		Application of permanent magnets in motors
		power density-operating temperature range
		severity of operation duty

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 No	Module	Micro content
2.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
2.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 stack operation 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 No	Module	Micro content
3.a Switched 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
3.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 No	Module	Micro content
4.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
4 .b Square and Sine Wave Permanent Magnet Brushless	Sine Wave Permanent Magnet Brushless DC Motor	Construction of Sine wave Permanent Magnet Brushless Motor
		Torque and EMF equations
		Torque/speed characteristics

DC Motor		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 ironequivalent circuit of LIM. (5 hrs)

Unit No	Module	Micro content
5.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
5.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

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/

CO PO MAPPING:

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**															
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PS0 1	PSO 2	PSO 3
CO 1	2	2	3	1								1			
CO 2	2	2	3	1								1			1
CO 3	2	2	3	1								1			1
CO 4	2	2	3	1								1			1
CO 5	2	2	3	1								1			1

III Year I Semester

L	T	P	C
2	0	0	2

INTERNET OF THINGS

Pre-Requisites: Fundamentals of computers and its importance

Preamble:"Internet of Things" (IoT) is a very new concept created and developed in recent years. This subject first introduces the concept and origin of IoT, then describes basic principles of IoT, next illustrates the framework of IoT, and finally takes examples to suggest applications of IoT. The subject intends to help students recognize IoT as a whole, to hold the clue and venation of the development of IoT, and to forecast future trends of IoT development.

Course objectives:
The student should be able to

1. study the introductory concepts, design procedures and enabling technologies of IoT
2. Learn the concepts of networking and building blocks of IoT.
3. Study changes in architectures of IoT and its challenges.
4. Know the procedure of IoT Design Methodology.
5. Learn about IoT solutions to different real time problems.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Unit – 1: Introduction to IoT (10 hrs)** Introduction to Internet of Things, Block diagram of IoT , Definition and characteristics of IoT, Physical Design of IoT, Logical Design of IoT, IoT Enabling Technologies, IoT levels. (Basic concepts only).	**CO1**
II	**Unit-2:IoT & M2M (10 hrs)** Machine to Machine, Difference between IoT & M2M, Software defined Networking, Network function virtualization, IoT Device and its basic building blocks	**CO2**
III	**Unit-3**:**Architecture and Challenges in IoT (10 hrs)** Three, Four, Five and Seven layer, Cloud and Fog based, Social IoT and its representative architecture, Design challenges, Development challenges, Security challenges, Other challenges, Need for IoT systems management.	**CO3**
IV	**Unit-4:IoT Platforms Design Methodology (10 hrs)** Introduction, Step by step procedure of IoT Design Methodology, Development of domain and Information model for IoT systems, Example case studies.	**CO4**
V	**Unit-5:Domain Specific IoTs (10 hrs)** Home automation, Smart cities, Environment, Energy, Retail, Logistics, Agricultural, Industry, Health and Lifestyle.	**CO5**

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

CO1	**Understand** the concepts and designing of IoT**{Understand level, KL2}**

CO2	**Explain** the concepts of networking and building blocks of IoT.**{Understand level, KL2}**
CO3	**Analyze** changes in architectures of IoT and its challenges **{Analyze level, KL4}**
CO4	**Explain** the procedure of IoT Design Methodology. **{Understand level, KL2}**
CO5	**Design** IoT solutions to different real time problems. **{Apply level, KL4}**

Text books:

1. **Internet of Things: A Hands-on Approach**, Arshdeep Bahga, Vijay Madisetti, Orient Blackswan Private Limited - New Delhi; First edition, ISBN: 8173719543
2. **The Internet of Things Key Applications and Protocols**, Olivier Hersent, David Boswarthick, Omar Elloumi, John Wiley & Sons Ltd, ISBN: 978-1-119-99435-0
3. **Architecting the Internet of Things**, Dieter Uckelmann, Mark Harrison, Florian Michahelles, Springer Heidelberg Dordrecht London New York, ISBN: 978-3-642-19156-5
4. **Fundamentals of Wireless Sensor Networks: Theory and Practice**, Waltenegus Dargie, Christian Poellabauer, John Wiley & Sons Ltd, ISBN: 978-0-470-97568-8

Reference books:

1. **Networks, Crowds, and Markets: Reasoning About a Highly Connected World**, David Easley, Jon Kleinberg, Cambridge University Press
2. **Rethinking the Internet of Things: A Scalable Approach to Connecting Everything**, daCosta Francis, Henderson Byron, Apress Publications, ISBN: 978-1-4302-5740-0CO4
3. **Getting Started with the Internet of Things**, CunoPfister, OReilly Media, ISBN: 97CO58-1- 4493-9357-1

Micro-Syllabus

Unit – 1: Introduction to IoT **(10 hrs)**

Introduction to Internet of Things, Block diagram of IoT , Definition and characteristics of IoT, Physical Design of IoT, Logical Design of IoT, IoT Enabling Technologies, IoT levels. (Basic concepts only).

Unit No	Module	Micro content
1a. Physical and Logical Design of IoT	Introduction	Introduction
		Block diagram of IoT
		Definition & characteristics of IoT
	Physical Design of IoT	Things in IoT, IoT Protocols
	Logical Design of IoT	IoT functional Blocks, IoT Communication Models, IoT communication APIs
1b. IoT Enabling Techniques & Levels	IoT Enabling Technologies	Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols, Embedded Systems
	IoT levels	IoT Leve-1 to IoT Leve-6

Unit-2:IoT & M2M **(10 hrs)**

Machine to Machine, Difference between IoT & M2M, Software defined Networking, Network function virtualization, IoT Device and its basic building blocks.

Unit No	Module	Micro content
2.a. Machine to Machine	Machine to Machine	Machine to Machine
		Difference between IoT & M2M
		Software defined Networking
		Network function virtualization
2.b**.** IoT Device building blocks	IoT basic building blocks	sensors,
		processors,
		gateways,
		applications

Unit-3:**Architecture and Challenges in IoT** **(10 hrs**

Three, Four, Five and Seven layer, Cloud and Fog based, Social IoT and its representative architecture, Design challenges, Development challenges, Security challenges, Other challenges, Need for IoT systems management.

Unit No	Module	Micro content
3.a. Architecture	Different Layers in IOT	Three, Four, Five and Seven layer
		Cloud and Fog based
		Social IoT and its representative architecture
3.b. Challenges in IoT	Challenges in IoT	Design challenges
		Development challenges
		Security challenges
		Other challenges
	IoT systems management	Need for IoT systems management

Unit-4:IoT Platforms Design Methodology **(10 hrs)**

Introduction, Step by step procedure of IoT Design Methodology, Development of domain and Information model for IoT systems, Example case studies

Unit No	Module	Micro content
4. Design Methodology	Step by step procedure	Introduction
		Step-1 to Step-10
	Models	Domain Model
		Information model
	case studies	Examples

Unit-5:Domain Specific IoTs **(10 hrs)**

Home automation, Smart cities, Environment, Energy, Retail, Logistics, Agricultural, Industry, Health and Lifestyle.

Unit No	Module	Micro content
5. Domain Specific IoTs	**Applications**	Home automation
		Smart cities
		Environment
		Energy
		Retail

		Logistics
		Agricultural
		Industry
		Health and Lifestyle

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

CO1	**Understand** the concepts and designing of IoT**{Understand level, KL2}**
CO2	**Explain** the concepts of networking and building blocks of IoT.**{Understand level, KL2}**
CO3	**Analyze** changes in architectures of IoT and its challenges **{Analyze level, KL4}**
CO4	**Explain** the procedure of IoT Design Methodology. **{Understand level, KL2}**
CO5	**Design**IoT solutions to different real time problems. **{Apply level, KL4}**

Text books:

1. **Internet of Things: A Hands-on Approach**, Arshdeep Bahga, Vijay Madisetti, Orient Blackswan Private Limited - New Delhi; First edition, ISBN: 8173719543
2. **The Internet of Things Key Applications and Protocols**, Olivier Hersent, David Boswarthick, Omar Elloumi, John Wiley & Sons Ltd, ISBN: 978-1-119-99435-0
3. **Architecting the Internet of Things**, Dieter Uckelmann, Mark Harrison, Florian Michahelles, Springer Heidelberg Dordrecht London New York, ISBN: 978-3-642-19156-5
4. **Fundamentals of Wireless Sensor Networks: Theory and Practice**, Waltenegus Dargie, Christian Poellabauer, John Wiley & Sons Ltd, ISBN: 978-0-470-97568-8

Reference books:

1. **Networks, Crowds, and Markets: Reasoning About a Highly Connected World**, David Easley, Jon Kleinberg, Cambridge University Press
2. **Rethinking the Internet of Things: A Scalable Approach to Connecting Everything**, daCosta Francis, Henderson Byron, Apress Publications, ISBN: 978-1-4302-5740-0CO4
3. **Getting Started with the Internet of Things**, CunoPfister, OReilly Media, ISBN: 97CO58-1- 4493-9357-1

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			2		3								1	
CO3			2		3									
CO4	3		1											1
CO5	3											2		

III Year I Semester

L	T	P	C
2	0	0	2

ELECTRICAL MACHINES MODELLING AND ANALYSIS

PRE-REQUISITES: 1) Electrical Machines-I
2) Electrical Machines-II

Course objectives: The student should be able to

1. Study the Establish unified theory of rotating machines.
2. Understand the concept of phase transformation.
3. Analyze different electrical machines for improved performance through modification of their characteristics.
4. Study develop concepts on mathematical modeling of electrical machines

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Basic concepts of Modeling (10 hrs)** Basic Two-pole Machine representation of Commutator machines, 3-phase synchronous machine with and without damper bars and 3-phase induction machine, Kron's primitive Machine-voltage, current and Torque equations.	**CO1**
II	**DC Machine Modeling (12 hrs)** Mathematical model of separately excited D.C motor-Sudden application of Inertia Load-Transfer function of Separately excited D.C Motor- Mathematical model of D.C Series motor, Shunt motor-Linearization Techniques for small perturbations.	**CO2**
III	**Reference frame theory & Modeling of single phase Induction Machines (12 hrs)** Linear transformation-Phase transformation - three phase to two phase transformation (abc to dq0) and two phase to three phase transformation dq0 to abc -Power equivalence Mathematical modeling of single phase induction machines.	**CO3**
IV	**Modeling of three phase Induction Machine (13 hrs)** Generalized model inarbitrary reference frame-Electromagnetic torque-Derivation of commonly used Induction machine models- Stator reference frame model-Rotor reference frame model-Synchronously rotating reference frame model	**CO4**
V	**Modeling of Synchronous Machines and Special Machines(13 hrs)** **Modeling of Synchronous Machine:** Synchronous machine inductances–voltage equations in the rotor's dq0 reference frame electromagnetic torque-current in terms of flux linkages-three synchronous machine model. **(7 hrs)** **Modeling of Special Machines:** Modeling of PM Synchronous motor, modeling of BLDC motor, modeling of Switched Reluctance motor. **(6 hrs)**	**CO5**
Content Beyond the syllabus: **DC Machine Modeling:** Steady State analysis-Transient State analysis **Modeling of three phase Induction Machine:** state space model with flux linkages as variables.		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Develop** modeling of dc machine **{Understand level, KL2}**
CO2	**Apply** mathematical modeling concepts to 3-phase Induction machines **{Apply level, KL3}**
CO3	**Evaluate** the control strategies based on dynamic modeling of 3-ph Induction machines **{ Evaluate level, KL5}**
CO4	**Evaluate** the control strategies based on dynamic modeling of 3-phase synchronous machine. **{Evaluate level, KL5}**
CO5	**Analyze** the BLDC Machine and switched reluctance machine based on mathematical modeling of BLDCM and SRM. **{Apply level, KL4}**

Learning Resources
Text books:
3. Generalized theory of Electrical Machinery –P.S.Bimbra- Khanna Publishers. 4. Electric Motor Drives - Modeling, Analysis& control -R.Krishnan- Pearson Publications1st edition -2002.
Reference books:
5. Analysis of Electrical Machinery and Drive systems – P.C.Krause, OlegWasynczuk, Scott D.Sudhoff – Second Edition-IEEE Press. 6. Dynamic simulation of Electric machinery using Matlab / Simulink –CheeMunOng-PHl. 7. Modern Power Electronics and AC Drives-B.K. Bose - PHI
e- Resources & other digital material
http://nptel.iitm.ac.in

Micro-Syllabus

Unit – 1: Basic concepts of Modeling (10 hrs)

Basic Two-pole Machine representation of Commutator machines, 3-phase synchronous machine with and without damper bars and 3-phase induction machine, Kron's primitive Machine-voltage, current and Torque equations.

Unit No	Module	Micro content
1a. Basic Two-pole Machine representation	Basic Two-pole Machine representation	Basic Two-pole Machine representation of Commutator machines
		3-phase synchronous machine with and without damper bars
		3-phase induction machine with and without damper bars
1b. Kron's primitive Machine	Kron's primitive Machine	Kron's primitive Machine
		Kron's primitive Machine voltage equation
		Kron's primitive Machine current equation
		Kron's primitive Machine Torque equation

Unit-2: DC Machine Modeling (12 hrs)

Mathematical model of separately excited D.C motor – Steady State analysis-Transient State analysis-Sudden application of Inertia Load-Transfer function of Separately excited D.C Motor-Mathematical model of D.C Series motor, Shunt motor-Linearization Techniques for small perturbations.

Unit No	Module	Micro content
2a Mathematical model of separately excited D.C motor	Mathematical model of separately excited D.C motor	Mathematical model of separately excited D.C motor,
		Steady State analysis,
		Transient State analysis,
		Sudden application of Inertia Load-Transfer function of Separately excited D.C Motor,
2b.Mathematical model of D.C Series motor & Shunt motor	Mathematical model of D.C Series motor & Shunt mot	Mathematical model of D.C Series motor,
		Mathematical model of D.C Shunt motor
		Linearization Techniques for small perturbations.

Unit-3: **Reference frame theory & Modeling of single phase Induction Machines (12 hrs)**

Linear transformation-Phase transformation - three phase to two phase transformation (abc to dq0) and two phase to three phase transformation dq0 to abc -Power equivalence Mathematical modeling of single phase induction machines.

Unit No	Module	Micro content
3a.Reference frame theory	**Reference frame theory**	Linear transformation,
		Phase transformation,
		three phase to two phase transformation
		two phase to three phase transformation
3b.Modeling of single phase Induction Machines	**Modeling of single phase Induction Machines**	Power equivalence Mathematical modeling of single phase induction machines.

Unit-4: Modeling of three phase Induction Machine (13 hrs)

Generalized model inarbitrary reference frame-Electromagnetic torque-Derivation of commonly used Induction machine models- Stator reference frame model-Rotor reference frame model-Synchronously rotating reference frame model-state space model with flux linkages as variables.

Unit No	Module	Micro content
4a.Electromagnetic torque-Derivation of commonly used Induction machine models	Electromagnetic torque-Derivation of commonly used Induction machine models	Generalized model inarbitrary reference frame,
		Electromagnetic torque
		Derivation of commonly used Induction machine models
4b.Stator and Rotor reference	Stator and Rotor reference frame model	Stator reference frame model
		Rotor reference frame model,

frame model		Synchronously rotating reference frame model
		state space model with flux linkages as variables.
		Comparison between DC and AC distribution systems.

Unit-5: Modeling of Synchronous Machines and Special Machines(13 hrs)

Modeling of Synchronous Machine: Synchronous machine inductances–voltage equations in the rotor's dq0 reference frame electromagnetic torque-current in terms of flux linkages-three synchronous machine model. **(7 hrs)**

Modeling of Special Machines: Modeling of PM Synchronous motor, modeling of BLDC motor, modeling of Switched Reluctance motor. **(6 hrs)**

Unit	**Module**	**Micro content**
5a.Modeling of Synchronous Machine	Modeling of Synchronous Machine	Synchronous machine inductances,
		voltage equations in the rotor's,
		reference frame electromagnetic torque,
		current in terms of flux linkages-three synchronous machine model.
5b.odeling of Special Machines	Modeling of Special Machines	Modeling of PM Synchronous motor
		modeling of BLDC motor,
		modeling of Switched Reluctance motor.

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

CO1	**Develop** modeling of dc machine **{Understand level, KL2}**
CO2	**Apply** mathematical modeling concepts to 3-phase Induction machines **{Apply level, KL3}**
CO3	**Evaluate** the control strategies based on dynamic modeling of 3-ph Induction machines **{ Evaluate level, KL5}**
CO4	**Evaluate** the control strategies based on dynamic modeling of 3-phase synchronous machine. **{Evaluate level, KL5}**
CO5	**Analyze** the BLDC Machine and switched reluctance machine based on mathematical modeling of BLDCM and SRM. **{Apply level, KL4}**

Text books:

1.Generalized theory of Electrical Machinery –P.S.Bimbra- Khanna Publishers.

2.Electric Motor Drives - Modeling, Analysis& control -R.Krishnan- Pearson Publications1st edition -2002.

Reference books:

1.Analysis of Electrical Machinery and Drive systems – P.C.Krause, OlegWasynczuk, Scott D.Sudhoff – Second Edition-IEEE Press.

2.Dynamic simulation of Electric machinery using Matlab / Simulink –CheeMunOng-PHl.

3.Modern Power Electronics and AC Drives-B.K. Bose - PHI

CO-PO mapping:

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

III Year I Semester

L	T	P	C
2	0	0	2

MICRO ELECTRO MECHANICAL SYSTEMS

PRE-REQUISITES: --

Course objectives: The student should be able to

1. To understand the standard micro fabrication techniques and working principles of mechanical sensors and actuators
2. To understand the fundamental principles of thermal sensors and actuators
3. To learn the fundamental principles of magnetic sensors and actuators and optic applications in MEMS
4. To understand Applications of RF MEMS and micro fluid actuation methods
5. To teach applications MEMS in chemical and biological systems.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**INTRODUCTION** Definition of Mems, mems history and development, micro machining, lithography principles &methods, structural and sacrificial materials. Thin film deposition, impurity doping, etching, surface micro machining, wafer bonding .LIGA **MECHANICAL SENSORS AND ACTUATORS:** Principles of sensing and actuation: beam and cantilever, capacitative, piezo electric, strain, pressure flow, pressure measurement by micro phone ,MEMS gyroscopes ,shear mode piezo actuator ,gripping piezo actuator ,inchworm technology	**CO1**
II	**THERMAL SENSORS AND ACTUATORS:** Thermal energy basics and heat transfer processes, thermisters, thermo devices, thermo couple, micro machined thermo couple probe ,peltier effect heat pumps, thermal flow sensors, micro hot plate gas sensors. mems thermo vessels, pyro electricity, shape memory alloys (SMA),U-shaped horizontal and vertical electro thermal actuator ,thermally activated mems relay micro spring thermal actuator data storage cantilever .	**CO2**
III	**MAGNETIC SENSORS AND ACTUATORS:** Magnetic materials for mems and properties, magnetic sensing and detection,magneto resistive sensor, more on hall effect ,magneto diodes ,magneto transistor ,mems magnetic sensor ,pressure sensor utilizing moke mag mems actuators by directional micro actuator feedback circuit integrated magnetic actuator ,large force reluctance actuator ,magnetic probe based storage device . **MICRO-OPTO –ELECTRO MECHANICAL SYSTEMS:**MOEMS technology ,properties of light ,light modulators ,beam splitter ,micro lens ,micro mirrors, digital micro mirror device(DMD),light detectors ,grating light valve (GLV),optical switch .wave guide and tuning shear stress measurement	**CO3**
IV	**RADIO FREQUENCY (RF) MEMS:** RF-based communication systems .RF MEMS, Mems inductors, varactors, tuner/filter resonator clarification of tuner, filter resonator, mems switches, phase shifter. **MICROFLUIDIC SYSTEMS:** Applications considerations on micro scale fluid,	**CO4**

	fluid actuation methods, dielectrophoresis (DEP),electro wetting ,electro thermal flow, thermo capillary effect electro osmosis flow, opto electro wetting (OEW),tuning using micro fluidics ,typical micro fluidic channel ,micro fluid dispenser, micro needle, molecular gate ,micro pumps	
V	**CHEMICAL AND BIO MEDICAL MICRO SYSTEMS:** Sensing mechanism &principle membrane transducer materials ,chem. Lab on chip (CLOC), chemo resisters ,chemo capacitors ,chemo transistors, electronic nose(E nose),mass sensitive chemo sensors, fluroscence detection ,calorimetric spectroscopy	**CO5**
Content Beyond the syllabus:		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	To understand the applications of micro-fabrication processes in MEMS and working principles of Mechanical sensors and actuators **(KL-2)**
CO2	To Explain the various working principles of Thermal sensors and actuators in MEMS. **(KL-2)**
CO3	To Learn working principles of Magnetic sensors, actuators and various principles Light and its applications in MEMS. **(KL-2)**
CO4	To Learn and apply the principles of RF and to understand multi domain problems of MEMS in micro-fluidic systems **(KL-2)**
CO5	An ability to learn knowledge of MEMS in Chemical and Bio Medical Micro Systems **(KL-2)**

Learning Resources
Text books:
1. MEMS, Nitaigour Premchand Mahalik,TMH Publishing co.
Reference books:
1. Foundation of MEMS .Chang Liu .Prentice Hall Ltd.
2. Introductory MEMS, Thomas M Adams, Richard A Layton, Springer International Publishers.
3. MEMS design and fabrication by Mohamed gad -el -hak CRC
4. MEMS and NEMS, Sergey EdwrdLyshevski, CRC Press, Indian Edition.
5. Mems and Micro systems: Design and manufacture .Tai-ran Hsu.TMH Publishers
6. BIO-Mems (Micro Systems) Gerald Urban, Springer.
e- Resources & other digital material:
1. http://www.csa.com/discoveryguides/mems/gloss_f.php
2. https://www.mems-exchange.org/MEMS/applications.html

Micro-Syllabus

Unit 1: Mechatronics systems – Elements & levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.		
Unit No	**Module**	**Micro content**
1a. Mechatronics systems	Introduction	Introduction to mechatronics and mechatronics systems
	Elements and levels of mechatronics system	different elements and classification of levels of mechatronics systems
	Design process	steps in design process of mechatronics systems
		traditional design vs mechatronics design
1b. Mechatronics systems	Systems	measurement systems and its basic elements
		control systems and its types
		microprocessor-based controllers
		advantages and disadvantages of mechatronics systems
	Sensors and Transducers	definitions od sensor and transducer and their differences
		performance terminology
		static and dynamic characteristics
		different types of sensors and transducers and examples for each type

Unit 2: Solid state electronic devices - PN junction diode, BJT, FET, DIAC, TRIAC and LEDs. Analog signal conditioning, operational amplifiers, noise reduction, filtering.		
Unit No	**Module**	**Micro content**
2a. Solid state electronic devices	Solid state electronic devices	different types of solid state electronic devices
		principle and working of PN junction diode, BJT, FET, DIAC, TRIAC and LEDs
	Signal conditioning	Need for signal conditioning
		Process of signal conditioning
		Elements used in signal conditioning
2b. Solid state electronic devices	Operational amplifiers	Brief introduction to amplifiers, operational amplifiers
		Different types of operational amplifiers
	Noise reduction and	Need for noise reduction and

	filtering.	filtering
		Classification of filters

Unit 3: Hydraulic and pneumatic actuating systems - Fluid systems, Hydraulic systems, and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems. Mechanical actuating systems and electrical actuating systems – basic principles and elements.

Unit No	Module	Micro content
3a.Actuating systems	Hydraulic and pneumatic actuating systems	Introduction to actuating systems
		Different types of actuating systems
		Different components and working of hydraulic and pneumatic actuating systems
		Control valves and its types
3b. Actuating systems	Hydraulic and pneumatic actuating systems	Electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems
	Mechanical and electrical actuating systems	Basic principles, elements and operations of Mechanical and electrical actuating systems

Unit 4: Digital electronics and systems - digital logic control, microprocessors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control.

Unit No	Module	Micro content
4a. Digital electronics and systems	Digital logic control	Introduction to digital electronics and systems
		Difference between analog and digital system
		Numbering systems and conversions
		Boolean algebra
		Different types of logic gates
	Microprocessors and Micro controllers	Difference between microprocessor and microcontroller
		Characteristics and important features of microprocessor
4b. Digital electronics and systems	Microprocessors and Micro controllers	Applications of microprocessors
		Characteristics and applications of microcontrollers
	Plc	Brief introduction to plc and its basic structure
		Components of a PLC, and programming
		PLCs versus computers
		Application of PLCs for control.

Unit 5: System and interfacing and data acquisition – Data Acquisition Systems, Analog to Digital and Digital to Analog conversions; Digital Signal Processing – data flow in DSPs, block diagrams, typical layouts, Interfacing motor drives. Design of mechatronics systems & future trends.

Unit No	Module	Micro content
5a. System and interfacing and data acquisition	Data acquisition systems (DAQ)	Introduction to Data Acquisition Systems
		Objectives and components of DAQ
		Block diagram of DAQ
		Advantages and disadvantages of DAQ
	Signal conversions	Analog to digital conversion
		Digital to analog conversion
5b. System and interfacing and data acquisition	Digital signal processing	Data flow in DSPs
		Block diagrams and typical layout of DSP
		Interfacing motor drives
	Design of mechatronics systems & future trends.	Design considerations of mechatronics systems
		Different steps in design of mechatronics systems
		Future trends in the field of mechatronics and its applications

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	To understand the applications of micro-fabrication processes in MEMS and working principles of Mechanical sensors and actuators **(KL-2)**
CO2	To Explain the various working principles of Thermal sensors and actuators in MEMS. **(KL-2)**
CO3	To Learn working principles of Magnetic sensors, actuators and various principles Light and its applications in MEMS. **(KL-2)**
CO4	To Learn and apply the principles of RF and to understand multi domain problems of MEMS in micro-fluidic systems **(KL-2)**
CO5	An ability to learn knowledge of MEMS in Chemical and Bio Medical Micro Systems **(KL-2)**

Learning Resources
Text books:
1. MEMS, NitaigourPremchandMahalik,TMH Publishing co.
Reference books:
1. Foundation of MEMS .Chang Liu .Prentice Hall Ltd.
2. Introductory MEMS, Thomas M Adams, Richard A Layton, Springer International Publishers.
3. MEMS design and fabrication by Mohamed gad -el -hak CRC

4. MEMS and NEMS, Sergey EdwrdLyshevski, CRC Press, Indian Edition.
5. Mems and Micro systems: Design and manufacture .Tai-ran Hsu.TMH Publishers
6. BIO-Mems (Micro Systems) Gerald Urban, Springer.
e- Resources & other digital material:
1. http://www.csa.com/discoveryguides/mems/gloss_f.php
2. https://www.mems-exchange.org/MEMS/applications.html

CO-PO Mapping:

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

III Year I Semester

L	T	P	C
3	0	0	3

POWER ELECTRONICS

PRE-REQUISITES: 1) Basic Circuit Analysis 2) Basics of Electronics

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

1. To study the characteristics of various power semiconductor devices and to design firing circuits for SCR.
2. To understand the operation of single phase full–wave converters and analyze harmonics in the input current.
3. To study the operation of three phase full–wave converters.
4. To understand the operation of choppers and AC-AC converters.
5. 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 (11 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 (13 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, Three-phase Dual converter.	**CO3**
IV	**DC–DC Converters (12 hrs)** 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)** 1- phase full bridge inverters with R and RL loads, Unipolar and Bipolar	**CO5**

	switching, 3-phase inverters: 120^0 and 180^0 conduction modes, Sinusoidal pulse width modulation method, Current Source Inverter (CSI)	

Content Beyond the syllabus:
Power diode, Series/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:

1. "Power Electronics" M.D.Singh,K B Khanchandani,2^{nd} edition, Tata Mc-Graw Hill publishers,2007.
2. "Power Electronics" P.S.Bhimbra, 3^{rd} edition, Khanna Publishers, 2002.
3. "Power Electronics" Daniel W.Hart, 1^{st} edition, Tata Mc-Graw Hill publishers,2011.

Reference books:

1. "Power Electronics: Circuits, Devices and Applications" M.Harnur Rashid,3^{rd} edition, Pearson,2009.
2. "Power Electronics: converters, applications & design" Ned Mohan, Tore M. Undeland, W.P. Riobbins3^{rd}edition,Wiley India Pvt. Ltd,2009.
3. "Thyristorised Power Controllers" G. K. Dubey,S.R.Doradla,A.Joshi, R. M. K.Sinha,1^{st} edition, New Age International (P) Limited Publishers, 1996

e- Resources & other digital material

2. https://nptel.ac.in/noc/courses/noc21/SEM1/noc21-ee01/
3. https://www.coursera.org/learn/power-electronics
4. https://www.classcentral.com/course/powerelectronics-716
5. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-334-power-electronics-spring-2007/lecture-notes/

Micro-Syllabus

Unit-1:Power Semi-Conductor Devices **(11 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 No	Module	Micro content
1.a static	Operation modes of Devices, Static I-V	Basics of converter topologies
		Device symbols and I-V characteristics (Ideal)

Characteristics of devices	graphs, SCR Operation	power MOSFET operation
		power IGBT operation
		operation of SCR–Static characteristics, Dynamic characteristics of SCR,two transistor analogy
1.b SCR firng ,commutation 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 **(13 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 No	Module	Micro content
2.a One quadrant converters	Half wave controlled converter, Full wave controlled converters	Half wave controlled converter with R,RL loads
		Freewheeling diode concept
		center tapped configuration
		bridge configuration
		Discontinuous conduction mode and continuous conduction modes
2.b.Two quadrant converters	Semi converter, 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-phase Half controlled bridge converter with R and RL loads: continuous and discontinuous conduction, Three-phase Fully controlled bridge converter with R and RL loads: continuous and discontinuous conduction, Three-phase Dual converter.

Unit No	Module	Micro content
3.a .Three phase rectifiers	Three pulse converter, six pulse converter	Half wave uncontrolled converter
		Half wave-controlled converter
		Full bridge converter
		Half bridge converters
3. b. Four quadrant converter	1-phase Dual converter	Circulating current mode
		Non-Circulating current mode

Unit-4:DC–DC Converters (12 hrs)

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 No	Module	Micro content
4.a.DC–DC	Choppers	Control strategies of chopper

Converters		Basic step down chopper
		Buck converter analysis in CCM
		Boost converter analysis in CCM
		Buck-Boost converter analysis in CCM
4.b .AC – AC Regulators	AC Voltage controller, Cyclo converter	Integral cycle control
		Phase angle control
		Step down cyclo converter
		Step up cyclo converter

Unit-5:DC–AC Converters (12 hrs)

1- 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)

Unit No	Module	Micro content
5.a.VSI	Single phase VSI, Three phase VSI	Introduction and classification of inverters
		full bridge inverter with R and RL loads
		180^0 conduction mode along with Fourier series
		120^0 conduction mode along with Fourier series
5.b.PWM & CSI	Pulse width modulation methods, CSI	Need of PWM
		Single Pulse PWM and Fourier series of Output voltage
		sine PWM
		Operation of CSI
		VSI Vs CSI

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}**

Text books:

1. "Power Electronics" M.D.Singh, K B Khanchandani, 2nd edition, Tata Mc-Graw Hill publishers,2007.
2. "Power Electronics" P.S.Bhimbra, 3rd edition, Khanna Publishers, 2002.
3. "Power Electronics" Daniel W.Hart, 1st edition, Tata Mc-Graw Hill publishers,2011.

Reference books:

1. "Power Electronics: Circuits, Devices and Applications" M. Harnur Rashid, 3rd edition, Pearson, 2009.
2. "Power Electronics: converters, applications & design" Ned Mohan, Tore M. Undeland,

W.P. Riobbins 3rd edition,Wiley India Pvt. Ltd,2009.

3. “Thyristorised Power Controllers” G. K. Dubey, S.R.Doradla, A.Joshi, R. M. K.Sinha, 1st edition, New Age International (P) Limited Publishers, 1996

CO-PO mapping Table with Justification

	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

L	T	P	C
3	0	0	3

UTILIZATION OF ELECTRICAL ENERGY

Pre-Requisites: Electrical Circuit Analysis, Power Systems,

Preamble: The objective of the course is to provide the first detailed treatment of fundamental understanding and application of electrical energy in power systems. Beginning with the basic terms, concepts and power system components representations, the course will present power generation technologies and power delivery systems.

Course objectives:

The main objectives are

1. To describe the concepts of electricity applications in heating and welding procedures
2. To explain the terminology of illumination engineering and its applications.
3. To gain the knowledge about electric traction systems and its performance parameters.
4. To describe the analytical concepts of electric traction systems with reference to braking, power and energy calculations.
5. To teach the theory about different electrical appliances and electric vehicles.

Unit No	Contents	Mapped CO
I	**Electric Heating & Welding (14hrs)** **Electric Heating (07 hrs)** Advantages and methods of electric heating–Resistance heating, induction heating and dielectric heating – Arc furnaces – Direct and indirect arc furnaces **Electric Welding (07 hrs)** Electric welding–Resistance and arc welding–Electric welding equipment–Comparison between AC and DC Welding	**CO1**
II	**Illumination(15 hrs)** **Illumination fundamentals (05 hrs)** Introduction, terms used in illumination, laws of illumination, polar curves, photometry, integrating sphere, sources of light. **Illumination concepts (10 hrs)** Discharge lamps, MV and SV lamps, comparison between tungsten filament lamps and fluorescent tubes, Basic principles of light control, Types and design of lighting, LED lighting, Street and flood lighting.	**CO2**
III	**Electric Traction-1(13 hrs)** **Electric Traction Speed - Time Curves and Mechanics of Train Movement (07 hrs)** Introduction, Systems of Traction, Systems of electric Traction, Speed-Time Curves for Train Movement, Mechanics of Train Movement, Train Resistance, Adhesive Weight, Coefficient of Adhesion, Load equalization. **Motors for Electric traction(06 hrs)** Introduction, Series and Shunt Motors for Traction Services, Two Series Motors are used to drive a Motor Car, AC Series Motor, Three Phase Induction Motor, Temperature rise calculations, Calculation of Tractive Effort, Horse Power and Specific Energy consumption for a given run.	**CO3**

IV	**Electric Traction-2(13 hrs)** **Braking (06 hrs)** Introduction, Regenerative Braking of Three Phase Induction Motors, Braking of Single Phase Series Motors, Mechanical braking, Magnetic Track Brake, Electro–Mechanical Drum Brakes. **Electric Traction Systems and Power Supply (07 hrs)** AC Electrification, Sub-Stations, Feeding and Distribution System for AC and DC Traction systems, Electrolysis by Current through Earth, Negative Booster, System of Current Collection, Trolley Wires.	**CO4**
V	**Applications(13 hrs)** **Domestic electrical appliances:** Calculation of energy consumption and efficiency of i. Electric iron. ii. Electric toaster. iii. Electric water heater. iv. Microwave oven. v. Fans (Ceiling and Table fan) vi. Washing Machine. vii. Grinder/ Mixer/ juicer. viii. Vacuum Cleaner. ix. Flour Mill. x. Air conditioner, Concept of Star System for energy conservation.**(07 hrs)** **Electric Vehicles:(06 hrs)** Introduction, Configurations of Electric Vehicles, Performance of Electric Vehicles, Tractive Effort in Normal Driving vehicles, Energy Consumption calculations.	**CO5**
Content Beyond the syllabus:(Not considered for evaluation) Electric Elevator machines and their motors, Electrolytic processes, Electric circuits used in Refrigeration, Air Conditioning and Water coolers, LCD displays, Electromechanical processes.		

Course Outcomes:

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

No	Description	POs, PSOs	KL
CO1	**Describe** about electric heating and welding procedures	PO1, PSO2	2
CO2	**Articulate** the terminology of illumination, **Explain** the working of electric lamps and design of lightning schemes	PO1, PSO2	2, 3
CO3	**Discuss** systems of electric traction, speed-time curves and mechanics of movement.	PO1, PSO2	2
CO4	**Explain** about braking methods used in traction systems and **calculate** different performance parameters of traction	PO1, PSO2	3
CO5	**Examine** different real time electrical appliances and applications in electric vehicles	PO1, PSO2	3

Text books:

1. **"Utilization of Electrical Energy",** V V L Rao, Universities Press, 1981.
2. **"Art & Science of Utilization of Electrical Energy"**, H. Partab, 2nd edition, DhanpatRai& Sons, 2017.
3. **"A Text book on Power System Engineering"**, M.L. Soni, P.V. Gupta, U.S. Bhatnagar and A. Chakrabarti, DhanpatRai Publishing Company (P) Limited, 2016.
4. **"Modern Electric,Hybrid Electric, and Fuel Cell Vehicles: Fundamentals Theory, and Design"**, MehrdadEhsani, YiminGao, Sebastien E Gay, Ali Emadi, 1st edition, CRC Press, 2004.

Reference books:
1. **"Utilization of Electrical Power including Electric drives and Electric traction",** N.V. Suryanarayana, 2nd edition, New Age Publishers, 2017. 2. **"Generation, Distribution and Utilization of Electric Energy"**, C.L.Wadhawa, 3rd edition, New Age International Private Limited, 2015. 3. **"Utilization, Generation and Conservation of Electrical Energy",** Sunil S Rao,1st edition, Khanna Publishers, 2000. 4. **"Utilization of Electric Power and Electric Traction",** G.C. Garg, 1st edition, Khanna Publishers, 2018.
e-resources & other digital material
1. https://nptel.ac.in/courses/108/105/108105060/
2. https://www.governmentpolytechnicnayagarh.org/upload/ueet(Pm).pdf
3. https://www.coursera.org/learn/electric-utilities
4. https://www.coursera.org/learn/electric-power-systems
5. https://www.coursera.org/lecture/electric-power-systems/distribution-ZujEz
6. https://www.edx.org/learn/electricity
7. http://indianrailways.gov.in/railwayboard/uploads/codesmanual/ACTraction-II-P-I/ACTractionIIPartICh1_data.htm
8. https://en.wikipedia.org/wiki/Traction_substation
9. https://www.engineeringenotes.com/electrical-engineering/electric-traction-electrical-engineering/power-supply-arrangement-for-ac-track-electrification-electricity/37184
10. https://membership.corrosion.com.au/blog/stray-traction-effects-wheres-the-problem/
11. https://encyclopedia2.thefreedictionary.com/Negative+Booster+Transformer
12. https://en.wikipedia.org/wiki/Current_collector
13. https://en.wikipedia.org/wiki/Overhead_line

MICRO-SYLLABUS

Unit–1: Electric Heating & Welding (14 hrs)

Electric Heating (07 hrs)

Advantages and methods of electric heating–Resistance heating, induction heating and dielectric heating – Arc furnaces – Direct and indirect arc furnaces

Electric Welding (07 hrs)

Electric welding–Resistance and arc welding–Electric welding equipment–Comparison between AC and DC Welding

Unit No	Module Name	Micro content
1a.	**Electric Heating**	Introduction, Advantages of Electric Heating and Heating methods
		Resistance Heating
		Resistance Furnaces, Temperature Control of Resistance Furnaces
		Design of Heating Element
		Induction Heating: Core Type Induction Furnace
		Vertical Core-Type Induction Furnace, Coreless Induction Furnace
		Dielectric Heating
1b.	**Electric Welding**	Electric Welding: Introduction, Advantages and Disadvantages of Welding

		Types of Electric Winding, Resistance Welding
		Types of resistance welding, Spot welding, Seam welding
		Projection welding, Butt welding
		Introduction to Electric Arc Welding, Carbon arc welding, Metal arc welding
		Atomic hydrogen arc welding, Inert gas metal arc welding
		Electric Welding Equipment, Comparison between AC and DC Welding

Unit–2: Illumination (15 hrs)

Illumination fundamentals (05 hrs)

Introduction, terms used in illumination, laws of illumination, polar curves, photometry, integrating sphere, sources of light.

Illumination concepts (10 hrs)

Discharge lamps, MV and SV lamps, comparison between tungsten filament lamps and fluorescent tubes, Basic principles of light control, Types and design of lighting, LED lighting, Street and flood lighting.

Unit No	Module Name	Micro content
2a.	**Illumination fundamentals**	Introduction, nature of light
		Definitions of various quantities related to illumination fundamentals
		Laws of illumination
		Polar curves, Photometry
		Integrating sphere, Lux meter
		Sources of light
2b.	**Illumination concepts**	Incandescent Lamps, Carbon arc Lamp
		Gaseous Discharge Lamps, Fluorescent Lamp
		Sodium Vapour Lamp, Mercury Vapour Lamps
		Comparison between filament lamps and fluorescent lamp
		Principles of light control
		Types and design of lighting schemes
		LED lighting
		Street and Flood lighting

Unit–3: Electric Traction-1 (13 hrs)

Electric Traction Speed - Time Curves and Mechanics of Train Movement (07 hrs)

Introduction, Systems of Traction, Systems of electric Traction, Speed-Time Curves for Train Movement, Mechanics of Train Movement, Train Resistance, Adhesive Weight, Coefficient of Adhesion, Load equalization.

Motors for Electric traction (06 hrs)

Introduction, Series and Shunt Motors for Traction Services, Two Series Motors are used to drive a Motor Car, AC Series Motor, Three Phase Induction Motor, Temperature rise calculations, Calculation of Tractive Effort, Horse Power and Specific Energy consumption for a given run.

Unit No	Module Name	Micro content

3a.	**Electric Traction Speed - Time Curves and Mechanics of Train Movement**	Introduction , Traction systems, Different systems of traction
		Systems of railway electrification
		Comparison between A.C. and D.C. Traction
		Electric Traction systems
		Trapezoidal and Quadrilateral Speed-Time curves
		Mechanics of train movement
		Train Resistance, Adhesive Weight, Coefficient of Adhesion
		Load equalization
3b.	**Motors for Electric traction**	Introduction
		Series and Shunt Motors for Traction Services
		Two Series Motors are used to drive a Motor Car
		AC Series Motor
		Three Phase Induction Motor
		Temperature rise calculations
		Calculation of Tractive Effort, Horse Power
		Calculation of Specific Energy consumption for a given run

Unit–4: Electric Traction-2 (13 hrs)
Braking (06 hrs)

Introduction, Regenerative Braking of Three Phase Induction Motors, Braking of Single Phase Series Motors, Mechanical braking, Magnetic Track Brake, Electro–Mechanical Drum Brakes.

Electric Traction Systems and Power Supply (07 hrs)

AC Electrification, Sub-Stations, Feeding and Distribution System for AC and DC Traction systems, Electrolysis by Current through Earth, Negative Booster, System of Current Collection, Trolley Wires.

Unit No	Module Name	Micro content
4a.	**Braking**	Introduction
		Regenerative Braking of Three Phase Induction Motors
		Braking of Single Phase Series Motors
		Mechanical braking
		Magnetic Track Brake
		Electro–Mechanical Drum Brakes
4b.	**Electric Traction Systems and Power Supply**	AC Electrification
		Traction Sub-Stations
		Feeding and Distribution System for ACTraction systems
		Feeding and Distribution System forDC Traction systems
		Electrolysis by Current through Earth
		Negative Booster
		System of Current Collection
		Trolley Wires

Unit–5: Applications (13 hrs)
Domestic electrical appliances: Calculation of energy consumption and efficiency of i. Electric iron. ii. Electric toaster. iii. Electric water heater. iv. Microwave oven. v. Fans (Ceiling and Table fan) vi. Washing Machine. vii. Grinder/ Mixer/ juicer. viii. Vacuum Cleaner. ix. Flour Mill. x. Air conditioner, Concept of Star System for energy conservation. **(07 hrs)**
Electric Vehicles: (06 hrs)
Introduction, Configurations of Electric Vehicles, Performance of Electric Vehicles, Tractive Effort in Normal Driving vehicles, Energy Consumption calculations.

Unit No	Module Name	Micro content
5a.	**Domestic electrical appliances**	Calculation of energy consumption and efficiency of i. Electric iron. ii. Electric toaster. iii. Electric water heater. iv. Microwave oven. v. Fans (Ceiling and Table fan) vi. Washing Machine. vii. Grinder/ Mixer/ juicer. viii. Vacuum Cleaner. ix. Flour Mill. x. Air conditioner
		Concept of Star System for energy conservation
5b.	**Electric Vehicles**	Introduction
		Configurations of Electric Vehicles
		Performance of Electric Vehicles
		Tractive Effort in Normal Driving vehicles
		Energy Consumption calculations

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

No	Description	POs, PSOs	KL
CO1	**Describe** about electric heating and welding procedures	PO1, PSO2	2
CO2	**Articulate** the terminology of illumination, **Explain** the working of electric lamps and design of lightning schemes	PO1, PSO2	2, 3
CO3	**Discuss** systems of electric traction, speed-time curves and mechanics of movement.	PO1, PSO2	2
CO4	**Explain** about braking methods used in traction systems and **calculate** different performance parameters of traction	PO1, PSO2	3
CO5	**Examine** different real time electrical appliances and applications in electric vehicles	PO1, PSO2	3

Text books:

1. **"Utilization of Electrical Energy",** V V L Rao, Universities Press, 1981.
2. **"Art & Science of Utilization of Electrical Energy"**, H. Partab, 2nd edition, DhanpatRai& Sons, 2017.
3. **"A Text book on Power System Engineering"**, M.L. Soni, P.V. Gupta, U.S. Bhatnagar and A. Chakrabarti, DhanpatRai Publishing Company (P) Limited, 2016.
4. **"Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals Theory, and Design"**, MehrdadEhsani, YiminGao, Sebastien E Gay, Ali Emadi, 1st edition, CRC Press, 2004.

Reference books:

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N.V. Suryanarayana, 2^{nd} edition, New Age Publishers, 2017.

2. **"Generation, Distribution and Utilization of Electric Energy"**, C.L.Wadhawa, 3^{rd} edition, New Age International Private Limited, 2015.
3. **"Utilization, Generation and Conservation of Electrical Energy",** Sunil S Rao, 1^{st} edition, Khanna Publishers, 2000.
4. **"Utilization of Electric Power and Electric Traction",** G.C. Garg, 1^{st} edition, Khanna Publishers, 2018.

e-resources & other digital material

1. https://nptel.ac.in/courses/108/105/108105060/
2. https://www.governmentpolytechnicnayagarh.org/upload/ueet(Pm).pdf
3. https://www.coursera.org/learn/electric-utilities
4. https://www.coursera.org/learn/electric-power-systems
5. https://www.coursera.org/lecture/electric-power-systems/distribution-ZujEz
6. https://www.edx.org/learn/electricity
7. http://indianrailways.gov.in/railwayboard/uploads/codesmanual/ACTraction-II-P-I/ACTractionIIPartICh1_data.htm
8. https://en.wikipedia.org/wiki/Traction_substation
9. https://www.engineeringenotes.com/electrical-engineering/electric-traction-electrical-engineering/power-supply-arrangement-for-ac-track-electrification-electricity/37184
10. https://membership.corrosion.com.au/blog/stray-traction-effects-wheres-the-problem/
11. https://encyclopedia2.thefreedictionary.com/Negative+Booster+Transformer
12. https://en.wikipedia.org/wiki/Current_collector
13. https://en.wikipedia.org/wiki/Overhead_line

CO–POs& PSOs Mapping:

CO No.	PO Number												PSO Number	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	1											1	
CO2	3		1											1
CO3	2													
CO4	2	1											1	1
CO5	2	1					1						2	

III Year I Semester

L	T	P	C
3	0	0	3

SIGNALS AND SYSTEMS

PRE-REQUISITES: Engineering Mathematics-1 and 3

Course objectives: The student should be able to

- Describe signals mathematically and understand how to perform mathematical operations on signals and Compute the Fourier series of a set of well-defined signals from first principles.
- Compute the Fourier transform of a set of well-defined signals and understand the Nyquist sampling theorem and the process of reconstructing a continuous-time signal from its samples.
- Perform the process of convolution and correlation between signals and Compute the output of an LTI system given the input and the impulse response through convolution sum and convolution integral.
- **Understand Laplace transforms and their properties for analysis of signals and systems.**
- **Understand Z-transforms and their properties for analysis of signals and systems.**

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Signals Analysis and Fourier Series** Signal Analysis: Definition Signal (Continuous time and Discrete time), Elementary signals such as Dirac delta, unit step, unit ramp, sinusoidal and exponential. Classification of signals, time operations on signals. Analogy between vectors and signals, Orthogonal signal space, Signal approximation using orthogonal functions, Mean square error, Closed or complete set of orthogonal functions. **(09hr)** Fourier Series: Representation of Fourier series, Dirichlet's conditions, Properties of Fourier Series, Trigonometric Fourier Series and Exponential/Complex Fourier Series, Complex Fourier spectrum. (06hr)	**CO1**
II	**Fourier Transform and Sampling Theorem** Fourier Transform: Deriving Fourier Transform from Fourier series, Fourier Transform convergence condition, Fourier Transform of standard signals, Fourier Transform of Periodic Signals, Properties of Fourier Transform, Fourier Transforms involving Impulse function and Signum function, Introduction to Hilbert Transform. (08hr) Sampling Theorem: Graphical and analytical proof for Band Limited Signals, impulse sampling, Natural and Flat top Sampling, Reconstruction of signal from its samples, effect of under sampling –Aliasing, Introduction to Band Pass sampling. (05hrs)	**CO2**
III	**Signal transmission through Linear Time Invariant(LTI) Systems and Convolution and Correlation** Signal transmission through Linear Time Invariant (LTI) Systems: System definition (continuous and discrete), properties of systems, impulse response, transfer function, LTI system response, Filter characteristics of linear systems.	**CO3**

	Distortion less transmission through a system, Signal bandwidth, system bandwidth, Causality and Poly-Wiener criterion for physical realizable systems.(07) Convolution and Correlation: Concept of convolution, convolution in time and frequency domain properties of Fourier Transform, graphical and analytical convolution, Cross correlation and auto correlation of functions, properties of correlation function, Energy density spectrum, Power density spectrum, Relation between auto correlation function and energy/power spectral density spectrum. Relation between convolution and correlation.(09)	
IV	**Laplace Transforms:** Laplace Transforms (L.T), Inverse Laplace Transform, Concept of Region of Convergence(ROC) for Laplace Transforms, Properties of ROC of Laplace Transform, Properties of Laplace Transform, Relation between LT and Fourier Transform of a signal, Response of LTI system using Laplace Transform, Laplace transform of causal periodic signals, Laplace transform of certain signals using waveform synthesis. (08hrs)	**CO4**
V	**Z-Transforms:** Concept of Z- Transform and Inverse Z-Transform, Distinction between Laplace, Fourier and Z -transforms, Region of Convergence in Z-Transform, Constraints on ROC for various classes of signals, Properties of ROC of Z-Transform, Properties of Z-transforms, Inverse Z-transform, Response of LTI system using Z-Transform, Introduction to DTFT, Relationship between ZT and DTFT, Conversion from Laplace transform to Z-transform and vice-versa, Introduction to DTFT, Relationship between ZT and DTFT. **(08hrs)**	**CO5**

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	The student will be able to **understand** various types of signals mathematically and able to **calculate** complex Fourier spectrum. **{Understand level, KL2,Calculate-KL-4}**
CO2	**Analyse** the continuous-time signals and continuous-time systems using Fourier transform and **Apply** sampling theorem to convert continuous-time signals to discrete-time signal and reconstruct the original signal from samples. **{ Analyse level-KL3, Apply Level-KL3}**
CO3	**Define** systems based on their properties and determine the response of LTI system. **Understand** the concept convolution, correlation, energy spectral density and power spectral density. **{Define KL-1, Understand level, KL2}**
CO4	**Compute** Laplace transforms to analyze continuous time signals and systems and understand the concept of region of convergence.**{ Compute level, KL4}**
CO5	**Compute** Z-transform to analyze discrete-time signals and systems, and understand the concept of region of convergence. **{ Compute level, KL4}**

Learning Resources
Text books:
1. Signals, Systems & Communications - B.P. Lathi, BS Publications,2003. 2. Signals and Systems - A.V. Oppenheim, A.S. Willsky and S.H.Nawab, PHI, 2nd Edn.

3. Signals & Systems- Narayan Iyer and K Satya Prasad ,Cengage Pub. 4. Principles of Linear Systems and Signals by B.P.Lathi, Oxford publications, Second Edition.
Reference books
1. Signals & Systems - Simon Haykin and Van Veen,Wiley, 2nd Edition. 2. Signals and Systems – K R Rajeswari 3. Fundamentals of Signals and Systems- Michel J. Robert, MGHInternational Edition, 2008. 4. **Signals and Stochastic Processes- Y Mallikarjuna Reddy and Giri Babu Kande, University Press, 1st edition.**
e- Resources & other digital material
1. https://nptel.ac.in/courses/108/106/108106163/
2. https://nptel.ac.in/courses/108/104/108104100/
3. https://nptel.ac.in/courses/108/105/108105065/
4. https://nptel.ac.in/courses/117/104/117104074/
5. https://nptel.ac.in/courses/117/101/117101055/
6. https://nptel.ac.in/courses/108/106/108106075/

MICRO-SYLLABUS:

UNIT – I: Signals Analysis and Fourier Series Signal Analysis: Definition Signal(Continuous time and Discrete time), Elementary signals such as Dirac delta, unit step, unit ramp, sinusoidal and exponential. Classification of signals(Even and odd, periodic and periodic, energy and power, random and deterministic, analog and digital and related problems), time operations on signals(time shifting, time scaling, time reversal and related problems). Analogy between vectors and signals, Orthogonal signal space, Signal approximation using orthogonal functions, Mean square error, Closed or complete set of orthogonal functions. **(09hr)** Fourier Series: Representation of Fourier series, Dirichlet's conditions, Properties of Fourier Series(Linearity, time shifting, time scaling, time reversal, time differentiation, frequency shifting, time convolution, time multiplication, parsevals identity and related problems), Trigonometric Fourier Series and Exponential/Complex Fourier Series, Complex Fourier spectrum(definition and related problems). (06hr)
UNIT – II: Fourier Transform and Sampling Theorem Fourier Transform: Deriving Fourier Transform from Fourier series, Fourier Transform convergence condition, Fourier Transform of standard signals, Fourier Transform of Periodic Signals, Properties of Fourier Transform, Fourier Transforms involving Impulse function and Signum function, Introduction to Hilbert Transform. (08hr) Related Problems Sampling Theorem: Graphical and analytical proof for Band Limited Signals, impulse sampling, Natural and Flat top Sampling, Reconstruction of signal from its samples, effect of under sampling –Aliasing, Introduction to Band Pass sampling. (05hrs) Related Problems
UNIT – III Signal transmission through Linear Time Invariant (LTI) Systems and Convolution and Correlation Signal transmission through Linear Time Invariant(LTI) Systems: System definition (continuous and discrete), properties of systems(Linearity, time invariance, causality, stability, memoryless, invertibility and related problems), impulse response, transfer function, LTI system response, Filter characteristics of linear systems. Distortion less transmission through a system, Signal bandwidth, system bandwidth, Causality and Poly-Wiener criterion for physical realizable systems.(07) **Convolution and Correlation:** Concept of convolution, convolution in time and frequency

domain properties of Fourier Transform, graphical and analytical convolution, Cross correlation and auto correlation of functions, properties of correlation function, Energy density spectrum, Power density spectrum, Relation between auto correlation function and energy/power spectral density spectrum. Relation between convolution and correlation.(09). **Related Problems.**
UNIT – IV **Laplace Transforms:** Laplace Transforms (L.T), Inverse Laplace Transform, Concept of Region of Convergence(ROC) for Laplace Transforms, Properties of ROC of Laplace Transform, Properties of Laplace Transform, Relation between LT and Fourier Transform of a signal, Response of LTI system using Laplace Transform, Laplace transform of causal periodic signals, **Laplace transform of certain signals using waveform synthesis. (08hrs)** **Related Problems**
UNIT –V **Z-Transforms:** Concept of Z- Transform and Inverse Z-Transform, Distinction between Laplace, Fourier and Z -transforms, Region of Convergence in Z-Transform, Constraints on ROC for various classes of signals, Properties of ROC of Z-Transform, Properties of Z-transforms, Inverse Z-transform, Response of LTI system using Z-Transform, Conversion from Laplace transform to Z-transform and vice-versa, Introduction to DTFT, Relationship between ZT and DTFT. (08hrs) Related Problems

Learning Resources
Text books:
1. Signals, Systems & Communications - B.P. Lathi, BS Publications,2003. 2. Signals and Systems - A.V. Oppenheim, A.S. Willsky and S.H.Nawab, PHI, 2nd Edn. 3. Signals & Systems- Narayan Iyer and K Satya Prasad ,Cengage Pub. 4. Principles of Linear Systems and Signals by B.P.Lathi, Oxford publications, Second Edition.
Reference books
1. Signals & Systems - Simon Haykin and Van Veen,Wiley, 2nd Edition. 2. Signals and Systems – K R Rajeswari 3. Fundamentals of Signals and Systems- Michel J. Robert, MGHInternational Edition, 2008. 4. Signals and Stochastic Processes- Y Mallikarjuna Reddy and Giri Babu Kande, University Press, 1st edition.
e- Resources & other digital material
1. https://nptel.ac.in/courses/108/106/108106163/
2. https://nptel.ac.in/courses/108/104/108104100/
3. https://nptel.ac.in/courses/108/105/108105065/
4. https://nptel.ac.in/courses/117/104/117104074/
5. https://nptel.ac.in/courses/117/101/117101055/
6. https://nptel.ac.in/courses/108/106/108106075/

CO-PO mapping

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

III Year I Semester

L	T	P	C
3	0	0	3

ENERGY CONSERVATION & AUDITING

CourseObjectives:

1. To understand energy efficiency, scope, conservation and technologies.
2. To design energy efficient lighting systems.
3. To estimate/calculate power factor of systems and propose suitable compensation techniques.
4. To understand energy conservation in HVAC systems.
5. To calculate life cycle costing analysis and return on investment on energy efficient technologies

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Basic Principles of Energy Audit and management (15h)** Energy audit – Definitions – Concept – Types of audit – Energy index – Cost index – Piecharts –Sankey diagrams – Load profiles – Energy conservation schemes and energy saving potential – Numerical problems – Principles of energy management – Initiating, planning, controlling, promoting, monitoring, reporting – Energy manager – Qualities and functions – Language – Questionnaire – Check list for top management	**CO1**
II	**Lighting(15h)** Modification of existing systems – Replacement of existing systems – Priorities**:** Definition of terms and units – Luminous efficiency – Polar curve – Calculation of illumination level –Illumination of inclined surface to beam – Luminance or brightness – Types of lamps –Types of lighting – Electric lighting fittings (luminaries) – Flood lighting – White light- LED and conducting Polymers – Energy conservation measures.	**CO2**
III	**Power Factor and energy instruments (12h)** Power factor – Methods of improvement – Location of capacitors – Power factor with nonlinear loads – Effect of harmonics on Power factor – Numerical problems. Energy Instruments – Watt–hour meter – Data loggers – Thermocouples – Pyrometers – Lux meters– Tong testers – Power analysis.	**CO3**
IV	**Space Heating and Ventilation (12h)** Ventilation – Air–Conditioning (HVAC) and Water Heating**:** Introduction – Heating of buildings – Transfer of Heat–Space heating methods – Ventilation and air conditioning –Insulation–Cooling load – Electric water heating systems – Energy conservation methods.	**CO4**
V	**Economic Aspects and Financial Analysis (14h)** Understanding energy cost - Economics Analysis – Depreciation Methods – Time value of money – Rate of return – Present worth method – Replacement analysis – Life cycle costing analysis – Energy efficient motors (basic concepts) – Economics of energy efficient motorsand systems.	**CO5**

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Explain energy efficiency, conservation and various technologies.
CO2	Design energy efficient lighting systems.
CO3	Calculate power factor of systems and propose suitable compensation techniques.
CO4	Explain energy conservation in HVAC systems
CO5	Calculate life cycle costing analysis and return on investment on energy efficient technologies.

Learning Resources

Text books:

1. Hand Book of Energy Audit by Sonal Desai- Tata McGraw hill
2. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd–2nd edition, 1995.

Reference books:

1. Energy management by W.R. Murphy & G. Mckay Butter worth, Elsevier publications. 2012
2. Electric Energy Utilization and Conservation by S C Tripathy, Tata McGraw hill publishing company Ltd. New Delhi.
3. Energy management by Paul o' Callaghan, Mc–Graw Hill Book company–1st edition, 1998.
4. Energy management hand book by W.C.Turner, John wiley and sons.
5. Energy management and conservation –k v Sharma and pvenkataseshaiah-I K International Publishing House pvt.ltd,2011.
6. http://www.energymanagertraining.com/download/Gazette_of_IndiaPartIISecI-37_25-08-2010.pdf

Website materials:

1. http://nptel.ac.in/courses/108104052/
2. http://freevideolectures.com/Course/2354/Power-Systems-Operation-and-Control
3. http://nptel.iitg.ernet.in/courses/Elec_Engg/IIT%20Bombay/Power%20Systems%20Operation%20and%20Control.html

Micro-Syllabus

Unit 1: Basic Principles of Energy Audit and management (15h)

Energy audit – Definitions – Concept – Types of audit – Energy index – Cost index – Pie charts –Sankey diagrams – Load profiles – Energy conservation schemes and energy saving potential – Numerical problems – Principles of energy management – Initiating, planning, controlling, promoting, monitoring, reporting – Energy manager – Qualities and functions – Language – Questionnaire – Check list for top management.

Unit No	Module	Micro content
1.a	Energy audit – Definitions – Concept – Types of audit	Energy audit – Definitions
		Concept – Types of audit
	Energy index – Cost index – Pie charts –Sankey diagrams – Load profiles	Energy index – Cost index – Pie charts – Sankey diagrams – Load profiles

	Energy conservation schemes and energy saving potential – Numerical problems	Energy conservation schemes and energy saving potential – Numerical problems
1.b	Principles of energy management- Initiating, planning, controlling, promoting, monitoring, reporting	Principles of energy management- Initiating, planning, controlling, promoting, monitoring, reporting
	Energy manager – Qualities and functions	Energy manager – Qualities and functions
	Language – Questionnaire – Check list for top management.	Language – Questionnaire – Check list for top management.

Unit 2: Lighting **(15h)**

Modification of existing systems – Replacement of existing systems – Priorities: Definition of terms and units – Luminous efficiency – Polar curve – Calculation of illumination level – Illumination of inclined surface to beam – Luminance or brightness – Types of lamps – Types of lighting – Electric lighting fittings (luminaries) – Flood lighting – White light- LED and conducting Polymers – Energy conservation measures.

Unit No	**Module**	**Micro content**
2. a.	Modification of existing systems – Replacement of existing systems – Priorities: Definition of terms and units – Luminous efficiency – Polar curve – Calculation of illumination level –Illumination of inclined surface to beam	Modification of existing systems – Replacement of existing systems
		Priorities: Definition of terms and units – Luminous efficiency – Polar curve
		Calculation of illumination level – Illumination of inclined surface to beam.
2. b.	Luminance or brightness – Types of lamps – Types of lighting – Electric lighting fittings (luminaries) – Flood lighting – White light- LED and conducting Polymers – Energy c	Luminance or brightness – Types of lamps – Types of lighting
		Flood lighting – White light- LED and conducting Polymers – Energy conservation measures.

Unit 3: Power Factor and energy instruments **(12h)**

Power factor – Methods of improvement – Location of capacitors – Power factor with nonlinear loads – Effect of harmonics on Power factor – Numerical problems. EnergyInstruments – Watt–hour meter – Data loggers – Thermocouples – Pyrometers – Lux meters– Tong testers – Power analysis.

Unit No	**Module**	**Micro content**
3. a.	Power factor – Methods of improvement	Power factor – Methods of improvement
	Location of capacitors – Power factor with nonlinear loads – Effect of harmonics on Power factor – Numerical problems	Location of capacitors – Power factor with nonlinear loads – Effect of harmonics on Power factor – Numerical problems
3.b.	Energy Instruments – Watt–hour meter – Data loggers.	Energy Instruments – Watt–hour meter – Data loggers
	Thermocouples – Pyrometers – Lux meters– Tong testers –	Thermocouples – Pyrometers – Lux meters– Tong testers – Power analysis

<table>
<tr><td></td><td>Power analysis</td><td></td></tr>
<tr><td colspan="3">Unit 4: Space Heating and Ventilation (12h)
Ventilation – Air–Conditioning (HVAC) and Water Heating: Introduction – Heating ofbuildings – Transfer of Heat–Space heating methods – Ventilation and air conditioning –Insulation–Cooling load – Electric water heating systems – Energy conservation methods.</td></tr>
<tr><td>Unit No</td><td>Module</td><td>Micro content</td></tr>
<tr><td rowspan="2">4. a.</td><td rowspan="2">Ventilation – Air–Conditioning (HVAC) and Water Heating: Introduction – Heating of buildings – Transfer of Heat–Space heating methods</td><td>Ventilation – Air–Conditioning (HVAC) and Water Heating: Introduction</td></tr>
<tr><td>Heating of buildings – Transfer of Heat–Space heating methods</td></tr>
<tr><td rowspan="3">4.b</td><td rowspan="3">Ventilation and air conditioning –Insulation–Cooling load – Electric water heating systems – Energy conservation methods</td><td>Ventilation and air conditioning – Insulation</td></tr>
<tr><td>Cooling load – Electric water heating systems</td></tr>
<tr><td>Energy conservation methods.</td></tr>
<tr><td colspan="3">Unit 5: Economic Aspects and Financial Analysis (14h)
Understanding energy cost - Economics Analysis – Depreciation Methods – Time value of money – Rate of return – Present worth method – Replacement analysis – Life cycle costing analysis – Energy efficient motors (basic concepts) – Economics of energy efficient motors and systems.</td></tr>
<tr><td>Unit No</td><td>Module</td><td>Micro content</td></tr>
<tr><td rowspan="2">5. a.</td><td rowspan="2">Understanding energy cost - Economics Analysis – Depreciation Methods – Time value of money – Rate of return – Present worth method</td><td>Understanding energy cost - Economics Analysis</td></tr>
<tr><td>Depreciation Methods – Time value of money – Rate of return – Present worth method.</td></tr>
<tr><td>5.b.</td><td>Replacement analysis – Life cycle costing analysis – Energy efficient motors (basic concepts) – Economics of energy efficient motors and systems</td><td>Replacement analysis – Life cycle costing analysis – Energy efficient motors (basic concepts) – Economics of energy efficient motors and systems</td></tr>
</table>

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

<table>
<tr><th colspan="2">Course Outcomes</th></tr>
<tr><td colspan="2">Upon successful completion of the course, the student will be able to</td></tr>
<tr><td>CO1</td><td>Explain energy efficiency, conservation and various technologies.</td></tr>
<tr><td>CO2</td><td>Design energy efficient lighting systems.</td></tr>
<tr><td>CO3</td><td>Calculate power factor of systems and propose suitable compensation techniques.</td></tr>
<tr><td>CO4</td><td>Explain energy conservation in HVAC systems</td></tr>
<tr><td>CO5</td><td>Calculate life cycle costing analysis and return on investment on energy efficient technologies.</td></tr>
</table>

CO-PO mapping

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

III Year I Semester

L	T	P	C
3	0	0	3

HIGH VOLTAGE ENGINEERING

PRE-REQUISITES: 1) Physics & Chemistry

Course objectives: The student should be able to

1. Understand electric field distribution and computation in different configuration of electrode systems
2. Understand HV breakdown phenomena in gases, liquids and solids dielectrics
3. Acquaint with the generating principle of operation and design of HVDC, AC and Impulse voltages and currents
4. Understand various techniques of AC, DC and Impulse measurement of high voltages and currents**.**
5. Know the insulating characteristics of dielectric materials **and** various testing techniques of HV equipments

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction to High Voltage Technology (13Hrs)** Electric Field Stresses – Uniform and non–uniform field configuration of electrodes – Estimation and control of electric Stress – Numerical methods for electric field computation.	**CO1**
II	Break down phenomenon in gaseous, liquid and solid insulation (13 Hrs) Gases as insulating media – Collision process – Ionization process – Townsend's criteria of breakdown in gases – Paschen's law – Liquid as Insulator – Pure and commercial liquids – Breakdown in pure and commercial liquid – Intrinsic breakdown – Electromechanical breakdown – Thermal breakdown –Breakdown of solid dielectrics, composite dielectrics used in practice.	**CO2**
III	Generation of High voltages and High currents (13 Hrs) Generation of high DC voltages – Generation of high alternating voltages – Generation of impulse voltages and currents – Tripping and control of impulse generators.	**CO3**
IV	Measurement of high voltages and High current (13Hrs) Measurement of high AC, DC and Impulse voltages – Voltages and measurement of high currents – Direct, alternating and Impulse.	**CO4**
V	Testing of electrical materials and apparatus (13Hrs) Measurement of DC resistivity – Measurement of dielectric constant and loss factor – Partial discharge measurements. Testing of insulators and bushings – Testing of isolators and circuit breakers – Testing of cables – Testing of transformers – Testing of surge arresters – Radio interference Measurements.	**CO5**

Content Beyond the syllabus:

1. **Applications of insulating materials in various equipment:** Applications in power transformers, rotating machines, cables, circuit breakers, power capacitors, HV bushings.
2. **Advancements in insulators design:** polymer insulators, composite insulators.

3. **Condition monitoring of high voltage equipment:** Intelligent monitoring of high voltage equipment with optical fibre sensors and chromatic techniques.

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Acquainted **with the performance of high voltages with regard to different configurations of electrode systems. (**Analyze, KL4)
CO2	Understand **theory of breakdown and withstand phenomena of all types of dielectric materials (**understand, KL2)
CO3	Acquaint **with the techniques of generation of AC,DC and Impulse voltages (**understand, KL2)
CO4	Apply **knowledge for measurement of high voltage and high current AC, DC and Impulse. (**apply, KL3**)**
CO5	Experiment **to measure dielectric property of electrical material and know the techniques of testing various equipment's used in HV engineering (**Analyze, KL4)

Learning Resources
Text books:
1. "**High Voltage Engineering: Fundamentals**", **E.Kuffel, W.S.Zaengl, J.Kuffel**, 2nd Edition, Elsevier, 2000. 2. "**High Voltage Engineering**", M.S.Naidu, V.Kamaraju, 3rd Edition, TMH, 2003.
Reference books:
1. "**High Voltage Engineering and Testing**", Ryan, 3rd Edition, IET Publishers, 2013. 2. "**High Voltage Engineering**", C.L.Wadhwa, 1st Edition, New Age Publishers, 1997. 3. "**High Voltage and Electrical Insulation Engineering**", Ravindra Aurora, Wolfgang Mosch, John Wiley Publications, 2011.
e- Resources & other digital material
1. https://nptel.ac.in/courses/108/104/108104048/
2. https://cds.cern.ch/record/1005044/files/p113

Micro-Syllabus

Unit – 1: Introduction to High Voltage Technology (13Hrs)

Electric Field Stresses – Uniform and non–uniform field configuration of electrodes – Estimation and control of electric Stress – Numerical methods for electric field computation

Unit No	Module	Micro content
1a. Electric Field stresses	Electric field stresses	Electric field stress
		Gas/Vacuum as insulator
		Liquid dielectrics
		Solids and composite dielectrics
		Uniform and non-uniform electric fields
1b. Estimation and control of electric stress	Estimation and control of electric stress	Estimation of electric field
		Estimation of electric field in geometric boundaries
		Numerical methods for electric field computation
		Finite element method
		Charge simulation method

		Boundary element method
		Surge voltages, their distribution and control

Unit-2: Break down phenomenon in gaseous, liquid and solid insulation (13 Hrs)

Gases as insulating media – Collision process – Ionization process – Townsend's criteria of breakdown in gases – Paschen's law – Liquid as Insulator – Pure and commercial liquids – Breakdown in pure and commercial liquid – Intrinsic breakdown – Electromechanical breakdown – Thermal breakdown –Breakdown of solid dielectrics, composite dielectrics used in practice

Unit	Module	Micro content
2a. Breakdown phenomenon in gases	Conduction and breakdown in gases	Gases as insulating media
		Collision processes
		Ionization process
		Townsends current growth equation
		Current growth in the presence of secondary processes
		Townsends criteria for breakdown
		Breakdown in electronegative gases
		Time lags for breakdown
		Streamer theory of breakdown in gases
		Paschen's law
		Breakdown in non-uniform fields and corona discharges (elementary treatment only)
		Practical Considerations In Using Gases And Gas Mixtures For Insulation Purposes
	Vacuum insulation	Vacuum as insulating media, conduction and breakdown in vacuum
2b. Breakdown in liquids and solid insulation	Conduction and breakdown in liquids	Liquids as insulators
		Classification of liquid dielectrics
		Characteristics of liquid dielectrics
		Pure and commercial liquids
		Conduction and breakdown in pure liquids
		Conduction and breakdown in commercial liquids
	Conduction and breakdown in solid dielectrics	Solids as insulators: intrinsic breakdown
		Electromechanical breakdown, thermal breakdown
		Breakdown in solid dielectrics in practice
		Breakdown in composite dielectrics in practice (elementary treatment only)
		Solid dielectrics used in practice (elementary treatment only)

Unit-3: **Generation of High voltages and High currents (13 Hrs)**

Generation of high DC voltages – Generation of high alternating voltages – Generation of impulse voltages and currents – Tripping and control of impulse generators.

Unit	Module	Micro content
3a. Generation of high voltages	Generation of High DC voltages	Half and full wave rectifier circuits
		Voltage doubler circuits
		Voltage multiplier circuit
		Van De Graff generator
	Generation of High AC voltages	Cascaded transformer connection
		Resonant transformers
		Generation of high frequency ac voltages: tesla coil
		Generation of impulse voltages: standard impulse wave form and representation
		RLC circuits for impulse wave form generation
		Multistage impulse generator: Marx circuit
		Generation of switching surges
3b. Generation of impulse currents	Generation of high currents	Impulse current waveform and representation
		RLC impulse current generator
		Generation of rectangular pulses
		Tripping and control of impulse generator

Unit-4: Measurement of high voltages and High current (13Hrs)

Measurement of high AC, DC and Impulse voltages – Voltages and measurement of high currents – Direct, alternating and Impulse.

Unit	Module	Micro content
4a.Measurement of high voltages	Measurement of high DC voltages	High ohmic series resistance with micro ammeter
		Resistance potential divider for ‘DC voltages
		Generating voltmeters
	Measurement of high AC & impulse voltages	Series impedance voltmeter
		Series capacitance voltmeter
		Capacitance potential divider & CVT
		Electrostatic voltmeters
		Peak reading ac voltmeters
		Spark gap arrangement for high voltage measurements
		Potential dividers for impulse voltage measurements
4b. Measurement of High currents	Measurement of high AC,DC and impulse currents	Measurement of high DC currents: Hall generators
		Measurement of high power frequency currents
		Measurement of high frequency & impulse currents
		Rogowski’s coil current transformers
		Measurements using CRO

Unit-5: Testing of electrical materials and apparatus (13Hrs)
Measurement of DC resistivity – Measurement of dielectric constant and loss factor – Partial discharge measurements
Testing of insulators and bushings – Testing of isolators and circuit breakers – Testing of cables – Testing of transformers – Testing of surge arresters – Radio interference measurements

Unit	Module	Micro content
5a. Testing of materials	Non destructive testing	Measurement of DC resistivity
		Measurement of dielectric constant and loss factor (only power frequency methods)
		Partial discharge measurements
		Discharge detection using straight detectors
		Balanced detection method
		Discharge detection in power cables
5b.Teting of apparatus	Destructive testing	Testing of insulators and bushings
		Testing of isolators and circuit breakers
		Testing of cables
		Testing of surge arresters
		Testing of transformers
		RI measurements

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

CO1	Acquainted **with the performance of high voltages with regard to different configurations of electrode systems. (**Analyze, KL4)
CO2	Understand **theory of breakdown and withstand phenomena of all types of dielectric materials (**understand, KL2)
CO3	Acquaint **with the techniques of generation of AC,DC and Impulse voltages (**understand, KL2**)**
CO4	Apply **knowledge for measurement of high voltage and high current AC, DC and Impulse. (**apply, KL3**)**
CO5	Experiment **to measure dielectric property of electrical material and know the techniques of testing various equipment used in HV systems. (**analyze, KL4**)**

Text books:

1. “**High Voltage Engineering: Fundamentals**”, **E.Kuffel, W.S.Zaengl, J.Kuffel**, 2nd Edition, Elsevier, 2000.
2. “**High Voltage Engineering**”, M.S.Naidu, V.Kamaraju, 3rd Edition, TMH, Year of publication, 2003.

Reference books:

5. “**High Voltage Engineering and Testing**”, Ryan, 3rd Edition, IET Publishers, 2013.
6. “**High Voltage Engineering**”, C.L.Wadhwa, 1st Edition, New Age Publishers, 1997.
7. “**High Voltage and Electrical Insulation Engineering**”, Ravindra Aurora, Wolfgang Mosch, John Wiley Publications, 2011.

CO-PO mapping Table

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

III Year I Semester

L	**T**	**P**	**C**
3	0	0	3

NEURAL NETWORKS & FUZZY LOGIC

Pre-requisites: Not specific

Course Objectives:

1. To introduce the concept of artificial neuron models
2. To study various neural network architectures and learning strategies
3. To explain ANN paradigms and application of ANN to Electrical Engineering problems.
4. To introduce fuzzy set operations and relations.
5. To study the design of fuzzy logic system

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction to Neural Networks: (12hrs)** **Introduction: (7hrs)** Introduction, Organization of the Human Brain, Organization of the Biological Neuron, Humans and Computers – Knowledge representation, Biological models- Hodgkin-Huxley Neuron Model, Integrate-and-Fire Neuron Model. **Artificial Neurons: (5hrs)** Artificial Neuron model, Activation functions, MC Culloch-pitts neuron model, Design of basic logic gates using single artificial neuron.	**CO1**
II	**Essentials of Artificial Neural Networks: (12hrs)** **Artificial Neural Network Architectures: (7hrs)** Neural Network Architectures, Single layer feed forward networks: concept of Perceptron, learning algorithm for perceptron – linear separability- XOR function. **Learning strategies: (5hrs)** Learning methods (Supervised, Unsupervised and Reinforced), Learning rules (Rosenblatt's Perceptron learning rule, Delta rule, Hebbian rule, Competitive learning rule, Gradient Descent learning rule).	**CO2**
III	**ANN Paradigm and its applications: (10hrs)** **ANN Paradigms: (6hrs)** Multi-layer feed forward networks –Generalized delta rule– Back Propagation algorithm – Radial Basis Function (RBF) network. **Applications of ANN: (4hrs)** Speed control of DC and AC motors using Neural Network.	**CO3**
IV	**Classical and Fuzzy set Theory (14hrs)** **Classical set Theory: (7hrs)** Introduction, Fuzzy versus crisp, properties of crisp sets- Verification of Demorgan's Law, Operations and relations of crisp sets. **Fuzzy set Theory: (7hrs)** Fuzzy sets, Membership functions, Basic Fuzzy set operations, Properties of Fuzzy sets, Fuzzy Cartesian Product, Operations on Fuzzy relations.	**CO4**
V	**Fuzzy Logic System Design and Applications (12hrs)** **Fuzzy Logic System Design: (7hrs)**	**CO5**

	Fuzzy Logic, Fuzzy Quantifiers, Fuzzy Inference, Fuzzy Rule based system, De-fuzzification methods. **Fuzzy Logic Control Applications: (5hrs)** Speed control of DC and AC motors using Fuzzy logic controller	

Content beyond syllabus:
Hybrid controller: Adaptive Neuro fuzzy system (ANFIS) information [Elementary Treatment Only]
Evolutionary programming: Basic genetic programming concepts and applications[Elementary Treatment Only]

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Understand the concept of artificial neuron.**(Understand KL2, Analyze KL4)**
CO2	Know various ANN architectures and learning strategies. **(Understand KL2, Analyze KL4, Apply KL3)**
CO3	Understand ANN paradigm and its application to solve Electrical Engineering problems. **(Understand KL2, Apply KL3)**
CO4	Understand fuzzy set theory and membership functions. **(Understand KL2)**
CO5	Design Fuzzy Logic System for Electrical Engineering problems. **(Understand KL2, Apply KL3)**

Learning Resources

Text Books:

1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by S.Rajasekaran and G.A. Vijayalakshmi Pai – PHI Publication.
2. Fuzzy logic with fuzzy applications- by T.J. Ross, TMH.

Reference Books:

1. Introduction to Artificial Neural Systems – Jacek M. Zurada, Jaico Publishing House, 1997.
2. Fundamentals of Neural Networks Architectures, Algorithms and Applications - by laurene Fausett, Pearson.
3. Neural Networks, Algorithms, Applications and programming Techniques by James A. Freeman, David M. Skapura.
4. Introduction to Neural Networks using MATLAB 6.0 by S N Sivanandam, S Sumathi, S N Deepa TMGH

Micro Syllabus

Unit-I : Introduction to Neural Networks: (12hrs)
Introduction: (7hrs)
Introduction, Organization of the Human Brain, Organization of the Biological Neuron, Humans and Computers – Knowledge representation, Biological models- Hodgkin-Huxley Neuron Model, Integrate-and-Fire Neuron Model.
Artificial Neurons: (5hrs)
Artificial Neuron model, Activation functions, MC Culloch-pitts neuron model, Design of basic logic gates using single artificial neuron.

Unit No	Module	Micro content
1.a	Biological Neuron	Human brain Organization, Biological neuron and its parts, comparison between Humans and Computers, Knowledge Representation.

	Biological Models	Hodgkin-Huxley Neuron Model, Integrate-and-Fire Neuron Model.
1.b	Artificial Neuron Models	Artificial Neuron model, Activation functions , MC Culloch-pitts neuron model.
	Design of Logic Gates	Design of basic logic gates using single artificial neuron (AND, OR and NOT Gates Only).

UNIT-II: Essentials of Artificial Neural Networks: (12hrs)

Artificial Neural Network Architectures: (7hrs)

Neural Network Architectures, Single layer feed forward networks: concept of Perceptron, learning algorithm for perceptron – linear separability- XOR function.

Learning strategies: (5hrs)

Learning methods (Supervised, Unsupervised and Reinforced), Learning rules (Rosenblatt’s Perceptron learning rule, Delta rule, Hebbian rule, Competitive learning rule, Gradient Descent learning rule).

Unit No	Module	Micro content
2.a	ANN Architectures	Neural Network Architectures (Single layer Feed Forward Network, Multi-layer Feed Forward Network and Recurrent Networks) [Elementary Treatment Only],
	Perceptron	Rosenblatt’s Perceptron Theory, Perceptron learning algorithm, perceptron as Classifier limitations of Perceptron model.
2.b	Learning Strategies	Learning methods (Supervised, Unsupervised and Reinforced) Only.
		Learning rules (Rosenblatt’s Perceptron learning rule, Delta rule, Hebbian rule, Competitive learning rule, Gradient Descent learning rule).

UNIT-III: ANN Paradigm and its applications: (10hrs)

ANN Paradigms: (6hrs)

Multi-layer feed forward networks –Generalized delta rule– Back Propagation algorithm – Radial Basis Function (RBF) network.

Applications of ANN: (4hrs)

Speed control of DC and AC motors using Neural Network.

Unit No	Module	Micro content
3.a	ANN Paradigms	Multi-layer feed-forward network (based on Back propagation algorithm), Generalized delta rule, Back Propagation algorithm step by step procedure.
		Radial-basis function networks, Radial base functions Difference between RBN & MLFFN.
3.b.	Applications of ANN	Neural Networks applications in Load Forecasting
		Speed control of DC and AC motors using Neural Network.

UNIT – IV: Classical and Fuzzy set Theory (14hrs) **Classical set Theory: (7hrs)** Introduction, Fuzzy versus crisp, properties of crisp sets- Verification of Demorgan's Law, Operations and relations of crisp sets. **Fuzzy set Theory: (7hrs)** Fuzzy sets, Membership functions, Basic Fuzzy set operations, Properties of Fuzzy sets, Fuzzy Cartesian Product, Operations on Fuzzy relations.		
Unit No	**Module**	**Micro content**
4.a.	Classical set Theory	Introduction to classical sets, Fuzzy Vs Classical Set Theory- Basic Definitions: Set, Single ton set, Null set, Power set, sub set Super set.
		Classical set properties, Operations and relations, Verification of Demorgan's Law.
4.b	Fuzzy set Theory	Fuzzy sets, Membership functions (Both Continuous type and Discrete type), Basic Fuzzy set operations.
		Properties of Fuzzy set, Fuzzy Cartesian Product, Operations on Fuzzy relations.
UNIT V: Fuzzy Logic System Design and Applications (12hrs) **Fuzzy Logic System Design: (7hrs)** Fuzzy Logic, Fuzzy Quantifiers, Fuzzy Inference, Fuzzy Rule based system, De-fuzzification methods. **Fuzzy Logic Control Applications: (5hrs)** Speed control of DC and AC motors using Fuzzy logic controller		
Unit No	**Module**	**Micro content**
5.a	Fuzzy Logic System Design	Fuzzy Logic, Fuzzy Quantifiers, Fuzzy Inference, Fuzzy Rule based system
		Defuzzification methods (Centroid method, Centre of sums method and Mean of Maxima Method Only).
5.b	Fuzzy Logic Control Applications	Speed control of DC motors using Fuzzy logic controller
		Speed control of AC motors using Fuzzy logic controller

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Understand the concept of artificial neuron.**(Understand KL2, Analyze KL4)**
CO2	Know various ANN architectures and learning strategies. **(Understand KL2, Analyze KL4, Apply KL3)**
CO3	Understand ANN paradigm and its application to solve Electrical Engineering problems. **(Understand KL2, Apply KL3)**
CO4	Understand fuzzy set theory and membership functions. **(Understand KL2)**
CO5	Design Fuzzy Logic System for Electrical Engineering problems. **(Understand KL2, Apply KL3)**

Learning Resources
Text Books: 1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by S.Rajasekaran and G.A. Vijayalakshmi Pai – PHI Publication. **2.** Fuzzy logic with fuzzy applications- by T.J. Ross, TMH.
Reference Books: 1. Introduction to Artificial Neural Systems – Jacek M. Zurada, Jaico Publishing House, 1997. 2. Fundamentals of Neural Networks Architectures, Algorithms and Applications - by laurene Fausett, Pearson. 3. Neural Networks, Algorithms, Applications and programming Techniques by James A. Freeman, David M. Skapura. 4. Introduction to Neural Networks using MATLAB 6.0 by S N Sivanandam, S Sumathi, S N Deepa TMGH.

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
CO1	3	1										1
CO2	3	2										1
CO3	2	3										2
CO4	3	3										2
CO5	3	3										2

III Year I Semester

L	T	P	C
3	0	0	3

ADVANCED PYTHON PROGRAMMING

PRE-REQUISITES:

- Fundamentals of Python
- Problem solving skills

Course objectives: The student should be able to

1. Able to learn advanced concepts in Python
2. Able to use advanced packages like numpy, scipy, opencv in Python for building data processing & visualizing applications.
3. Able to process digital imaging applications

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Python Fundamentals**: Introduction to Python, Data Structures – List, Dictionaries, Sets and Tuples. **(6 hrs)** **Modules, Python Packages, Libraries:** Modules - Creating modules, import statement, from Import statement, name spacing. Math Module: Constants, Power and logarithmic functions, Trigonometric functions. Numpy Library: Numpy import, Basic functions, Matrices Addition, Subtraction Multiplication, Transpose, Inverse, Eigen values and Eigenvectors using Numpy **(8hrs)**	**CO1**
II	**Python packages:** Introduction to PIP, Installing Packages via PIP, Using Python Packages **(4hrs)** **Data Visualization** – Matplotlib - Loading the library and importing the data, How Mat plot lib works?, modifying the appearance of a plot, Plotting multiple plots, Modifying the tick marks, Scatter plots, Bar plots. **(8hrs)**	**CO2**
III	**File Handling –** Introduction to Files, File modes, Reading, Writing data from files, Copy one file to another, deletion of files. Other file programs in Python. **(4hrs)** **Text Processing:** Word, character and line counting, Frequency count. Usage of with() and split(). Reading and writing into CSV formats. **(8hrs)**	**CO3**
IV	**Image Processing** - Installing Jupiter notebook. Image & Its properties. Image processing applications. Image I/O and display with Python, Reading, saving and displaying an image using Open CV - PyPI, matplotlib Sample programs – Image statistics Croping, Converting images from RGB to Gray and resizing the image. **(12 hrs)**	**CO4**
V	**Using Databases and SQL –** Introduction to Database Concepts, usage of SQLite, Create, Insert & Retrieve data, Spidering twitter using a database. Sample Python codes **(8 hrs)**	**CO5**

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Recall** the usage of Python Concepts.

CO2	**Use** different Python packages for Data Visualization
CO3	**Demonstrate** File handling & text processing
CO4	**Demonstrate** applications that performs Image processing
CO5	**Connect** database with Python.

Learning Resources
Text books:
1. Python for Everybody: Exploring Data Using Python 3, Charles Severance 2. The Hitchiker's Guide to Python, O'Reilly publications
Reference books:
1. Hands-On Image Processing with Python, O'Reilly Publications 2. *Think Python*, Allen Downey, Green Tea Press
e- Resources & other digital material
6. https://nptel.ac.in/courses/117/105/117105079/
7. https://nptel.ac.in/courses/106/106/106106145/#
8. https://realpython.com/python-mysql/

Micro-Syllabus

Unit-I: Python Fundamentals: Introduction to Python, Data Structures – List, Dictionaries, Sets and Tuples.

Modules, Python Packages, Libraries: Modules - Creating modules, import statement, from Import statement, name spacing. Math Module: Constants, Power and logarithmic functions, Trigonometric functions. Numpy Library: Numpy import, Basic functions, Matrices Addition, Subtraction Multiplication, Transpose, Inverse, Eigen values and Eigenvectors using Numpy

Unit No	Module	Micro content
1. a	Python Fundamentals	Introduction to Python features, advantages and disadvantages, applications
		Lists - different types of problems using lists
		Tuples
		Dictionaries - converting lists into dictionaries and other problems
		sets
1. b	Modules, Python Packages, Libraries	Module creation and import
		Math module and functions - basic math, statistical and logarithmic, trigonometric functions
		Numpy basic mathematical operations - matrix applications
		Eigen values and vectors

Unit-II: Python packages: Introduction to PIP, Installing Packages via PIP, Using Python Packages

Data Visualization – Matplotlib - Loading the library and importing the data, How Mat plot lib works?, modifying the appearance of a plot, Plotting multiple plots, Modifying the tick marks, Scatter plots, Bar plots.

Unit No	Module	Micro content
2.a	Introduction to PIP	Installation process, commands

		Installation of various packages
		Using Python packages
2.b	Data Visualization	Loading and importing matplotlib
		Multiple plots - small applications
		Updating plot ticks, scatter plots - sample applications
		Bar plots sample applications

Unit-III: File Handling – Introduction to Files, File modes, Reading, Writing data from files, Copy one file to another, deletion of files. Other file programs in Python. **(4hrs)**
Text Processing: Word, character and line counting, Frequency count. Usage of with() and split(). Reading and writing into CSV formats**.** **(8hrs)**

Unit No	Module	Micro content
3a.	File Handling	Introduction to Files, File modes
		Reading and writing files - sample
		programs - copy, reverse, reading lines, reading words, deletion of files
		Updating a file
3b.	Text processing	Word, line, character count programs
		Frequency count
		Usage of with() and split()
		Reading different files like CSV
		Implement read, update, cells/rows/columns in a CSV file

Unit-IV: Image Processing - Installing Jupiter notebook. Image & Its properties. Image processing applications. Image I/O and display with Python, Reading, saving and displaying an image using Open CV - PyPI, matplotlib.

Unit No	Module	Micro content
4	Image processing	• Introduction to images and their properties • Reading and writing images • Types of images • Display images using opencv • Usage of PyPI (methods for image processing) • Image enhancement operations • other simple image based programs

Unit-V: Using Databases and SQL – Introduction to Database Concepts, usage of SQLite, Create, Insert & Retrieve data, Spidering twitter using a database. Sample Python codes **(8 hrs)**

Unit No	Module	Micro content
5	**Database connectivity**	Database concepts - tables, rows and columns, primary keys, referential integrity
		Usage of SQlite
		DDL and DML commands
		Basic storage and retrieval operations on database
		Spidering twitter data and related python code modules

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

CO1	**Recall** the usage of Python Concepts.

CO2	**Use** different Python packages for Data Visualization
CO3	**Demonstrate** File handling & text processing
CO4	**Demonstrate** applications that performs Image processing
CO5	**Connect** database with Python.

Text books:
Python for Everybody: Exploring Data Using Python 3, Charles Severance 2. The Hitchiker's Guide to Python, O'Reilly publications
Reference books:
1. Hands-On Image Processing with Python, O'Reilly Publications 2. *Think Python*, Allen Downey, Green Tea Press
Digital resources:
1. https://nptel.ac.in/courses/117/105/117105079/
2. https://nptel.ac.in/courses/106/106/106106145/#
3. https://realpython.com/python-mysql/

CO-PO mapping

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

III Year I Semester

L	T	P	C
3	0	0	3

BLOCKCHAINTECHNOLOGIES

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**INTRODUCTION:** Scenarios, Challenges Articulated, Blockchain, Blockchain Characteristics, Opportunities Using Blockchain, History of Blockchain. Evolution of Blockchain: Evolution of Computer Applications, Centralized Applications, Decentralized Applications, Stages in Blockchain Evolution, Consortia, Forks, Public Blockchain Environments	**CO1**
II	**BLOCKCHAIN CONCEPTS:** Introduction, Changing of Blocks, Hashing, Merkle-Tree, Consensus, Mining and Finalizing Blocks, Currency aka tokens, security on blockchain, data storage on blockchain, wallets, coding on blockchain: smart contracts, peer-to-peer network, types of blockchain nodes, risk associated with blockchain solutions, life cycle of blockchain transaction.	**CO2**
III	**ARCHITECTING BLOCKCHAIN SOLUTIONS:** Introduction, Obstacles for Use of Blockchain, Blockchain Relevance Evaluation Framework, Blockchain Solutions Reference Architecture, Types of Blockchain Applications, Cryptographic Tokens, Types of Blockchain Solutions, Architecture Considerations, Architecture with Blockchain Platforms, Approach for Designing Blockchain Applications.	**CO3**
IV	**ETHEREUM BLOCKCHAIN IMPLEMENTATION:** Introduction, Tuna Fish Tracking Use Case, Ethereum Ecosystem, Ethereum Development, Ethereum Tool Stack, Ethereum Virtual Machine, Smart Contract Programming, Integrated Development Environment, Truffle Framework, Ganache, UnitTesting, Ethereum Accounts, My Ether Wallet, Ethereum Networks/Environments, Infura, Ether scan, Ethereum Clients, Decentralized Application, Meta mask.	**CO4**
V	**ADVANCED CONCEPTS IN BLOCKCHAIN**: Introduction, Inter Planetary FileSystem (IPFS),Zero-Knowledge Proofs, Oracles, Self-Sovereign Identity, Blockchain with IoT, Initial Coin Offering, Blockchain Cloud Offerings, Blockchain and its Future Potential.	**CO5**

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Describe various blockchain fundamentals
CO2	Explain the working mechanism of a blockchain and smart contracts
CO3	Illustrate different blockchain applications and their architectural styles
CO4	Explain the implementation of blockchain in the Ethereum ecosystem
CO5	Explain advanced concepts of blockchain and its integration with IoT

Learning Resources
Text books:
1.“Blockchain for Enterprise Application Developers”, Ambadas, Arshad Sarfarz Ariff,Sham-Wiley 2.“Mastering Bit coin: Programming the Open Blockchain”, Andreas M.Antonpoulos,O’Reilly.
Reference books:
1. Blockchain: A Practical Guide to Developing Business, Law, and Technology Solutions, Joseph Bambara, PaulR.Allen, McGrawHill. 2. Blockchain: Blue print for aNew Economy, Melanie Swan,O’Reilly
e- Resources & other digital material
https://github.com/blockchainedindia/resources

III Year I Semester

L	T	P	C
3	0	0	3

DIGITAL SYSTEM DESIGN WITH VHDL

PRE-REQUISITES: Digital Circuits & Logic Design

Course objectives: The student should be able to

1. To understand various Digital Logic Families and their Interfacing
2. To know the basics of VHDL and programming models
3. To implement digital systems using VHDL
4. To design and implement combinational circuits using VHDL code and relevant ICs
5. To design and implement sequential circuits using VHDL code and relevant ICs.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Unit-1:Digital Logic Families-** (16 hours) Introduction to logic families, CMOS logic, CMOS steady state and dynamic electrical behaviour, CMOS logic families. Bipolar logic, Transistor-Transistor logic and TTL families, CMOS/TTL interfacing, low voltage CMOS logic and interfacing, Emitter coupled logic, Parameters to choose logic families for the design applications.	**CO1**
II	**Unit-2:Introduction to VHDL-** (13 hours) Introduction to HDL, design flow with VHDL, Program structure in VHDL. Levels of abstraction, VHDL elements: data types, data objects, operators and identifiers. VHDL programming models: data flow, structural and behavioral with examples on simple combinational and sequential circuits.	**CO2**
III	**Unit-3: Digital Design Using VHDL-**(12 hours) Concurrent vs. Sequential statement, *Concurrent statements:* WHEN, GENERATE, BLOCK. Process: single and multiple, variable assignment vs signal assignment. *Sequential statements:* IF, WAIT, CASE, LOOP, NULL, EXIT, ASSERTION, CASE vs IF, CASE vs WHEN. Delay Models: Inertial and Transport, Comparison of VHDL with other procedural languages.	**CO3**
IV	**Unit-4:Combinational Logic IC Design-** (12 hours) Adders: Ripple Carry, Carry Look ahead, Adder-Sub tractors, Multiplexers, Decoders/De-multiplexers, Encoders: Priority Encoders, Parity Checkers, ALU, Comparators, Design considerations of these combinational circuits using VHDL code and relevant IC.	**CO4**
V	**Unit-5:Sequential Logic IC Design-**(13 hours) SSI Latches and Flip-flops, Shift Registers, Synchronous and Asynchronous Counters, Ring and Johnsons Counter, Applications: Sequence detector, Traffic light controller, Vending machine controller, Signal Generator, Serial data receiver. Design considerations of these sequential circuits using VHDL code and relevant IC	**CO5**

Content Beyond the syllabus:
Implementation of Booths Multiplier
Implementation of Serial Adder
Guessing Game State Machine

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the structural description and electrical characteristics of various digital logic families. **{Understand level, KL2}**
CO2	**Understand** the basics of HDL and Programming models of VHDL.**{Understand level, KL2}**
CO3	**Implement** digital systems using VHDL. **{Analyze level, KL4}**
CO4	**Implement** the Combinational logic using ICs and VHDL code. **{Evaluate level, KL5}**
CO5	**Model**the Sequential circuits using ICs and VHDL code**{Apply level, KL4}**

Learning Resources

Text books:

1. Digital Design Principles & Practices – John F. Wakerly, PHI/ Pearson Education Asia, 3rd Ed., 2005.
2. Circuit Design with VHDL - V. A. Pedroni, MIT Press, Cambridge, 2004.
3. VHDL Primer – J. Bhasker, Pearson Education/ PHI, 3rd Edition.
4. Cem Unsalan, Bora Tar "Digital System Design with FPGA: Implementation using Verilog and VHDL ", McGraw Hill Education. 2017

Reference books:

1. Fundamentals of Digital Logic with VHDL Design- Stephen Brown, ZvonkoVranesic, McGrawHill, 3rd Edition, 2009.
2. Digital systems principles and Applications-Ronald J. Tocci, Neal S.Widmer, Eighth Edition, Prentice Hall.
3. VHDL: Programming by Example- Douglas L. Perry, Fourth Edition, Tata McGraw-Hill, 2003.
4. Digital Logic Circuit Analysis and Design - V. P. Nelson, H.T. Nagle, B.D. Carroll, and D. Irwin, 1st Edition, Prentice Hall International, 1995

e- Resources & other digital material

1. https://technobyte.org/vhdl-course-tutorials/
2. http://www.secs.oakland.edu/~llamocca/VHDLforFPGAs.html
3. https://www.fpga4student.com/p/vhdl-project.html

Micro-Syllabus

Unit-1:Digital Logic Families-(16 hours)

Introduction to logic families, CMOS logic, CMOS steady state and dynamic electrical behaviour, CMOS logic families. Bipolar logic, Transistor-Transistor logic and TTL families, CMOS/TTL interfacing, low voltage CMOS logic and interfacing, Emitter coupled logic, Parameters to choose logic families for the design applications.

Unit No	Module	Micro content
1a.	Introduction to logic	Introduction to logic families

Introduction to logic families	families up to CMOS logic.	CMOS logic (Basic logic gates)
		CMOS steady state and dynamic electrical behaviour
		CMOS logic families (classifications and features)
		Bipolar logic (Introduction, Schottky-clamped transistor)
1b. Interfacing of different logic families	TTL &Interfacing of different logic families	Transistor-Transistor logic (2-input LS-TTL NAND and NOR gates)
		TTL families (features and comparison)
		CMOS/TTL interfacing
		low voltage CMOS logic and interfacing
		Emitter coupled logic (Basic ECL inverter, 2-input OR/NOR gate)
		comparison of logic families

Unit-2:Introduction to VHDL- (13 hours)

Introduction to HDL, design flow with VHDL, Program structure in VHDL. Levels of abstraction, VHDL elements: data types, data objects, operators and identifiers. VHDL programming models: data flow, structural and behavioural with examples on simple combinational and sequential circuits.

Unit No	Module	Micro content
2a. Introduction to HDL	Introduction to HDL and VHDL elements	Introduction to HDL and types
		Design flow and program structure in VHDL.
		Levels of abstraction in VHDL
		Data types, Data objects
		operators and identifiers
2b. VHDL programming models	VHDL programming models	Data Flow with examples
		Behavioural with examples
		Structural with examples
		Introduction to HDL and types
		Design flow and program structure in VHDL.

Unit-3: Digital Design Using VHDL-(12 hours)

Concurrent vs. Sequential statement, *Concurrent statements:* WHEN, GENERATE, BLOCK. Process: single and multiple, variable assignment vs signal assignment. *Sequential statements:* IF, WAIT, CASE, LOOP, NULL, EXIT, ASSERTION, CASE vs IF, CASE vs WHEN. Delay Models: Inertial and Transport, Comparison of VHDL with other procedural languages.

Unit No	Module	Micro content
3a. Concurrent & Sequential Statements	Concurrent & Sequential Statements-1	WHEN, GENERATE, BLOCK
		Process: single and multiple
		variable assignment vs signal assignment.
		IF Statement and examples

		WAIT statements
		CASE Statement
3b. Concurrent & Sequential Statements	Concurrent & Sequential Statements-2	LOOP, NULL and EXIT statements
		ASSERTION statements
		CASE vs IF, CASE vs WHEN
		Delay Models: Inertial Delay
		Transport Delay
		Design Examples
		Comparison of VHDL withother procedural languages

Unit-4:Combinational Logic IC Design- (12 hours)

Adders: Ripple Carry, Carry Look ahead, Adder-Sub tractors, Multiplexers, Decoders/De-multiplexers, Encoders: Priority Encoders, Parity Checkers, ALU, Comparators, Design considerations of these combinational circuits using VHDL code and relevant IC.

Unit No	Module	Micro content
4a. Combinational Logic IC Design	**Combinational Logic IC Design-1**	Ripple Carry
		Carry Look ahead(74×283)
		Multiplexers (74×151, 74×153, 74×157)
		Decoders/De-multiplexers(74×138)
		VHDL implementations of above-mentioned IC's
4b. Combinational Logic IC Design	**Combinational Logic IC Design-2**	Encoders: Priority Encoders (74x148)
		Parity Checkers (74×280)
		ALU (74×181)
		Comparators (74×85, 74×682)
		VHDL implementations of above-mentioned IC's

Unit-5:Sequential Logic IC Design-(13 hours)

SSI Latches and Flip-flops, Shift Registers, Synchronous and Asynchronous Counters, Ring and Johnsons Counter, Applications: Sequence detector, Traffic light controller, Vending machine controller, Signal Generator, Serial data receiver. Design considerations of these sequential circuits using VHDL code and relevant IC

Unit No	Module	Micro content
5a. Latches and Flip-flops and its applications	Latches and Flip-flops and its applications	SSI Latches and Flip-flops (ICs)
		Shift Registers (74×164, 74x366)
		Universal Shift Register (74×194)
		Synchronous Counters (74×163)
		Asynchronous Counters
		Ring and Johnsons Counter (Design with 74×194 IC)
5b.	State Machines and	Introductions toState Machines

State Machines	case studies	Sequence detector
		Traffic light controller
		Signal Generator, Serial data receiver.
		Vending machine

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

CO1	**Understand** various Digital Logic Families and their Interfacing **{Understand level, KL2}**
CO2	**Understand** the basics of VHDL and programming models**{Understand level, KL2}**
CO3	**Implement** digital systems using VHDL**{Apply level, KL3}**
CO4	**Design and implementation** of combinational circuits using VHDL code and relevant ICs {**Evaluate Level, KL5}**
CO5	**Design and implementation** of sequential circuits using VHDL code and relevant ICs.{**Evaluate Level, KL5}**

Text books:

1. Digital Design Principles & Practices – John F. Wakerly, PHI/ Pearson Education Asia, 3rd Ed., 2005.
2. Circuit Design with VHDL - V. A. Pedroni, MIT Press, Cambridge, 2004.
3. VHDL Primer – J. Bhasker, Pearson Education/ PHI, 3rd Edition.
4. Cem Unsalan, Bora Tar "Digital System Design with FPGA: Implementation using Verilog and VHDL ", McGraw Hill Education. 2017

Reference books:

1. Fundamentals of Digital Logic with VHDL Design- Stephen Brown, ZvonkoVranesic, McGrawHill, 3rd Edition, 2009.
2. Digital systems principles and Applications-Ronald J. Tocci, Neal S.Widmer, Eighth Edition, Prentice Hall.
3. VHDL: Programming by Example- Douglas L. Perry, Fourth Edition, Tata McGraw-Hill, 2003.
4. Digital Logic Circuit Analysis and Design - V. P. Nelson, H.T. Nagle, B.D. Carroll, and D. Irwin, 1st Edition, Prentice Hall International, 1995

CO-PO mapping

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

III Year I Semester

	L	T	P	C
	0	**0**	**3**	**1.5**

ELECTRICAL MACHINES-II LAB

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 motor and Single 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

1. Brake test on three phase Squirrel cage Induction Motor.
2. Determination of the symmetrical impedances of a synchronous machine.
3. 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 Abijith Chakrabarthi 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 Table with Justification:

Mapping	P01	P02	P03	P04	P05	P06	P07	P08	P09	P010	P011	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	-

III Year I Semester

L	T	P	C
0	**0**	**3**	**1.5**

IoT LAB

Pre-Requisites:

A course on “ C + + Programming ”.
A course on “Python Programming”.

Course objectives:

Students will be explored to the interconnection and integration of the physical world and thecyber space. They are also able to design &develop IOT Devices.

List of Experiments:

1. Basic program and device interfacing for Arduino and Node MCU and operating system installation in Raspberry pi.
2. Interfacing LCD with Arduino, Node MCU and raspberry pi.
3. Interfacing DHT11 humidity sensor with raspberry pi and Arduino.
4. Intruder detection using PIR sensor using Arduino and raspberry pi
5. Distance measurement using Ultrasonic sensor by connecting to Arduino and Raspberry pi
6. ESP8266 WI-FI Module Interface with Arduino and DHT11 data upload to the cloud server.
7. Motor forward and reverse control using L293D motor driver Arduino and raspberry pi.
8. Voice – Activated Arduino Bluetooth Android.3 and Raspberry pi.
9. Measuring pulse and spo2 in body using MAX30100 sensor and data uploading to cloud using Arduino ESP8266 and raspberry pi.
10. Measuring soil moisture using REES52 sensor and data uploading to cloud using Arduino ESP8266 and raspberry pi.
11. Detecting poisonous gas using MQ-2 gas sensor and data uploading to cloud using Arduino ESP8266 and raspberry pi
12. IoT based smart energy meter using Arduino and Raspberry pi
13. Installation of NodeJS on Raspberry Pi and connecting sensor for data monitoring.
14. Develop IoT based smart lock system for Motorcycle/Car
15. Develop IoT based Smart water flow system
16. Develop IoT based home security system
17. Develop IoT based smart Ignition for Motorcycle/Car
18. Develop IoT based fuel level indication system in Automobile.

Software(s) used:

1. For Arduino and Node MCU software used is Arduino IDE
2. For Raspberry pi operating raspbian OS

Course Outcomes:

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

No	Description	POs, PSOs	KL
CO1	Determine the various codes of Arduino, Nodemcu& Raspberry pi Programming.	PO3, PSO1	3,4
CO2	Differentiate the features of various IOT platforms.	PO4, PSO1	3,4
CO3	Able to choose the best available IOT principle for solving the problem	PO5, PSO2	5,4
CO4	Able to design simple IOT applications using Arduino, NodeMcu and Raspberry pi boards	PO11,PSO2	6

Text books:

1. AdrianMcEwen, “Designing the Internet of Things”, Wiley Publishers, 2013, ISBN:78-1-118-43062-0
2. Daniel Kellmereit, “The Silent Intelligence: The Internet of Things”. 2013, ISBN0989973700

e-resources:

1. https://circuitdigest.com/internet-of-things-iot-projects.
2. https://create.arduino.cc/projecthub/projects/tags/raspberry%2Bpi.
3. https://create.arduino.cc/projecthub/projects/tags/iot.
4. https://iotdesignpro.com/iot-projects.

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

III Year I Semester

L	T	P	C
0	0	3	1.5

POWER ELECTRONICS LAB

Pre-Requisites: 1) Basic Circuit Analysis
2) Engineering Mathematics

Preamble: Introduction to Power Electronics– various power electronics devices, Pulse width modulation, AC to DC Converters, AC Voltage Regulator and DC to AC Converters.
.
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 bridgeconverters 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 10 of the following experiments are to be conducted
1. Study of Characteristics of Thyristor, MOSFET & IGBT.
2. Design and development of a firing circuit for Thyristor.
3. Design and development 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 2 of the following 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

No	Description	POs, PSOs	KL
CO1	Study the characteristics of various power electronic devices and analyze gate drive circuits of IGBT.	PO1, PSO2	1,3
CO2	Analyze the performance of single phase and three phase full wave	PO1, PSO2	2,3

	bridge converters with both resistive and inductive loads.		
CO3	Understand the operation of single phase AC voltage regulator with resistive and inductive loads.	PO1, PSO2	1,2
CO4	Understand the working of Buck converter, Boost converter, single phase square wave inverter and PWM inverter.	PO1, PSO2	2,3

Text books:

1. Elements of Power Electronics–Philip T.Krein.oxford.
2. 2. Power Electronics – by P.S.Bhimbra, Khanna Publishers.

e-resources:

5. http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/power_electronics/labs/index.php
6. https://www.vlab.co.in/broad-area-electrical-engineering
7. https://www.vlab.co.in/broad-area-electronics-and-communications

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

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III Year II Semester

L	T	P	C
3	0	0	3

HIGH VOLTAGE AC & DC TRANSMISSION

PRE-REQUISITES:1) Power Electronics,
2) Power Systems-I & II

Course objectives: The student should be able to

1. To understand the phenomena associated with transmission line, operating at extra high voltages and detail analysis of several phenomena viz. electrostatic field, charges, voltage gradient and conductor configuration
2. The objective is to discuss phenomena of corona, losses, audible noise, radio interference and measurement of these quantities.
3. To understand the phenomena of HVDC, HVDC equipment comparison with AC and the latest state of art in HVDC transmission.
4. To understand method of conversion of AC to DC, performance of various level of pulse conversion and control characteristics of conversion
5. To understand the requirements of reactive power control and filtering technique in HVDC system and to understand the harmonics in AC side of power line in a HVDC system and design of filters

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction of EHV AC transmission(13 hrs)** Necessity of EHV AC transmission – Advantages and problems – Power handling capacity and line losses – Mechanical considerations – Resistance of conductors - Electrostatics – Field of sphere gap – Field of line charges and properties **(07hrs)** Charge ~ potential relations for multi–conductors – Surface voltage gradient on conductors – Bundle spacing and bundle radius Examples – Distribution of voltage gradient on sub conductors of bundle – Examples. **(06 hrs)**	**CO1**
II	**Corona effects(11 hrs)** Power loss and audible noise (AN) – Corona loss formulae – Charge voltage diagram – Generation – Characteristics – Limits and measurements of AN **(05hrs)** Radio interference (RI) – Corona pulses generation – Properties and limits – Biological effects Electrical and magnetic fields on human beings and animals-Recent advances in UHV power transmission**(06 hrs)**	**CO2**
III	**Basic Concepts of DC Transmission(13 hrs)** Basic Concepts of DC Transmission Economics & Terminal equipment of HVDC transmission systems: Types of HVDC Links – Apparatus required for HVDC Systems **(07 hrs)** Comparison of AC &DC transmission – Application of DC Transmission System – Planning & Modern trends in DC transmission.**(6hrs)**	**CO3**
IV	**Analysis of HVDC Converters and System Control(13 hrs)** Choice of Converter configuration – Analysis of Graetzciruit – Characteristics of 6	**CO4**

	Pulse & 12 Pulse converters – Cases of two 3 phase converters in star – Star mode and their performance **(7 hrs)** Principal of DC Link Control - Converters Control Characteristics – Firing angle control – Current and extinction angle control– Starting and stopping of DC link – Power Control. **(6 hrs)**	
V	**Reactive Power Control, Harmonics and Filters in HVDC(15 hrs)** Reactive Power Requirements in steady state – Conventional control strategies – Alternate control strategies sources of reactive power – AC Filters – Shunt capacitors – Synchronous condensers. **(6 hrs)** Harmonics and Filters Generation of Harmonics – Characteristics harmonics – Calculation of AC Harmonics – Non–Characteristics harmonics – Adverse effects of harmonics – Calculation of voltage & current harmonics – Effect of Pulse number on harmonics. Types of AC filters, Design of Single tuned filters – Design of High pass filters..**(9 hrs)**	**CO5**
Content Beyond the syllabus: **Reactive Power Requirements:** Reactive Power Requirements in steady state-Conventional control strategies-Alternate control strategiessources 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	Acquaint with HV transmission system with regard to power handling capacity, losses, conductor resistance and electrostatic field associate with HV**{Understand level, KL2}**
CO2	To develop ability for determining corona, radio interference, audible noise generation and frequency spectrum for single and three phase transmission lines.**{ Analyze level, KL4}**
CO3	To acquire knowledge in transmission of HVDC power with regard to terminal equipment, type of HVDC connectivity and planning of HVDC system **{ Understand level, KL2}**
CO4	To be able to develop knowledge with regard to choice of pulse conversion, control characteristic, firing angle control and effect of source impedance. **{ Analyze level, KL4}**
CO5	To develop knowledge of reactive power requirements of conventional control, filters and reactive power compensation in HVDC system, calculate voltage and current harmonics, and design of filters. **{ Analyze level, KL4}**

Learning Resources
Text books:
1. HVDC Power Transmission Systems: Technology and system Interactions – by K.R.Padiyar, New Age International (P) Limited, and Publishers. 2. Direct Current Transmission – by E.W.Kimbark, John Wiley & Sons. 3. EHVAC Transmission Engineering by R. D. Begamudre, New Age International (P) Ltd..
Reference books:

EHVAC and HVDC Transmission Engineering and Practice – S.Rao. Power Transmission by Direct Current – by E.Uhlmann, B.S.Publications HVDC Transmission – J. Arrillaga.
e- Resources & other digital material
1. https://nptel.ac.in/courses/108/102/108102047/
2. https://www.coursera.org/learn/electric-power-systems

Micro-Syllabus

UNIT-I: Introduction of EHV AC transmission:(13 hrs)

Preliminaries of EHV Transmission: Necessity of EHV AC transmission – Advantages and problems – Power handling capacity and line losses – Mechanical considerations – Resistance of conductors -

Voltage gradients: Electrostatics – Field of sphere gap – Field of line charges and properties Charge - potential relations for multi–conductors – Surface voltage gradient on conductors – Bundle spacing and bundle radius Examples – Distribution of voltage gradient on sub conductors of bundle – Examples.

Unit No	Module	Micro content
1.a. Preliminaries of EHV Transmission	Requirement of EHV transmission	Necessity of high voltage transmission
		EHV transmission system advantages and disadvantages
	Power handling capacity	Standard transmission voltages, average values of line parameters
		Power handling capacity and line losses: simple problems
	Mechanical considerations	Types of vibrations and oscillations: Aeolian vibrations, galloping, wake induced oscillations
		Dampers and spacers
	Resistance of conductors and temperature effects	Resistance of conductors
		Effect of conductor resistance
		Power loss in transmission
		Temperature rise of conductors and current carrying capacity
		Bundle conductors: bundle spacing and bundle radius, GMR of bundle
1.b Voltage gradients	Electrostatics	Field of point charge and its properties
		Field of sphere gap, field of line charges and their properties,
		Charge potential relations for multi conductor line
	Surface voltage	Surface voltage gradients on conductors: single conductor, 2-conductor bundle
		Maximum SVG for bundle conductor with N>=3
		Mangoldt formula

	gradients	Distribution of voltage gradient on sub conductors of bundle –simple problems

UNIT-II: Corona effects: (11 hrs)

Power loss and audible noise (AN) – Corona loss formulae – Charge voltage diagram – Generation – Characteristics – Limits and measurements of AN

Radio interference (RI) – Corona pulses generation – Properties and limits –Biological effects Electrical and magnetic fields on human beings and animals- Recent advances in UHV power transmission

Unit No	Module	Micro content
2.a Corona effects (AN)	Power loss	I^2R loss and corona los
		Corona loss formulae
		The corona current
		Charge-voltage diagram and corona loss
	Audible Noise	Audible noise: generation and characteristics
		Limits for audible noise
		AN measurements and meters
2.b Corona effects (RI)	Radio interference	Corona pulses generation and their properties
		Limits for RI fields
	Biological effects	Effects of electrical fields and magnetic fields on human beings and animals
	Recent advances	Recent advances in UHV transmission and challenges

Unit III Basic Concepts of DC Transmission(13 hrs)

Basic Concepts of DC Transmission Economics & Terminal equipment of HVDC transmission systems: Types of HVDC Links – Apparatus required for HVDC Systems

Comparison of AC &DC transmission – Application of DC Transmission System – Planning & Modern trends in DC transmission.

Unit No	Module	Micro content
3.a Basic Concepts of DC Transmission	Basic Concepts	Introduction to DC Transmission
	Types of HVDC Links	Monopolar HVDC Link, Bipolar HVDC Link, Homopolar HVDC link, back to back HVDC Link
	Apparatus Required	Apparatus required in HVDC transmission, like converter stations, Converter Transformer, smoothing reactor, Filters, Reactive Power Sources, Switchgear components
3.b Basic Concepts of DC Transmission	Comparison of AC and DC	Comparison of AC and DC Transmission , Economics of Comparison, Technical Comparison, Reliability
	Application	Applications of DC Transmission
	Planning and Modern Trends	Planning of DC Transmission and Modern Trends DC Transmission

Unit IV Analysis of HVDC Converters and System Control(13 hrs)

Choice of Converter configuration – Analysis of Graetz circuit – Characteristics of 6 Pulse & 12

Pulse converters – Cases of two 3 phase converters in star – Star mode and their performance Principal of DC Link Control - Converters Control Characteristics – Firing angle control – Current and extinction angle control– Starting and stopping of DC link – Power Control		
Unit No	**Module**	**Micro content**
4.a Analysis of HVDC Converters and System Control	Choice of Converter configuration	Types of Converters, Pulse number, Valve utilization factor, Transformer Utilization factor,
	Analysis of Graetz Circuit	Analysis of Graetz circuit without overlap, Average DC voltage, Current, Harmonics analysis
	Analysis of Graetz Circuit	Analysis of Graetz circuit without overlap, Average DC voltage, Current, Harmonics analysis, Cases of two and three valve conduction mode of 3 phase converter and its performance
	12 Pulse Converter	12 Converter operation , average dc output voltage , AC Current Harmonics
4.b Analysis of HVDC Converters and System Control	Principal of DC Link Control	Steady State Equivalent circuit, Converter Control Characteristics, Voltage dependent control
	Firing angle control	Firing angle control, Individual phase control-constant alpha control, inverse cosine control, drawbacks of IPC,Equidistant Pulse Control-Pulse Frequency Control (PFC), Pulse Period Control, pulse Phase Control (PPC) , drawbacks of EPC
	Constant Current Control	Current and Extension angle control, Starting and Stopping of dc link , power Control
Unit V Reactive Power Control, Harmonics and Filters in HVDC(15 hrs) Reactive Power Requirements in steady state – Conventional control strategies –Alternate control strategies sources of reactive power – AC Filters – Shunt capacitors – Synchronous condensers. Harmonics and Filters Generation of Harmonics – Characteristics harmonics – Calculation of AC Harmonics – Non–Characteristics harmonics – Adverse effects of harmonics – Calculation of voltage & current harmonics – Effect of Pulse number on harmonics. Types of AC filters, Design of Single tuned filters – Design of High pass filters.		
Unit No	**Module**	**Micro content**
5.a Reactive Power Control, Harmonics and Filters in HVDC	Reactive Power Control	Reactive power requirements in Steady state, Alternative control strategies,
	Sources of Reactive Power	Sources of reactive power,-AC filters, Shunt Capacitors, Synchronous condenser
5.b Reactive Power Control, Harmonics and Filters in HVDC	Generation of Harmonics	Sources of Harmonics generation, adverse effects of harmonics, Generation of harmonics-Characteristic harmonics , calculation of voltage and current harmonics , Non characteristic harmonics , effect of pulse number on harmonics

	Design of filters	Types of AC Filters, Design of Single tuned filters – Design of High pass filters.

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Acquaint with HV transmission system with regard to power handling capacity, losses, conductor resistance and electrostatic field associate with HV **{Understand level, KL2}**
CO2	To develop ability for determining corona, radio interference, audible noise generation and frequency spectrum for single and three phase transmission lines.**{ Analyze level, KL4}**
CO3	To acquire knowledge in transmission of HVDC power with regard to terminal equipment, type of HVDC connectivity and planning of HVDC system **{ Understand level, KL2}**
CO4	To be able to develop knowledge with regard to choice of pulse conversion, control characteristic, firing angle control and effect of source impedance. **{ Analyze level, KL4}**
CO5	To develop knowledge of reactive power requirements of conventional control, filters and reactive power compensation in HVDC system , calculate voltage and current harmonics, and design of filters. **{ Analyze level, KL4}**

Learning Resources
Text books:
1. HVDC Power Transmission Systems: Technology and system Interactions – by K.R.Padiyar, New Age International (P) Limited, and Publishers. 2. Direct Current Transmission – by E.W.Kimbark, John Wiley & Sons. 3. EHVAC Transmission Engineering by R. D. Begamudre, New Age International (P) Ltd..
Reference books:
1. EHVAC and HVDC Transmission Engineering and Practice – S.Rao. 2. Power Transmission by Direct Current – by E.Uhlmann, B.S.Publications 3. HVDC Transmission – J. Arrillaga.
e- Resources & other digital material
1.https://nptel.ac.in/courses/108/104/108104013/

Co Po Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PS03
CO1	2	3	2	1								1			
CO2	2	3	2	1								1	1		
CO3	2	3	2	1								1			
CO4	2	3	2	1								1			1
CO5	2	3	2	1								1			1

III Year II Semester

L	T	P	C
3	0	0	3

ADVANCED CONTROL SYSTEM

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 of time 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 describing functions 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 describing functions 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 and asymptotic 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 and asymptotic 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.

Course Outcomes:

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)**}

Text books:
1. K. Ogata "Discrete Time Control Systems", 1996, PHI. 2. K. Ogata "Modern Control Engineering", 1996, PHI. 3. R. C. Dorf and R. H. Bishop, Modern Control Systems, 8th ed., Pearson Education, Delhi, 2004.
Reference books:
1. C. D. Johnson, Process Control Instrumentation Technology, 7th ed., Prentice Hall of India, New Delhi, 2003. **2.** M. Gopal, "Modern Control System Theory",New Age International Publishers, 2nd edition,1996. **3.** Madangopal "Digital control and state variables methods" 1997, PHI. 4. Modern control engineering – Katsuhiko Ogata, Pearson Edn.

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	PSO-3
CO 1	3	2	-	1	-	-	-	-	-	-	-	-	-	2	2
CO 2	2	3	-	-	-	-	-	-	-	-	-	-	-	-	3
CO 3	-	3	2	-	-	-	-	-	-	-	-	-	2	2	-
CO 4	-	2	3	-	-	-	-	-	-	-	-	-	-	-	2
CO 5	-	-	-	-	3	-	-	-	-	-	-	2	-	2	-

III Year II Semester

L	T	P	C
3	0	0	3

ELECTRICAL MACHINE DESIGN

PRE-REQUISITES: 1) Electrical Machines-I
2) Electrical Machines-II
3) Special Electrical Machines

Course objectives: The student should be able to

6. Study the Principles of Design of static and rotating machines.
7. To understand the design of cooling system of transformers
8. Know the main dimensions of static and rotating machines, field coil, stator and rotor.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**D.C.Machines (13 hrs)** E.M.F generated from full pitch -fractional pitch with and without distributed windings -distribution factor. Design of main dimensions from output equation. Design of Armature winding- Design of field system	**CO1**
II	**Transformers (12 hrs)** Derivation of output equation -volt per turn importance and calculation of main dimensions for three phase and single phase transformers -window dimensions. Yoke design and coil design –Design of transformer tank with tubes.	**CO2**
III	**Induction Motor (12 hrs)** Derivation of output equation -calculation of main dimensions -Stator design -number of slots -shape and area of slots. Rotor design for squirrel cage and slip ring types.	**CO3**
IV	**Synchronous Machines (12 hrs)** Derivation of output equation –Calculations of Main Dimensions for salient pole and cylindrical rotor alternators. Stator design -number of stator slots and slot dimensions, Pole design for salient pole generators.	**CO4**
V	**Computer Aided Design (9 hrs)** Advantage of computer aided design –Flow chart for computer aided design.	**CO5**
Content Beyond the syllabus: **D.C.Machines:** Design of inter-pole and commutator. **Synchronous Machines (salient pole):** pole winding calculations. Design of rotor for cylindrical rotor alternator-Design of rotor windings.		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the basic concepts of electrical machine design and the principles of computerized design of electrical machines **{Understand level, KL2}**
CO2	**Understand** the specifications and design of main dimensions of transformer, cooling

	systems **{ Understand level, KL2}**
CO3	**Evaluate** the design of dc machine and performance calculations**{ Evaluate level, KL5}**
CO4	**Analyze** the design of induction motor stator & rotor**{ Apply level, KL4}**
CO5	**Analyze** the design of synchronous machine (both. Salient pole & non-salient pole).**{Apply level, KL4}**

Learning Resources
Text books:
5. A.K. Sawhney, A Course in Electrical machine Design, Dhanpatrai& Sons, 6. M.G. Say, Performance and Design of AC Machines, CBS.
Reference books:
1. CEDT Manual on design and technology on low power transformers and inductors by IISC, Bangalore. 2. V.N.Mittle, Design of Electrical Machines, Standard Publishers Distributors2009. 3. A.E. Clayton Performance and Design of AC Machines. 4. R.K. Agarwal, Principles Of Electrical Machine Design, S.K.Kataria&Sons,2010. 5. M. Ramamoothy, Computer aided design of electrical equipment, Affiliated East West press Pvt Ltd New Delhi.
e- Resources & other digital material
9. http://www.faadooengineers.com/threads/9454-Electrical-Machine-Designfull-notes-e-books-pdf-all-units
10. http://nptel.iitm.ac.in

Micro-Syllabus

Unit – 1: D.C.Machines (13 hrs)

E.M.F generated from full pitch -fractional pitch with and without distributed windings - distribution factor. Design of main dimensions from output equation.

Design of Armature winding- Design of field system

Unit No	Module	Micro content
1a.E.M.F generated from full pitch -fractional pitch with and without distributed windings	Design of main dimensions from output equation.	E.M.F generated from full pitch,
		fractional pitch with and without distributed windings,
		distribution factor,
		Design of main dimensions from output equation.
1b. Design of Armature winding	Design of field system	Design of Armature winding,
		Design of field system

Unit-2: Transformers (12 hrs)

Derivation of output equation -volt per turn importance and calculation of main dimensions for three phase and single phase transformers -window dimensions.

Yoke design and coil design –Design of transformer tank with tubes.

Unit No	Module	Micro content
2a. Derivation of output equation	calculation of main dimensions for three phase and single phase	Derivation of output equation,
		volt per turn importance,
		calculation of main dimensions for three phase

	transformers	transformers,
		calculation of main dimensions for single phase transformers,
		window dimensions
2b. Yoke design and coil design	Design of transformer tank with tubes.	Yoke design,
		coil design
		Design of transformer tank with tubes

Unit-3: Induction Motor (12 hrs)

Derivation of output equation -calculation of main dimensions -Stator design -number of slots -shape and area of slots.

Rotor design for squirrel cage and slip ring types.

Unit No	Module	Micro content
3a.Derivation of output equation	Stator design -number of slots -shape and area of slots.	Derivation of output equation,
		calculation of main dimensions,
		Stator design -number of slots -shape and area of slots.
3b.Rotor design for squirrel cage	Rotor design for slip ring types	Rotor design for squirrel cage
		slip ring types

Unit-4: Synchronous Machines (12 hrs)

Derivation of output equation –Calculations of Main Dimensions for salient pole and cylindrical rotor alternators.

Stator design -number of stator slots and slot dimensions, Pole design for salient pole generators.

Unit No	Module	Micro content
4a.Derivation of output equation	Main Dimensions for salient pole and cylindrical rotor alternators.	Derivation of output equation,
		Calculations of Main Dimensions for salient pole and cylindrical rotor alternators.
		Layout of 33/11 kV substation (Diagram and arrangement of equipment)
4b.Stator design -number of stator slots and slot dimensions	Pole design for salient pole generators.	Stator design,
		number of stator slots and slot dimensions,
		Pole design for salient pole generators

Unit-5: Computer Aided Design (9 hrs)

Advantage of computer aided design –Flow chart for computer aided design.

Unit No	Module	Micro content
5a.Advantage of computer aided design	Advantage of computer aided design	Advantage of computer aided design,
5b.Flow chart for computer aided design	Flow chart for computer aided design	Flow chart for computer aided design

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

CO1	**Understand** the basic concepts of electrical machine design and the principles of computerized design of electrical machines **{Understand level, KL2}**
CO2	**Understand** the specifications and design of main dimensions of transformer, cooling systems **{ Understand level, KL2}**
CO3	**Evaluate** the design of dc machine and performance calculations**{ Evaluate level, KL5}**
CO4	**Analyze** the design of induction motor stator & rotor**{ Apply level, KL4}**
CO5	**Analyze** the design of synchronous machine (both. Salient pole & non-salient pole).**{Apply level, KL4}**

Text books:

1. A.K. Sawhney, A Course in Electrical machine Design, Dhanpatrai& Sons,
2. M.G. Say, Performance and Design of AC Machines ,CBS.

Reference books:

1. CEDT Manual on design and technology on low power transformers and inductors by IISC, Bangalore.
2. V.N.Mittle, Design of Electrical Machines, Standard Publishers Distributors2009.
3. A.E. Clayton Performance and Design of AC Machines.
4. R.K. Agarwal, Principles Of Electrical Machine Design, S.K.Kataria&Sons,2010.
5. M. Ramamoothy, Computer aided design of electrical equipment, Affiliated East West press Pvt Ltd New Delhi.

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
CO 1	3													
CO 2	3													
CO 3	3													
CO 4	3	1											1	
CO 5	3	1												

III Year II Semester

L	T	P	C
3	0	0	3

RENEWABLE ENERGY SOURCES

(Professional Elective –II)

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, 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 wind energy conversion systems Betz coefficient systems tip speed ratio.
5. To study basic principle and working of hydro, tidal, fuel cell and geothermal systems.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Solar Energy Systems and Solar Geometry** **Solar Energy Systems:** Energy conservation principle – Energy scenario (world and India) – various forms of renewable energy - Solar radiation**:** Outside earth's atmosphere – Earth surface – Analysis of solar radiation data. **Solar Geometry:** Latitude angle-Zenith angle- Altitude angle- Declination angle-Solar azimuth angle-Slop- Surface azimuth angle- angle of incidence- Solar Time-Hour angle- Sunrise, Sunset and daylight– Radiation on tilted surfaces – Numerical problems.	**CO1**
II	**Solar Thermal and Solar Photovoltaic Systems** **Solar Thermal Systems** Introduction-Liquid flat plate collectors-Performance Analysis– Concentrating collectors & its types- Applications (Solar pond, Solar Water heater, Solar Cookers & Solar still). **Solar Photovoltaic Systems** Solar photovoltaic cell, module, array – Construction –Solar Cell I-V characteristics – Equivalent circuit -Maximizing the performance of solar cell – Solar PV Systems.	**CO2**
III	**PV System design and Wind Energy System** **PV System design:** Balance of system components – PV System design**:** storage sizing – PV system sizing – Maximum power point techniques**-** Perturb and observe (P&O) technique. **Wind Energy Syatem** Sources of wind energy - Power in Wind- Wind Energy Conversion System-Wind Turbine-operating characteristics-Types of turbines– Power output of wind turbine-Selection of generator– Maximum power point tracking.	**CO3**

IV	**Hydro and Tidal power systems** **Hydro power systems:** Basic working principle – Conversion of Hydro Power-Classification of small hydropower Plant-Operation of Micro Hydro Power Plant– Types of Water turbines. **Tidal power systems:** Origin of Tides - Tidal Energy – Operation of Tidal plant - Tidal energy conversation Schemes – Numerical problems. **Wave Energy:** Power Associated to Wave – Wave Energy Conversion devices.	**CO4**
V	**Fuel cells and geothermal systems** **Fuel cell:** Basic Working Principle - Classification of fuel for fuel cells – Fuel cell voltage– Efficiency – V-I characteristics-Application. **Geothermal:** Resources- Geothermal based electric power generation - Classification – Dry steam – Wet steam- Hot water Resources–Hot Dry Rock Resources.	**CO5**

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 and wind energy conversion systems. **{Evaluate level, KL5}**
CO4	Understand working of hydro, tidal and wave power plant operations.{**Understand level, KL2}**
CO5	**Explain** importance of fuel cell and geothermal system .**{Explain level, KL3}**

Learning Resources
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 Fancies 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
e- Resources & other digital material
1. https://nptel.ac.in/courses/112105051
2. https://www.tatapower.com/bussiness/renewable-energy.aspx
3. https://www.cleanlineenergy.com/technology/wind-and-solar
4. https://www. youtube.com/watch?=xokHLFE96h8
5. https://www.youtube.com/watch?v=GZKKWz_tX1c

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Micro-Syllabus

Unit – 1: Solar Energy Systems and Solar Geometry

Solar Energy Systems:

Energy conservation principle – Energy scenario (world and India) – various forms of renewable energy - Solar radiation**:** Outside earth's atmosphere – Earth surface – Analysis of solar radiation data.

Solar Geometry:

Latitude angle-Zenith angle- Altitude angle- Declination angle-Solar azimuth angle- Slop- Surface azimuth angle- angle of incidence- Solar Time-Hour angle- Sunrise, Sunset and daylight– Radiation on tilted surfaces – Numerical problems.

Unit No	Module	Micro content
1. Solar Energy Systems and Solar Geometry	Solar Energy Systems	Energy conversion principle
		Energy Scenario (world and India)
		Various forms of renewable energy
		Solar radiation on outside earth's atmosphere
		Solar radiation on Earth surface,
		analysis of solar radiation data
	Solar Geometry	Latitude angle
		Zenith angle and Altitude angle
		Declination angle
		Slop and Surface azimuth angle
		angle of incidence
		Solar Time-Hour angle
		Sunrise, Sunset and daylight
		Radiation on tilted surfaces
		Numerical problems.

Unit-2: Solar Thermal and Solar Photovoltaic Systems

Solar Thermal Systems

Introduction-Liquid flat plate collectors-Performance Analysis– Concentrating collectors & its types-Applications (Solar pond, Solar Water heater, Solar Cookers & Solar still).

Solar Photovoltaic Systems

Solar photovoltaic cell, module, array – Construction –Solar Cell I-V characteristics –Equivalent circuit -Maximizing the performance of solar cell – Solar PV Systems.

Unit No	Module	Micro content
2. Solar Thermal and Solar Photovoltaic Systems	Solar Thermal Systems	Introduction to Liquid flat plate collectors
		Performance Analysis
		Concentrating collectors & its types
		Applications (Solar pond, Solar Water heater, Solar Cookers & Solar still)
	Solar Photovoltaic Systems	Solar photovoltaic systems,
		Solar photovoltaic cell, module & Array
		Construction of Solar photovoltaic systems
		Solar Cell I-V characteristics
		Equivalent circuit
		Maximizing the performance of solar cell
		Solar PV Systems

Unit-3: **PV System design and Wind Energy System**
PV System design:
Balance of system components – PV System design**:** storage sizing – PV system sizing – Maximum power point techniques- Perturb and observe (P&O) technique.
Wind Energy System
Sources of wind energy - Power in Wind- Wind Energy Conversion System-Wind Turbine-operating characteristics-Types of turbines– Power output of wind turbine- Selection of generator– Maximum power point tracking.

Unit No	Module	Micro content
3. PV System design and Wind Energy System	PV System design	Balance of system components
		PV System design: storage sizing – PV system sizing
		Maximum power point techniques
		Perturb and observe (P&O) technique
	Wind Energy System	Sources of wind energy
		Power in Wind
		Wind Energy Conversion System Wind Turbine
		Operating characteristics
		Types of turbines : Horizontal axis and vertical axis machines
		Power output of wind turbine
		Selection of generators (synchronous, induction)
		Maximum power point tracking

Unit-4: Hydro and Tidal power systems
Hydro power systems:
Basic working principle – Conversion of Hydro Power-Classification of small hydropower Plant-Operation of Micro Hydro Power Plant– Types of Water turbines.
Tidal power systems:
Origin of Tides - Tidal Energy – Operation of Tidal plant - Tidal energy conversation Schemes – Numerical problems.
Wave Energy: Power Associated to Wave – Wave Energy Conversion devices.

Unit No	Module	Micro content
4. Hydro And Tidal Power Systems	Hydro power systems	Basic working principle
		Conversion of Hydro Power
		Classification of small hydropower Plant
		Operation of Micro Hydro Power Plant
		Types of Water turbines
	Tidal power systems	Origin of Tides
		Tidal Energy
		Operation of Tidal plant
		Tidal energy conversation Schemes
		Numerical problems.

	Wave Energy	Power Associated to Wave
		Wave Energy Conversion devices

Unit 5: Fuel cells and geothermal systems

Fuel cell:

Basic Working Principle - Classification of fuel for fuel cells – Fuel cell voltage– Efficiency – V-I characteristics-Application.

Geothermal:

Resources- Geothermal based electric power generation - Classification – Dry steam –Wet steam- Hot water Resources–Hot Dry Rock Resources.

Unit No	Module	Micro content
5.Fuel cells and geothermal systems	Fuel cell	Basic Working Principle
		Classification of fuel for fuel cells
		Fuel cell voltage
		Efficiency
		V-I characteristics
		Application
	Geothermal	Resources
		Geothermal based electric power generation
		Dry steam
		Wet steam
		Hot water Resources
		Hot Dry Rock Resources

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 and wind energy conversion systems. **{Evaluate level, KL5}**
CO4	Understand working of hydro, tidal and wave power plant operations.{**Understand level, KL2}**
CO5	**Explain** importance of fuel cell and geothermal system .**{Explain level, KL3}**

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

III Year II Semester

L	T	P	C
3	0	0	3

MICROPROCESSORS AND MICROCONTROLLERS

Pre-Requisites: Digital Electronics

Preamble: 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

1. 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.	**CO5**

Content Beyond the Syllabus:

1. Difference between 8085 and 8086- Distinguish between RISC and CISC architecture
2. Difference between 8051 and PIC family
3. Applications of 8051 microcontroller
4. Applications of PIC18 micro controller

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 21^{st} 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
3. “**Microcontrollers – Principles and Applications**”, Ajit Pal, PHI Learning Pvt Ltd, 2011.
4. **“Microprocessors and Interfacing**”, Douglas V Hall, Mc–Graw Hill, 2^{nd} Edition.

e-resources:

1. https://nptel.ac.in/courses/108107029/

Micro-Syllabus

Unit 1Introduction 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	Module	Micro content
1.a	Introduction and evolution of Microprocessors–	Evolution and Applications of Microprocessors.
		Differences between 8085 and 8086.
	8086 Pin diagram	8086 common pins, minimum mode and maximum mode pins.
	Architecture of 8086	Detailed architecture(BIU and EU)
1.b	Register Organization of 8086	General purpose registers, segment registers, Pointer and Index registers, flag register.
	Memory organization	Physical Memory organization (odd bank and even

	of 8086	bank) [Elementary treatment only]
	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	**Module**	**Micro content**
2.a	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
2.b	Minimum and Maximum mode operations- Read and write cycle timing diagrams	Block diagram of Minimum mode-Operation
		Read and write cycle timing diagrams
		Block diagram of Maximum mode-Operation
		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	**Module**	**Micro content**
3.a	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
3.b	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
	Command words of 8259	Initialization command words and operational command words.
	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	Module	Micro content
4.a.	Introduction to 8051 Micro Controller– Architecture– Register set–I/O ports	Features, Pin diagram and block diagram and applications of 8051
		Registers of 8051
4.b	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	Module	Micro content
5.a.	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
		I/O ports in different family of PIC
5.b.	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]

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 3. "**Microcontrollers – Principles and Applications**", Ajit Pal, PHI Learning Pvt Ltd, 2011. 4. **"Microprocessors and Interfacing**", Douglas V Hall, Mc–Graw Hill, 2nd Edition.
e-resources:
1. https://nptel.ac.in/courses/108107029/

CO–POs& PSOs Mapping:

	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

L	T	P	C
3	0	0	3

ELECTRICAL MEASUREMENTS & INSTRUMENTATION

Pre-Requisites: 1) Basic Circuit Analysis

Preamble: This course introduces the 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 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 and CRO.
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:** Error analysis; Classification – Deflecting, Controlling and Damping torques – PMMC, MI, Electrodynamometer typeinstruments– 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 & Energy: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 Type of P.F. Meters – Single phase and three phase dynamometer and moving irontype (Elementary treatment only) Single phase induction type energy (Elementary treatment only) Electrical resonance type frequency meter and Weston type synchro scope, Phase sequence indicator (Elementary treatment only)	**CO2**
III	**Potentiometers & Bridges** **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). **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	**CO3**

IV	**Transducers** **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.	**CO4**
V	**Digital Meters:** 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: **Oscilloscope:** Hysteresis loop using lissajious patterns in CRO (Elementary treatment only)		

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.{Apply level, KL3}
CO2	Understand the concepts used in measurement of power, power factor, and energy & know the application of synchroscope and sequence indicators.{Understanding 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 & frequency of signals with CRO{Apply level, KL3}
CO5	Acquire proper knowledge and working principle of various types of digital instruments {Apply level, KL3}

Learning Resources

Text books:

1. Electrical & Electronic Measurement & Instruments by A.K.Sawhney, Dhanpat Rai & Co 17^{th} edition 2000.
2. Electronic Instrumentation by H S Kalsi, 2^{nd} Edition, McGraw-Hill Publishing, 2004.
3. Electrical Measurements and measuring Instruments - by E.W. Golding and F.C. Widdis, 5^{th} 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

Micro-Syllabus

<table>
<tr><td colspan="3">Unit 1: Measuring Instruments& Instrument Transformers
Measuring Instruments: 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.</td></tr>
<tr><td>Unit</td><td>Module</td><td>Micro content</td></tr>
<tr><td rowspan="6">(A) Measuring Instruments</td><td>Error analysis</td><td>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</td></tr>
<tr><td rowspan="2">Classification, Torques</td><td>Classification of instruments</td></tr>
<tr><td>Deflecting, Controlling and damping torques</td></tr>
<tr><td rowspan="3">PMMC, MI, ED, ES type instruments, Expression for torque</td><td>PMMC instruments: Torque equation, merits & demerits</td></tr>
<tr><td>MI instruments: Torque equation, merits & demerits</td></tr>
<tr><td>ED instruments: torque equation, merits & demerits</td></tr>
<tr><td rowspan="5">(B) Range extension & Instrument transformer</td><td rowspan="2">Extension of ranges using Shunts and Multipliers-numerical problems</td><td>Extension of range of PMMC and MI instruments</td></tr>
<tr><td>Simple Numerical problems on extension of range of instruments</td></tr>
<tr><td rowspan="3">Instrument transformers: C.T& P.T</td><td>Use of Instrument transformers, ratios of instrument transformers, burden</td></tr>
<tr><td>CT: Principle of operation and working, effect of CT secondary open circuit</td></tr>
<tr><td>PT: Principle of operation and working</td></tr>
<tr><td colspan="3">UNIT-II: Measurement of Power, Power factor & Energy
Measurement of Power, Power factor: 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
Type of P.F. Meters – Single phase and three phase dynamometer and moving irontype (Elementary treatment only)
Measurement of Energy: Single phase induction type energy meter (Elementary treatment only
Electrical resonance type frequency meter and Weston typesynchroscope, Phase sequence indicator (Elementary treatment only)</td></tr>
<tr><td>Unit</td><td>Module</td><td>Micro content</td></tr>
<tr><td rowspan="6">(A) Measurement of Power, Power factor</td><td rowspan="4">Measurement of Power and Power factor</td><td>Power in DC & AC circuits</td></tr>
<tr><td>Electrodynamometer type wattmeter construction, theory, shape of scale</td></tr>
<tr><td>Errors in ED type wattmeter’s and compensation</td></tr>
<tr><td>LPF wattmeter</td></tr>
<tr><td rowspan="2">Power in Polyphase circuits</td><td>Power measurement in polyphase circuits</td></tr>
<tr><td>Measurement of Reactive power and simple</td></tr>
</table>

		numerical problems on power measurement
	Power factor meters	Principle of operation of ED & MI power factor meter (Elementary treatment only)
(B) Measurement of Energy	Measurement of Energy	Single phase induction type energy meter principle of operation (Elementary treatment only), meter constant
	Frequency meters, synchroscope, phase sequence indicators Applications (elementary treatment only)	Electrical resonance type frequency meter
		Weston type synchroscope
		Phase sequence indicators: static and rotating

UNIT-III: Potentiometers & Bridges

Potentiometers: Principle and operation of D.C. Crompton's potentiometer – Standardization – Applications: Measurement of unknown resistance – Current – Voltage. AC Potentiometers: polar and coordinate types – Standardization(Elementary treatment only).

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, De sautys bridge, Schering's bridge, Wagner's earth device

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

UNIT – IV: Transducers

Transducers: Q-meters, Definition and Classification of Resistive, Inductive and Capacitive Transducer, LVDT, Strain Gauge,Thermistors, Thermocouples, Piezo electric and Photo Diode Transducers

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)

UNIT V: Digital Meters

Digital Meters: 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, 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 & frequency meter, tachometer	Principle and operation of digital phase meter
		Principle and operation of frequency meter
		Principle and operation of tachometer

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.**{Apply level, KL3}**
CO2	**Understand** the concepts used in measurement of power, power factor, and energy & know the application of synchro scope and sequence indicators.**{Understanding 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 & frequency of signals with CRO**{Apply level, KL3}**
CO5	**Acquire** proper knowledge and working principle of various types of digital instruments **{Apply level, KL3}**

Text books:

1. Electrical & Electronic Measurement & Instruments by A.K.Sawhney, Dhanpat Rai & Co 17^{th} edition 2000.
2. Electronic Instrumentation by H S Kalsi, 2^{nd} Edition, McGraw-Hill Publishing, 2004.
3. Electrical Measurements and measuring Instruments - by E.W. Golding and F.C. Widdis, 5^{th} 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.

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	2												
CO4	2		3											
CO5	2		3											

III Year II Semester

L	T	P	C
3	0	0	3

POWER SYSTEMS-III

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:

6. To study the Gauss Seidel, Newton Raphson, Decoupled and Fast Decoupled load flow methods.
7. To understand the short circuit calculations for symmetrical and unsymmetrical faults.
8. To study the stability analysis of power systems.
9. **To understand optimal dispatch of generation with and without losses.**
10. **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.	**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**
III	**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	**CO3**

	improve transient stability, Numerical Problems.	
IV	**Economic 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** **Load Frequency Control-I: (7hrs)** Modeling of speed governing system-steam turbine-generator, Control area concept, Single area control-Transfer function and Block diagram representation of an isolated power system, Steady state analysis, Dynamic response, Numerical Problems. **Load Frequency Control-II: (6hrs)** Proportional plus Integral control of single area and its block diagram representation, Two area control- Transfer function and Block diagram representation, Tie-line bias control.	**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 and real time load frequency control concepts.		

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	
Text books:	
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 and Static 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 Economic 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

Load Frequency Control-I: (7hrs)

Modelling of speed governing system-steam turbine-generator, Control area concept, Single area control-Transfer function and Block diagram representation of an isolated power system, Steady state analysis, Dynamic response, Numerical Problems.

Load Frequency Control-II: (6hrs)

Proportional plus Integral control of single area and its block diagram representation, Two area control- Transfer function and Block diagram representation, Tie-line bias control.

Unit No	Module	Micro content
5a.	Load Frequency Control-I	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
		Numerical Problems
5b.	**Load Frequency Control-II**	Proportional plus Integral control of single area-steady state frequency error derivation
		Transfer function and Block diagram representation of two area control
		Concept of Tie-line bias control
		Load frequency and economic dispatch control

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 types of 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

Text books:

1. Modern Power system Analysis- I.J.Nagrath&D.P.Kothari: Tata McGraw-Hill Publishing Company, 2^{nd} 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

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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

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	2												
CO4	2		3											
CO5	2		3											

III Year II Semester

L	T	P	C
2	0	0	2

MACHINE LEARNING

PRE-REQUISITES: 1) Basic Statistics, 2) Data Mining

Course objectives: The student should be able to

1. Recognize the characteristics of machine learning, binary classification
2. Solve classification problems using multiclass classification and concept learning
3. Apply Tree based and Rule based learning models to real world problems
4. Apply Linear models and Distance based classification and clustering algorithms
5. Analyze Bayesian classifiers and Understand the concept behind neural networks for learning non-linear functions

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**The ingredients of machine learning, Tasks: (08 hrs)** The problems that can be solved with machine learning, Looking for structure, Evaluating performance on a task, **Models: the output of machine learning:** Geometric models, Probabilistic models, Logical models, Grouping and grading, **Features:** the workhorses of machine learning, Two uses of features, Feature construction and transformation. **Binary classification and related tasks: (06 hrs)** Classification, Assessing classification performance, Visualizing classification performance, Class probability estimation, Assessing Class probability estimates	**CO1**
II	**Beyond binary classification: (07 hrs)** Handling more than two classes, Multi class classification Multi class scores and probabilities, Regression, Unsupervised and descriptive learning, Predictive and descriptive clustering. **Concept learning: (07 hrs)** The hypothesis space, Least general generalization, Internal disjunction ,Paths through the hypothesis space, Most general consistent hypotheses, Closed concepts, Beyond conjunctive concepts	**CO2**
III	**Tree models: (06 hrs)** Decision trees, Ranking and probability estimation trees, Tree learning as variance reduction. **Rule models: (06 hrs)** Learning ordered rule lists, Learning unordered rule sets, Descriptive rule learning, First-order rule learning.	**CO3**
IV	**Linear models: (07 hrs)** The least-squares method, multivariate linear regression, regularized regression, using least-squares regression for classification, Support vector machines, Soft margin SVM. **Distance Based Models: (07 hrs)**	**CO4**

	Ways of measuring distance, Neighbours and exemplars, Nearest Neighbours classification, Distance based clustering, k means algorithm, Clustering around mediods, Silhouettes, Hierarchical Clustering.	
V	**Bayesian Learning: (06 hrs)** Introduction, Bayes Theorem, Bayes Optimal Classifier, Gibbs Algorithm, Naïve Bayes Classifier, Learning to classify Text. **Artificial Neural Networks: (06 hrs)** Introduction, Neural network representation, appropriate problems for neural network learning, Multilayer networks and the back propagation algorithm.	**CO5**

Content Beyond the syllabus: **Features:** Kinds of feature, Feature transformations, Feature construction and selection. Model ensembles: Bagging and random forests, Boosting. **Dimensionality Reduction:** Principal Component Analysis (PCA), Implementation and demonstration.

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Recognize** the characteristics of machine learning, binary classification **{Understand level, KL2} {Analyze level, KL4}**
CO2	**Solve** classification problems using multiclass classification and concept learning **{Evaluate level, KL5}**
CO3	**Apply** Tree based and Rule based learning models to real world problems **{Apply level, KL3}**
CO4	**Apply** Linear models and Distance based classification and clustering algorithms **{Apply level, KL3}**
CO5	**Analyze** Bayesian classifiers and **Understand** the concept behind neural networks for learning non-linear functions **{Understand level, KL2} {Analyze level, KL4}**

Learning Resources

Text books:

1. Machine Learning: The art and Science of algorithms that make sense of data, Peter Flach, Cambridge University Press, 2012.
2. Tom M. Mitchell, Machine Learning, India Edition 2013, McGraw Hill Education.
3. Chris Albon : Machine Learning with Python Cookbook , O'Reilly Media, Inc.2018.

Reference books:

1. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
2. Ethem Alpaydın, Introduction to machine learning, second edition, MIT press.
3. T. Hastie, R. Tibshirani and J. Friedman, "Elements of Statistical Learning", Springer Series , 2nd edition.

e- Resources & other digital material

1. Kevin Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012, https://www.cs.ubc.ca/~murphyk/MLbook/pml-intro-5nov11.pdf

2.	Professor S. Sarkar , IIT Kharagpur "Introduction to machine learning", https://www.youtube.com/playlist?list=PLYihddLFCgYuWNL55Wg8ALkm6u8U7gps
3.	Professor Carl Gustaf Jansson, KTH, Video Course on Machine Learning https://nptel.ac.in/noc/individual_course.php?id=noc19-cs35
4.	Tom Mitchell, "Machine Learning", http://www.cs.cmu.edu/~tom/10701_sp11/lectures.shtml

Micro-Syllabus

Unit – 1: The ingredients of machine learning, Tasks: (08 hrs)

The problems that can be solved with machine learning, Looking for structure, Evaluating performance on a task, **Models: the output of machine learning:** Geometric models, Probabilistic models, Logical models, Grouping and grading, **Features:** The workhorses of machine learning, Two uses of features, Feature construction and transformation.

Binary classification and related tasks: (06 hrs)

Classification, Assessing classification performance, Visualizing classification performance, Class probability estimation, Assessing Class probability estimates.

Unit No	Module	Micro content
1a. The ingredients of machine learning, Tasks	**The ingredients of machine learning, Tasks**	The problems that can be solved with machine learning
		Looking for structure
		Evaluating performance on a task
	Models: the output of machine learning	Geometric models, Probabilistic models
		Logical models, Grouping and grading
	Features	The workhorses of machine learning
		Two uses of features
		Feature construction and transformation
1b. Binary classification and related tasks	**Binary classification and related tasks**	Classification
		Assessing classification performance
		Visualizing classification performance
		Class probability estimation
		Assessing Class probability estimates

Unit-2: Beyond binary classification: (07 hrs)

Handling more than two classes, Multi class classification, Multi class scores and probabilities, Regression, Unsupervised and descriptive learning, Predictive and descriptive clustering.

Concept learning: (07 hrs)

The hypothesis space, Least general generalization, Internal disjunction, Paths through the hypothesis space, Most general consistent hypotheses, Closed concepts, Beyond conjunctive concepts.

Unit No	Module	Micro content
2a. Beyond binary classification	**Beyond binary classification**	Handling more than two classes
		Multi class classification
		Multi class scores and probabilities
		Regression

		Unsupervised and descriptive learning
		Predictive and descriptive clustering
2b. Concept learning	**Concept learning**	The hypothesis space
		Least general generalization
		Internal disjunction
		Paths through the hypothesis space
		Most general consistent hypotheses
		Closed concepts
		Beyond conjunctive concepts

Unit-3: **Tree models: (06 hrs)**

Decision trees, Ranking and probability estimation trees, Tree learning as variance reduction.

Rule models: (06 hrs)

Learning ordered rule lists, Learning unordered rule sets, Descriptive rule learning, First-order rule learning.

Unit No	Module	Micro content
3a. Tree models	**Tree models**	Decision trees
		Ranking and probability estimation trees
		Tree learning as variance reduction
3b. Rule models	**Rule models**	Learning ordered rule lists
		Learning unordered rule sets
		Descriptive rule learning
		First-order rule learning

Unit-4: Linear models: (07 hrs)

The least-squares method, multivariate linear regression, regularized regression, using least-squares regression for classification, Support vector machines, Soft margin SVM.

Distance Based Models: (07 hrs)

Ways of measuring distance, Neighbours and exemplars, Nearest Neighbours classification, Distance based clustering, k means algorithm, Clustering around mediods, Silhouettes, Hierarchical Clustering.

Unit No	Module	Micro content
4a. Linear models	**Linear models**	The least-squares method
		multivariate linear regression
		regularized regression
		using least-squares regression for classification
		Support vector machines
		Soft margin SVM
4b. Distance Based Models	**Distance Based Models**	Ways of measuring distance
		Neighbours and exemplars
		Nearest Neighbours classification
		Distance based clustering
		k means algorithm
		Clustering around mediods
		Silhouettes
		Hierarchical Clustering

Unit-5: Bayesian Learning: (06 hrs) Introduction, Bayes Theorem, Bayes Optimal Classifier, Gibbs Algorithm, Naïve Bayes Classifier, Learning to classify Text. **Artificial Neural Networks: (06 hrs)** Introduction, Neural network representation, appropriate problems for neural network learning, Multilayer networks and the back propagation algorithm.		
Unit No	**Module**	**Micro content**
5a. Bayesian Learning	**Bayesian Learning**	Introduction
		Bayes Theorem, Bayes Optimal Classifier
		Gibbs Algorithm
		Naïve Bayes Classifier, Learning to classify Text
5b. Artificial Neural Networks	**Artificial Neural Networks**	Introduction
		Neural network representation
		appropriate problems for neural network learning
		Multilayer networks and the back propagation algorithm

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

CO1	**Recognize** the characteristics of machine learning, binary classification **{Understand level, KL2} {Analyze level, KL4}**
CO2	**Solve** classification problems using multiclass classification and concept learning **{Evaluate level, KL5}**
CO3	**Apply** Tree based and Rule based learning models to real world problems **{Apply level, KL3}**
CO4	**Apply** Linear models and Distance based classification and clustering algorithms **{Apply level, KL3}**
CO5	**Analyze** Bayesian classifiers and **Understand** the concept behind neural networks for learning non-linear functions **{Understand level, KL2} {Analyze level, KL4}**

Learning Resources
Text books:
1. Machine Learning: The art and Science of algorithms that make sense of data, Peter Flach, Cambridge University Press, 2012. 2. Tom M. Mitchell, Machine Learning, India Edition 2013, McGraw Hill Education. 3. Chris Albon : Machine Learning with Python Cookbook , O'Reilly Media, Inc.2018.
Reference books:
1. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014. 2. Ethem Alpaydın, Introduction to machine learning, second edition, MIT press. 3. T. Hastie, R. Tibshirani and J. Friedman, "Elements of Statistical Learning", Springer Series , 2nd edition.
e- Resources & other digital material
1. Kevin Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012,

	https://www.cs.ubc.ca/~murphyk/MLbook/pml-intro-5nov11.pdf
2.	Professor S. Sarkar , IIT Kharagpur “Introduction to machine learning”, https://www.youtube.com/playlist?list=PLYihddLFCgYuWNL55Wg8ALkm6u8U7gps
3.	Professor Carl Gustaf Jansson, KTH, Video Course on Machine Learning https://nptel.ac.in/noc/individual_course.php?id=noc19-cs35
4.	Tom Mitchell, “Machine Learning”, http://www.cs.cmu.edu/~tom/10701_sp11/lectures.shtml

CO-PO mapping

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

III Year II Semester

L	T	P	C
2	0	0	2

BIG DATA ANALYTICS

PRE-REQUISITES: 1) Java Programming, DBMS, Data Mining

Course objectives: The student should be able to

1. Understand the Data Mining Concepts and Big Data Introduction
2. Provide an overview of Apache Hadoop
3. Provide HDFS Concepts and Interfacing with HDFS
4. Understand Map Reduce Jobs
5. Provide hands on Hadoop Eco System
6. To study different types Case studies on the current research and applications of the Hadoop and big data in Smart Grids

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Data Mining Concepts: (10 hrs)** Data Mining, KDD Process, Kinds of Patterns Can Be Mined, Applications of DM. Data pre-processing: Data Cleaning - Missing Values, Noisy Data, Data Cleaning as a Process; Data Integration - Entity Identification Problem, Redundancy and Correlation Analysis, Tuple Duplication, Data Value Conflict Detection and Resolution; Data Reduction; Data Transformation and Data Discretization, Overview of Data Mining Techniques. **Introduction to Big Data: (04 hrs)** Big Data-definition, Characteristics of Big Data (Volume, Variety, Velocity), Data in the Warehouse and Data in Hadoop, Why is Big Data Important? Patterns for Big Data Development, Examples of Big Data Analytics.	**CO1**
II	**Introduction to Hadoop: (07 hrs)** Working with Big Data: Google File System, A Brief History of Hadoop, Apache Hadoop and the Hadoop Ecosystem, Hadoop Releases, Hadoop Installation Modes. **Hadoop Distributed File System: (07 hrs)** HDFS, Building Blocks of Hadoop (Namenode, Datanode, Secondary Namenode, JobTracker, TaskTracker), Introducing and Configuring Hadoop cluster (Local, Pseudo-distributed mode, Fully Distributed mode), Configuring XML files.	**CO2**
III	**Map Reduce**: **(12 hrs)** Introduction, How MapReduce works? MR Execution Flow with an Example, Understanding Hadoop API for MapReduce Framework (Old and New), Components of MapReduce: Driver code, Mapper code, Reducer code, RecordReader, Combiner, Partitioner; MR Program for Word Count.	**CO3**
IV	**Pig**: **(07 hrs)** Admiring the Pig Architecture, Installation and Running of Pig, Execution Types, Evaluating Local and Distributed Modes, Pig Latin Editors, Comparison with databases, Pig Latin, Functions, Data Processing Operators, Checking out the Pig Script Interfaces, Scripting with Pig Latin, Running Pig Programs. **Hive**: **(05 hrs)** Installing Hive, An Example, Running Hive, Comparison with Traditional Databases,	**CO4**

	HiveQL, Tables, Querying Data.	
V	**Big Data Analytics in Smart Grids: (16 hrs)** **Smart Grid:** Architectural Designs, Smart Grid Communications And Measurement Technology, Performance Analysis Tools For Smart Grid Design. **(11 hrs)** **Big Data for Smart Grid:** Need of Data Analysis in Smart Grid, Building the Foundation for Data Analytics, Applying Analytical Models in the Utility, Big Data Integration, Frameworks, and Databases, **(03 hrs)** **Big Data implementation in smart grid:** the case of customer data analytics **(02 hrs)**	**CO5**

Content Beyond the syllabus: (03 hrs)

Introduction to Data Structures using Java: Introduction to Data Structures, Stack, Queue, Linked List, Set, Map, Wrapping and Unwrapping, Generic Classes, Generic Methods (Elementary treatment only)

Map Reduce Programs: Word Count Example (Elementary treatment only)

Course Outcomes

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

CO1	**Understand** the concepts of Data mining and Big Data Analytics, Analyze Hadoop Architecture **{Understand level, KL2} {Analyze level, KL4}**
CO2	**Master** the concepts of Hadoop Distributed File System.**{Apply level, KL3}**
CO3	**Acquire** knowledge on Map Reduce Framework. **{ Evaluate level, KL5}**
CO4	**Apply** Pig and Hive concepts for Data Processing. **{Evaluate level, KL5}**
CO5	**Analyze** the Data Analytics on Smart Grid. **{Analyze level, KL4}**

Learning Resources

Text books:

1. Jiawei Han and Micheline Kamber, Data Mining Concepts & Techniques, 3 ed, Elsevier Publishers.
2. Dirk deRoos, Chris Eaton, George Lapis, Paul Zikopoulos, Tom Deutsch , "Understanding Big Data Analytics for Enterprise Class Hadoop and StreamingData", 1st Edition, TMH,2012.
3. TomWhite, Hadoop,"TheDefinitiveGuide",3rdEdition,O'Reilly Publications, 2012.
4. Smart Grid: Fundamentals of Design and Analysis, 1st Edition, Wiley- IEEE Press.
5. Carol L. Stimmel, Big Data Analytics Strategies for the Smart Grid, CRC Press. 2015.
6. Daki, H., El Hannani, A., Aqqal, A. et al. Big Data management in smart grid: concepts, requirements and implementation. J Big Data 4, 13 (2017). https://doi.org/10.1186/s40537-017-0070-y.

Reference books:

1. Michael Berthold, DavidJ. Hand, "Intelligent Data Analysis", Springer, 2007.
2. David Loshin, "BigDataAnalytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", Morgan Kaufmann Publishers, 2013.
3. Hadoop in Practice by AlexHolmes, MANNING.
4. Hadoop in Action by ChuckLam, MANNING.

e- Resources & other digital material

1. https://onlinecourses.swayam2.ac.in/arp19_ap60/preview
2. Big Data Use cases for Beginners | Real Life Case Studies | Success Stories https://www.youtube.com/watch?v=HHR0-iJp2sM

3. Alexey Grishchenko, Hadoop vs MPP, https://0x0fff.com/hadoopvs-mpp/
4. Random notes on bigdata- SlideShare: www.slideshare.net/yiranpang/random-notes-on-big-data-26439474
5. https://nptel.ac.in/courses/106/104/106104189/
6. Prof. Nandansudharsanam and Prof . B.Ravindran , IIT Madras, Introduction to Data Analytics http://nptel.ac.in/courses/110106064/23

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Micro-Syllabus

Unit – 1: Data Mining Concepts:
Data Mining, KDD Process, Kinds of Patterns Can Be Mined, Applications of DM.
Data pre-processing:
Data Cleaning - Missing Values, Noisy Data, Data Cleaning as a Process;
Data Integration - Entity Identification Problem, Redundancy and Correlation Analysis, Tuple Duplication, Data Value Conflict Detection and Resolution; Data Reduction;
Data Transformation and Data Discretization, Overview of Data Mining Techniques.
Introduction to Big Data:
Big Data-definition, Characteristics of Big Data (Volume, Variety, Velocity), Data in the Warehouse and Data in Hadoop, Why is Big Data Important? Patterns for Big Data Development, Examples of Big Data Analytics.

Unit No	Module	Micro content
1a. Data Mining Concepts	**Data Mining Concepts**	Data Mining, KDD Process, Kinds of Patterns Can Be Mined
		Applications of data mining, Data pre-processing
		Data Cleaning - Missing Values, Noisy Data
		Data Cleaning as a Process
		Data Integration - Entity Identification Problem,
		Redundancy and Correlation Analysis
		Tuple Duplication
		Data Value Conflict Detection and Resolution
		Data Reduction
		Data Transformation
		Data Discretization
		Overview of Data Mining Techniques
1b. Introduction to Big Data	**Introduction to Big Data**	Big Data-definition, Characteristics of Big Data (Volume, Variety, Velocity)
		Data in the Warehouse and Data in Hadoop
		Why is Big Data Important? Patterns for Big Data Development
		Examples of Big Data Analytics

Unit-2: Introduction to Hadoop:
Working with Big Data: Google File System, A Brief History of Hadoop, Apache Hadoop and the Hadoop Ecosystem, Hadoop Releases, Hadoop Installation Modes.
Hadoop Distributed File System:

HDFS, Building Blocks of Hadoop (Namenode, Datanode, Secondary Namenode, JobTracker, TaskTracker), Introducing and Configuring Hadoop cluster (Local, Pseudo-distributed mode, Fully Distributed mode), Configuring XML files.

Unit No	Module	Micro content
2a. Introduction to Hadoop	**Introduction to Hadoop**	Data, Data Storage and Analysis
		Google File System
		A Brief History of Hadoop
		Apache Hadoop and the Hadoop Ecosystem
		Hadoop Releases
		Hadoop Installation Modes
2b. Hadoop Distributed File System	**Hadoop Distributed File System**	The Design of HDFS, HDFS Concepts
		Building Blocks, Namenodes and Datanodes
		Basic Filesystem Operations
		Introducing and Configuring Hadoop cluster – Local Mode, Pseudo-distributed mode, Fully Distributed mode
		Configuring XML Files

Unit-3: **Map Reduce**:
Introduction, How MapReduce works? MR Execution Flow with an Example, Understanding Hadoop API for MapReduce Framework (Old and New), Components of MapReduce: Driver code, Mapper code, Reducer code, RecordReader, Combiner, Partitioner; MR Program for Word Count.

Unit No	Module	Micro content
3. Map Reduce	**Map Reduce**	Introduction to Map Reduce
		How MapReduce works?
		MR Execution Flow with an Example
		Understanding Hadoop API for MR Framework (old)
		Understanding Hadoop API for MR Framework (new)
		Basic Concept of Map and Reduce
		Driver Code
		Mapper Code
		Reducer Code
		Record Reader, Combiner, Partitioner
		Example basic level programs for Map Reduce concepts implementation (Word Count)

Unit-4: Pig:
Admiring the Pig Architecture, Installation and Running of Pig, Execution Types, Evaluating Local and Distributed Modes, Pig Latin Editors, Comparison with databases, Pig Latin Functions, Data Processing Operators, Checking out the Pig Script Interfaces, Scripting with Pig Latin, Running Pig Programs.
Hive:
Installing Hive, An Example, Running Hive, Comparison with Traditional Databases, HiveQL, Tables, Querying Data.

Unit No	Module	Micro content
4a. Pig	**Pig**	Admiring the Pig Architecture
		Installation and Running of Pig, Execution Types
		Evaluating Local and Distributed Modes, Pig Latin Editors
		Comparison with databases, Pig Latin Functions
		Data Processing Operators,

		Checking out the Pig Script Interfaces
		Scripting with Pig Latin
		Running Pig Programs
4b. Hive	**Hive**	Installing Hive
		An Example, Running Hive
		Comparison with Traditional Databases
		HiveQL
		Tables, Querying Data

Unit-5: Big data analytics in Smart Grids:
Smart Grid: Architectural Designs, Smart Grid Communications And Measurement Technology, Performance Analysis Tools For Smart Grid Design.
Big Data for Smart Grid: Need of Data Analysis in Smart Grid, Building the Foundation for Data Analytics, Applying Analytical Models in the Utility, Big Data Integration, Frameworks, and Databases.
Big Data implementation in smart grid: the case of customer data analytics

Unit No	Module	Micro content
5a. Smart Grid	**Smart Grid**	Architectural Designs
		Smart Grid Communications And Measurement Technology
		Performance Analysis Tools For Smart Grid Design
5b. Big Data for Smart Grid	**Big Data for Smart Grid**	Need of Data Analysis in Smart Grid
		Building the Foundation for Data Analytics,
		Applying Analytical Models in the Utility
		Big Data Integration
		Frameworks. Databases
5c. Big Data implementation in smart grid	**Big Data implementation in smart grid**	The case of customer data analytics

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

CO1	**Understand** the concepts of Data mining and Big Data Analytics, Analyze Hadoop Architecture **{Understand level, KL2} {Analyze level, KL4}**
CO2	**Master** the concepts of Hadoop Distributed File System.**{Apply level, KL3}**
CO3	**Acquire** knowledge on Map Reduce Framework. **{ Evaluate level, KL5}**
CO4	**Apply** Pig and Hive concepts for Data Processing. **{Evaluate level, KL5}**
CO5	**Analyze** the Data Analytics on Smart Grid. **{Analyze level, KL4}**

Learning Resources

Text books:

1. Jiawei Han and Micheline Kamber, Data Mining Concepts & Techniques, 3 ed, Elsevier Publishers.
2. Dirk deRoos, Chris Eaton, George Lapis, Paul Zikopoulos, Tom Deutsch , "Understanding Big Data Analytics for Enterprise Class Hadoop and StreamingData", 1st Edition, TMH,2012.
3. TomWhite, Hadoop,"TheDefinitiveGuide",3rdEdition,O'Reilly Publications, 2012.
4. Smart Grid: Fundamentals of Design and Analysis, 1st Edition, Wiley- IEEE Press.
5. Carol L. Stimmel, Big Data Analytics Strategies for the Smart Grid, CRC Press. 2015.

6. Daki, H., El Hannani, A., Aqqal, A. et al. Big Data management in smart grid: concepts, requirements and implementation. J Big Data 4, 13 (2017). https://doi.org/10.1186/s40537-017-0070-y.

Reference books:

1. Michael Berthold, DavidJ. Hand, "Intelligent Data Analysis", Springer, 2007.
2. David Loshin, "BigDataAnalytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", Morgan Kaufmann Publishers, 2013.
3. Hadoop in Practice by AlexHolmes, MANNING.
4. Hadoop in Action by ChuckLam, MANNING.

CO-PO Mapping

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

III Year II Semester

L	T	P	C
2	0	0	2

NANO TECHNOLOGY

PRE-REQUISITES:

1. Basic knowledge on materials.

Course objectives: The student should be able

1. To have the knowledge of fundamentals of nano technology.
2. To understand different structures of nano materials.
3. To study the structures of nano carbon, nano thermal and nano semiconductor materials.
4. To have a thorough knowledge of nano sensors.
5. To study the applications of nano technology in different engineering fields.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction and classification (12 hrs)** Summary of electronic properties of atoms and solids, effects of Nano meter length scales, fabrication methods, preparation, safety and storage issues.	**CO1**
II	**Nano Structures(12 hrs)** Importance of Nano-technology, Bottom-up and Top-down approaches, Zero Dimensional Nano-structures - Nano particles through homogenous nucleation and heterogeneous nucleation; One Dimensional Nano-structures - Nano wires and Nano rods, Spontaneous growth, Evaporation and condensation growth, Two dimensional Nano-structures - Fundamentals of film growth. Physical vapour Deposition (PVD) and Chemical Vapour Deposition (CVD):	**CO2**
III	**Carbon Nano Structures(12 hrs)** DLCs, Fullerenes, C60, C80 SWNT and MWNT; Properties: Mechanical, Optical and Electrical properties. **Thermo Electric Materials** Concept of phonon, Thermal conductivity, Specific heat, Exothermic & Endothermic processes. **Nano Semiconductors**: Nano scale electronic devices including CMOS, Potentiometric sensors etc., MRAM devices	**CO3**
IV	**Nano sensors(12 hrs)** Introduction to sensors. Characteristics and terminology - Fundamentals of sensors, Sensors for aerospace and defense. Organic and inorganic Nano sensors. Sensor for bio-medical applications, Bioelectronics, Nanoparticle-biomaterial hybrid systems for sensing applications. Gas sensor. Biosensors: Principles, DNA and nucleotide-based biosensors, Protein-based biosensors,	**CO4**
V	**Application of Nanotechnology(12 hrs)** Consumer goods, Cosmetics, Nano catalyst, paints, food and agriculture industries, Nanotechnology for waste reduction and improved energy efficiency, nanotechnology based water treatment strategies. Nano-toxicology. Use of Nano-particles for environmental remediation and water treatment.	**CO5**

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Know the fundamentals, properties and fabrication methods of Nano components
CO2	Know the structures of zero, one and two dimensional Nano components
CO3	Know the structures of carbon, thermal and semiconductor materials
CO4	Have the knowledge of Nano sensors and their applications
CO5	Apply the Nano technology in different engineering and other fields.

Learning Resources

Text books:

1. Encyclopedia of Nanotechnology- Hari Singh Nalwa
2. Introduction to Nano technology by Charles P. Poole Jr and Frank J. Owens, Wiley-Inter science, 2003

Reference books

1. Springer Handbook of Nanotechnology - Bharat Bhusan
2. Handbook of Semiconductor Nanostructures and NanodevicesVol 1-5- A. A. Balandin, K. L. Wang.
3. Nanostructures and Nanomaterials - Synthesis, Properties and Applications - Cao, Guozhong.

Micro Syllabus

Unit 1: Introduction and classification(12 hrs)

Summary of electronic properties of atoms and solids, effects of Nano meter length scales, fabrication methods, preparation, safety and storage issues.

Unit No	Module	Micro content
1.	**Introduction and classification**	Summary of electronic properties of atoms and solids,
		Effects of nano meter length scales
		Introduction to fabrication methods,
		Preparation of nano materials
		Safety and storage issues related to nano technology
		Summary of electronic properties of atoms and solids,
		Effects of nano meter length scales
		Introduction to fabrication methods,
		Preparation of nano materials
		Safety and storage issues related to nano technology

Unit-2: Nano Structures(12 hrs)

Importance of Nano-technology, Bottom-up and Top-down approaches, Zero Dimensional Nano-structures - Nano particles through homogenous nucleation and heterogeneous nucleation; One Dimensional Nano-structures - Nano wires and Nano rods, Spontaneous growth, Evaporation and condensation growth, Two dimensional Nano-structures - Fundamentals of film growth. Physical vapour Deposition (PVD) and Chemical Vapour Deposition (CVD):

Unit No	Module	Micro content
2.	Introduction	Importance of Nano-technology
		Bottom-up and Top-down approaches
	Zero Dimensional Nano-structures	Nano particles through homogenous nucleation and heterogeneous nucleation;

	One Dimensional Nano-structures	Nano wires and nano rods, Spontaneous growth, Evaporation and condensation growth,
	Two dimensional nano-structures	Fundamentals of film growth, Physical vapour Deposition (PVD) and Chemical Vapour Deposition (CVD)

Unit-3: Carbon Nano Structures(12 hrs)

DLCs, Fullerenes, C60, C80 SWNT and MWNT; Properties: Mechanical, Optical and Electrical properties.

Thermo Electric Materials

Concept of phonon, Thermal conductivity, Specific heat, Exothermic & Endothermic processes.

Nano Semiconductors: Nano scale electronic devices including CMOS, Potentiometric sensors etc., MRAM devices

Unit No	Module	Micro content
3.	**Carbon Nano Structures**:	DLCs, Fullerenes, C_{60}, C_{80} SWNT and MWNT; Properties: Mechanical, Optical and Electrical properties.
	Thermo Electric Materials:	Concept of phonon, Thermal conductivity, Specific heat, Exothermic & Endothermic processes.
	Nano Semiconductors	Nanoscale electronic devices including CMOS, Potentiometric sensors and MRAM devices

Unit-4: Nano sensors(12 hrs)

Introduction to sensors. Characteristics and terminology - Fundamentals of sensors, Sensors for aerospace and defense. Organic and inorganic Nano sensors. Sensor for bio-medical applications, Bioelectronics, Nanoparticle-biomaterial hybrid systems for sensing applications. Gas sensor. Biosensors: Principles, DNA and nucleotide-based biosensors, Protein-based biosensors.

Unit No	Module	Micro content
4.a.	Sensors	Introduction to sensors
		Characteristics and terminology - Fundamentals of sensors, Sensors for aerospace and defense Organic and inorganic nanosensors
		Sensor for bio-medical applications, Bioelectronics, Nanoparticle-biomaterial hybrid systems for sensing applications,
	Sensors	Gas sensor
		Biosensors: Principles, DNA and nucleotide-based biosensors, Protein-based biosensors.

Unit-5: Application of Nanotechnology(12 hrs)

Consumer goods, Cosmetics, Nano catalyst, paints, food and agriculture industries, Nanotechnology for waste reduction and improved energy efficiency, nanotechnology based water treatment strategies. Nano-toxicology. Use of Nano-particles for environmental remediation and water treatment.

Unit No	Module	Micro content
5.a	Application of Nanotechnology	Consumer goods, Cosmetics, Nano catalyst, paints, food and agriculture industries,
		Nanotechnology for waste reduction and improved

		energy efficiency,
		Nanotechnology based water treatment strategies.
		Nano-toxicology
		Use of Nano-particles for environmental remediation and water treatment
		Consumer goods, Cosmetics, Nano catalyst, paints, food and agriculture industries,
5.b	Application of Nanotechnology	Nanotechnology for waste reduction and improved energy efficiency,
		Nanotechnology based water treatment strategies.
		Nano-toxicology
		Use of Nano-particles for environmental remediation and water treatment
		Nanotechnology for waste reduction and improved energy efficiency,

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Know the fundamentals, properties and fabrication methods of Nano components
CO2	Know the structures of zero, one and two dimensional Nano components
CO3	Know the structures of carbon, thermal and semiconductor materials
CO4	Have the knowledge of Nano sensors and their applications
CO5	Apply the Nano technology in different engineering and other fields.

Learning Resources

Text books:

1. Encyclopedia of Nanotechnology- Hari Singh Nalwa
2. Introduction to Nano technology by Charles P. Poole Jr and Frank J. Owens, Wiley-Inter science, 2003

Reference books

1. Springer Handbook of Nanotechnology - Bharat Bhusan
2. Handbook of Semiconductor Nanostructures and NanodevicesVol 1-5- A. A. Balandin, K. L.Wang.
3. Nanostructures and Nanomaterials - Synthesis, Properties and Applications - Cao, Guozhong.

CO-PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	3	1	3	2	3	2	1	0	0	1	0	2	3	2
CO2	3	1	3	2	3	2	1	0	0	1	0	2	3	2
CO3	3	1	3	2	3	2	1	0	0	1	0	2	3	2
CO4	3	1	3	2	3	2	1	0	0	1	0	2	3	2
CO5	3	1	3	2	3	3	3	0	0	1	0	2	3	2

III Year II Semester

L	T	P	C
2	0	0	2

DIGITAL SIGNAL PROCESSING

PRE-REQUISITES: 1) Signals & Systems
2) Mathematics,
3) Concept of Communications

Course objectives: The student should be able to

1. Analyze the Discrete Time Signals and Systems
2. Know the importance of FFT algorithm for computation of Discrete Fourier Transform
3. Learn the FIR and IIR Filter design procedures
4. Able to realize the digital filters with different structures
5. Know the need of Multirate Processing & Learn the concepts of DSP Processors

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction to Discrete Time Signals & Systems. (12 Hrs.)** Introduction to Digital Signal Processing, Discrete time Signals, Signal Processing, Discrete time Systems, Linear Shift Invariant Systems, Condition for Stability. Linear Constant Coefficient Difference Equations, Discrete Time Fourier Transformation and its Properties, Linear Convolution, Review of Z-Transforms –Solutions of Difference Equations using Z-Transforms, Stability Criteria in Z-Transform	**CO1**
II	**DFT & FFT (14 Hrs.)** DFS, Properties of DFS, DFT, Properties of DFT, DFT as Linear Transformation, Circular Convolution, Sectional Convolution-Overlap Add and Overlap Save Methods , Linear Convolution using Circular Convolution. Introduction to FFT, Efficient Computation of DFT, Radix-2 Algorithms-Decimation in Time and Decimation in Frequency Algorithms, Inverse DFT using FFT .	**CO2**
III	**Design And Realization of IIR filters (12Hrs.)** Introduction to Digital Filters, Analog Filter Approximations-Butterworth &Chebyshev, Digital IIR Filters Design from Analog filters, Analog and Digital frequency transformations. Basic structures of IIR systems, Transposed forms	**CO3**
IV	**Design And Realization of FIR filters (14 Hrs.)** Introduction to FIR Filters, Characteristics of FIR Filters, Frequency Response, Design of FIR Filters- Fourier Series Method , Frequency Sampling method and Window Method. Basic structures of FIR systems, Lattice structures, Lattice-ladder structures.	**CO4**
V	**Multirate Digital Signal Processing & Introduction to DSP processors (12 Hrs.)** Introduction, Down Sampling, Decimation, Spectrum of Down Sampling, Up Sampling, Interpolation, Spectrum of Up Sampling, Cascading Sample Rate	**CO5**

	Converters, Sampling Rate Conversion, Applications of Multirate DSP. **(6 Hrs.)** Introduction to DSP processors, Basic architecture of TMS320 6713 DSP processor, Applications of DSP processors - Detection of QRS complex of ECG signals, Generation and detection of DTMF signals, Speech compression using Linear Predictive Coding. **(6 Hrs.)**	

Content Beyond the syllabus:

Discrete Cosine Transformation: Formulas for Discrete Cosine and Inverse Discrete Cosine Transformation, Properties and Applications.

Speech Processing Technologies: How to develop speech processing algorithms

Medical Applications of Digital Signal Processing.

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Analyze** the Discrete Time Signals and Systems & Apply the difference equations concept in the analysis of Discrete time systems. **{Apply level, KL1,3}**
CO2	**Know** the importance of FFT algorithm for computation of Discrete Fourier Transform &**Use** the FFT algorithm for **solving** the DFT of a given signal**{Apply level, KL1,2}**
CO3	**Design** a Digital filter (FIR&IIR) from the given specifications **{Analyze level, KL6}**
CO4	**Realize** the digital filters. **{Evaluate level, KL5}**
CO5	**Compare** different types of Multirate Processing and **Understand**the concepts of DSP Processors. **{Apply level, KL1,4}**

Learning Resources

Text books:

1 Digital Signal Processing, Principles, Algorithms, and Applications: John G. Proakis, Dimitris
2 G.Manolakis,Pearson Education / PHI, 2007..
3 Discrete Time Signal Processing – A.V.Oppenheim and R.W. Schaffer, PHI Private Limited.
4 Digital Signal Processors – Architecture, Programming and Applications,, B.Venkataramani, M.Bhaskar, TATA McGraw Hill, 2002
5 Digital Signal Processing – K Raja Rajeswari, I.K. International Publishing House

Reference books:

1 Digital Signal Processing: Andreas Antoniou, TATA McGraw Hill , 2006.
2 Digital Signal Processing: MH Hayes, Schaum's Outlines, TATA Mc-Graw Hill, 2007..
3 Digital Signal Processing – Ramesh babu, Sci Tech publications
4 Digital Signal Processing – Alan V. Oppenheim, Ronald W. Schafer, PHI Ed., 2006

Micro-Syllabus

Introduction to Discrete Time Signals & Systems.

Introduction to Digital Signal Processing, Discrete time Signals, Signal Processing, Discrete time Systems, Linear Shift Invariant Systems, Condition for Stability. Linear Constant Coefficient Difference Equations, Discrete Time Fourier Transformation and its Properties, Linear Convolution, Review of Z-Transforms –Solutions of Difference Equations using Z-Transforms, Stability Criteria in Z-Transform.

Unit No	Module	Micro content
1. Discrete Time Signals and Systems	**Signals, System and Processing**	DSP Introduction , Difference between ASP & DSP, Block diagram of DSP, Advantages , Drawbacks and Applications
		Basic discrete time signals , classification of DT signals , Problems
		Time scaling time reversal , time shifting , addition and multiplication etc
		Classification of systems and problems related
		Solutions of Difference Equations , natural response , forced response and total response
	Transformations	Fourier transform and its inverse , properties , Frequency response
		Matrix method , table method and graph method
		Review of Z-Transforms, relation between Z and DTFT
		Solutions using Z-Transform
		Stability criteria , Poles and Zeroes

DFT & FFT

DFS, Properties of DFS, DFT, Properties of DFT, DFT as Linear Transformation, Circular Convolution, Sectional Convolution-Overlap Add and Overlap Save Methods , Linear Convolution using Circular Convolution.

Introduction to FFT, Efficient Computation of DFT, Radix-2 Algorithms- Decimation in Time and Decimation in Frequency Algorithms, Inverse DFT using FFT .

Unit No	Module	Micro content
2a. DFT	**DFS**	DFS and properties of DFS
	DFT	Introduction , Properties , relation with Z, DTFT
		DFT as Linear Transformation
	Circular Convolution	Types , Problems
	Sectional Convolution	Overlap Add and Overlap Save method
		Linear convolution using circles and matrix method
2b. FFT	**Fast Fourier Transformation**	Introduction , Diff. between DFT and FFT
		Derivation of DIT and DIF, Problems
		Inverse using Radix 2 DIT and DIF

Design And Realization of IIR filters

Introduction to Digital Filters, Analog Filter Approximations-Butterworth & Chebyshev, Digital IIR Filters Design from Analog filters, Analog and Digital frequency transformations. Basic structures of IIR systems, Transposed forms

Unit No	Module	Micro content
3a. IIR Design	**Introduction**	Comparison between analog and digital filters. Frequency response characteristics
	Analog Filter	Butterworth filter, steps to find transfer function ,

	Approximations	problems
		Chebyshev filter, steps to find transfer function , problems
	Digital IIR Filters Design	Mapping techniques , design examples of Impulse Invariant Transformation Method
		Design examples of Bilinear Transformation Method
3b. IIR Realization	**Types of Structures**	Direct form I and II realizations , Transposed forms
		Cascade and Parallel form realizations

Design And Realization of FIR filters

Introduction to FIR Filters, Characteristics of FIR Filters, Frequency Response, Design of FIR Filters- Fourier Series Method , Frequency Sampling method and Window Method. Basic structures of FIR systems, Lattice structures, Lattice-ladder structures.

Unit No	**Module**	**Micro content**
4a. FIR Design	**Introduction and Characteristics of FIR Filters**	Introduction to FIR Filters
		Characteristics of FIR Filters, Comparison of IIR & FIR filters
	Frequency Response of FIR filters	Symmetric & N Even, Symmetric & N Odd, Asymmetric& N Even, Asymmetric& N Odd
	Design of FIR Filters	Fourier Series Method
		Window Method
		Frequency Sampling method
4b. FIR Realization	**Structures**	Direct form, cascade form, Linear phase realizations
		Lattice structure
		Lattice-Ladder structure
		Comparison between DC and AC distribution systems.

Unit-5:Multirate Digital Signal Processing & Introduction to DSP processors

Introduction, Down Sampling, Decimation, Spectrum of Down Sampling, Up Sampling, Interpolation, Spectrum of Up Sampling, Cascading Sample Rate Converters, Sampling Rate Conversion, Applications of Multirate DSP.

Introduction to DSP processors, Basic architecture of TMS320 6713 DSP processor, Applications of DSP processors - Detection of QRS complex of ECG signals, Generation and detection of DTMF signals, Speech compression using Linear Predictive Coding.

Unit No	**Module**	**Micro content**
5a. Multirate Digital Signal	**Introduction**	Multirate DSP Definition and examples
	Decimation	Down sampling and Decimation
		Frequency Spectrum of Decimation

Processing	**Interpolation**	Up Sampling and Interpolation
		Spectrum of Up Sampling
	Cascading Sample Rate Converters	Cascading procedure with examples
	Sampling Rate Conversion	Sampling rate conversion procedure with block diagrams
	Applications of Multirate DSP	Advantages and Applications
5b. DSP processors	**Introduction to DSP processors**	Comparison with general purpose microprocessors and advantages
	Basic architecture of TMS320 6713 DSP processor	Basic architecture of TMS320 6713 DSP processor
	Applications of DSP processors	Applications of DSP processors, Detection of QRS complex of ECG signals, Generation and detection of DTMF signals, Speech compression using Linear Predictive Coding

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

CO1	**Analyze** the Discrete Time Signals and Systems & Apply the difference equations concept in the analysis of Discrete time systems. **{Apply level, KL1,3}**
CO2	**Know** the importance of FFT algorithm for computation of Discrete Fourier Transform &**Use** the FFT algorithm for **solving** the DFT of a given signal**{Apply level, KL1,2}**
CO3	**Design** a Digital filter (FIR&IIR) from the given specifications **{Analyze level, KL6}**
CO4	**Realize** the digital filters. **{Evaluate level, KL5}**
CO5	**Compare** different types of Multirate Processing and **Understand**the concepts of DSP Processors. **{Apply level, KL1,4}**

Text books:

1. Digital Signal Processing, Principles, Algorithms, and Applications: John G. Proakis, Dimitris G.Manolakis,Pearson Education / PHI, 2007..
2. Discrete Time Signal Processing – A.V.Oppenheim and R.W. Schaffer, PHI Private Limited.
3. Digital Signal Processors – Architecture, Programming and Applications,, B.Venkataramani, M.Bhaskar, TATA McGraw Hill, 2002
4. Digital Signal Processing – K Raja Rajeswari, I.K. International Publishing House

Reference books:

1. Digital Signal Processing: Andreas Antoniou, TATA McGraw Hill , 2006.
2. Digital Signal Processing: MH Hayes, Schaum's Outlines, TATA Mc-Graw Hill, 2007..
3. Digital Signal Processing – Ramesh babu, Sci Tech publications
4. Digital Signal Processing – Alan V. Oppenheim, Ronald W. Schafer, PHI Ed., 2006

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		1				1						1	
CO3	3		2				1							
CO4	3		2				1							1
CO5	3		1				1							1

III Year II Semester

L	T	P	C
3	0	0	3

MANAGERIAL ECONOMIC AND FINANCIAL ANALYSIS

PRE-REQUISITES: 1) Basic Sciences and Humanities
Course objectives: The student should be able to

1. To equip the students with the basic inputs of managerial economics and demand concepts.
2. To understand the concepts of production and cost for various business decision.
3. To understand the different types of market, market structures & pricing strategies and their applications in business decision making and to know the different forms of Business organization and the concept of Business Cycles.
4. To understand the fundamental of accounting and analysis of accounting statements for managerial decision making.
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 Managerial Economics and demand Analysis: 10 Hrs** Definition of Managerial Economics –Scope of Managerial Economics and its relationship with other subjects –Concept of Demand, Types of Demand, Determinants of Demand- Demand schedule, Demand curve, Law of Demand and its limitations- Elasticity of Demand, Types of Elasticity of Demand and Measurement- Demand forecasting and Methods of forecasting.	**CO1**
II	**Theory of Production and Cost Analysis: 13 Hrs** Production Function – Isoquant and Isocost, MRTS, Least Cost Combination of Inputs - Laws of Returns to scale - Internal and External Economies of Scale, Cost Analysis: Cost concepts, Cost & output relationship in short run & long run - Break-even Analysis (BEA)-Determination of Break-Even Point - Significance and limitations.	**CO2**
III	**Introduction to Markets, Pricing Policies & Types of Business Organization and Business Cycles: 12 Hrs** Market Structures: Perfect Competition, Monopoly, Monopolistic competition and Oligopoly – Features – Price and Output Determination – Methods of Pricing: Average cost pricing, Limit Pricing, Market Skimming Pricing, and Internet Pricing: Flat Rate Pricing, Usage sensitive pricing and Priority Pricing. Features and Evaluation of Sole Trader, Partnership, Joint Stock Company – Business Cycles: Phases of Business Cycles.	**CO3**
IV	**Introduction to Financial Accounting & Analysis: 13 Hrs** **Financial Accounting and analysis:** Accounting –significance -- Book Keeping-Double entry system –Journal- Ledger- Trial Balance- Final Accounts with simple adjustments. **Financial Statement Analysis through ratios:** Ratio-analysis of financial statement using different ratios (Liquidity -Profitability- Solvency -Activity	**CO4**

	ratios).	
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: Economics, Micro Economics, Macro Economics, Scope of Micro& Macro Economics, Concept of supply**.**
Theory of Production and Cost Analysis: Production Process, Types of production.
Types of Business organization: State & Public Enterprises.

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	To equipped with the knowledge of estimating the Demand and demand elasticities for a product.
CO2	The knowledge of understanding of the Input-Output-Cost relationships and estimation of the least cost combination of inputs
CO3	To understand the nature of different markets and Price Output determination under various market conditions and also to have the knowledge of different Business Units.
CO4	To prepare Financial Statements and the usage of various Accounting tools for analysis
CO5	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 2011.
2. Dr. N. Appa Rao, Dr. P. Vijay Kumar: ‘Managerial Economics and Financial Analysis’, Cengage Publications, New Delhi – 2011.
3. Prof. J.V. Prabhakara rao, Prof. P. Venkatarao. ‘Managerial Economics and Financial Analysis’, Ravindra Publication.

Reference books:

1. V. Maheswari : Managerial Economics, Sultan Chand.
2. Suma Damodaran : Managerial Economics, Oxford 2011.
3. Dr. B. Kuberudu and Dr. T. V. Ramana : Managerial Economics & Financial Analysis, Himalaya Publishing House 2011.
4. Vanitha Agarwal : Managerial Economics, Pearson Publications 2011.
5. Sanjay Dhameja : Financial Accounting for Managers, Pearson.
6. Maheswari: Financial Accounting, Vikas Publications.
7. S. A. Siddiqui & A. S. Siddiqui: Managerial Economics and Financial Analysis, New Age International Publishers, 2012.

e- Resources & other digital material

1. **www.managementstudyguide.com**
2. **www.tutorialspoint.com**
3. **www.lecturenotes.in**

Micro-Syllabus

UNIT – I Introduction to Managerial Economics and demand Analysis:
Definition of Managerial Economics –Scope of Managerial Economics and its relationship with other subjects –Concept of Demand, Types of Demand, Determinants of Demand- Demand schedule, Demand curve, Law of Demand and its limitations- Elasticity of Demand, Types of Elasticity of Demand and Measurement- Demand forecasting and Methods of forecasting.

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
	Concept of Managerial economics	Nature & scope of Managerial Economics
		Importance of Managerial Economics
		Difference between Economics & Managerial Economics
	relationship with other subjects	Linkage with other Disciplines
	Basic Economic tools of Managerial economics	Opportunity cost Principle, Incremental principle, Time perspective principle, Discounting Principle, Eqi marginal Principle
	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
	Demand fore casting	types of demand forecasting

UNIT - II Theory of Production and Cost Analysis:
Production Function – Isoquant and Isocost, MRTS, Least Cost Combination of Inputs - Laws of Returns to scale - Internal and External Economies of Scale, Cost Analysis: Cost concepts, Cost & output relationship in short run & long run - Break-even Analysis (BEA)-Determination of Break-Even Point - Significance and limitations.

Unit	Module	Micro Content
Unit II	Theory of Production	Production function, Production process, importance of production, assumptions
	Isoquant and Isocost	Meaning and Types, properties
	MRTS, Least Cost Combination of Inputs	Schedule of Marginal rate of technical substitution, combination of different inputs
	Laws of Returns to scale	Schedule and graph

	Economies of scale	Internal and external
	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 – III Introduction to Markets, Pricing Policies & Types of Business Organization and Business Cycles:
Market Structures: Perfect Competition, Monopoly, Monopolistic competition and Oligopoly – Features – Price and Output Determination – Methods of Pricing: Average cost pricing, Limit Pricing, Market Skimming Pricing, and Internet Pricing: Flat Rate Pricing, Usage sensitive pricing and Priority Pricing. Features and Evaluation of Sole Trader, Partnership, Joint Stock Company – Business Cycles: Phases of Business Cycles.

Unit III	Market Structures	Meaning, definitions, types of market
	Perfect Competition	Features, price output determination under perfect competition
	Monopoly	Features, price output determination under perfect competition
	Monopolistic competition	Features, price output determination under perfect competition
	Oligopoly	features
	pricing	Methods of pricing and internet pricing
	Type of business organization: Sole trader	Features, Advantages & disadvantages, suitability
	Partnership	Features, Advantages & disadvantages, suitability
	Joint stock company	Features, Advantages & disadvantages, suitability
	Business cycle	Phases of business cycle

UNIT – IV Introduction to Financial Accounting & Analysis:
Financial Accounting and analysis: Accounting –significance -- Book Keeping-Double entry system –Journal- Ledger- Trial Balance- Final Accounts with simple adjustments.
Financial Statement Analysis through ratios: Ratio-analysis of financial statement using different ratios (Liquidity -Profitability- Solvency -Activity ratios).

Unit IV	Financial Accounting	Meaning, definitions, objectives & significance, users of accounting, accounting cycle, GAAP.
	Book Keeping	Single and double entry book keeping, types of Accounting
	Journal	Features, Pro-forma, Advantages & Limitations, preparation of journal entries, simple problems
	ledger	Features, Pro-forma, Advantages & Limitations, preparation of ledger, simple problems.
	Trial Balance	Features, Pro-forma, Advantages & Limitations, preparation of Trial balance, simple problems.

	Final accounts	Trading account- Pro-forma, Simple problems
		Profit & Loss account- Pro-forma, Simple problems
		Preparation of balance sheet with simple adjustments
	Financial Statement Analysis through ratios	Ratio Analysis, uses and types of ratios, significance, analysis of financial statements using Liquidity -Profitability- Solvency -Activity ratios

UNIT - V Capital and Capital Budgeting:
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

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

CO1	To equipped with the knowledge of estimating the Demand and demand elasticities for a product.
CO2	The knowledge of understanding of the Input-Output-Cost relationships and estimation of the least cost combination of inputs
CO3	To understand the nature of different markets and Price Output determination under various market conditions and also to have the knowledge of different Business Units.
CO4	To prepare Financial Statements and the usage of various Accounting tools for analysis
CO5	To evaluate various investment project proposals with the help of capital budgeting techniques for decision making.

Text books:

1. Dr. A. R. Aryasri – Managerial Economics and Financial Analysis, TMH 2011.
2. Dr. N. Appa Rao, Dr. P. Vijay Kumar: ‘Managerial Economics and Financial Analysis’, Cengage Publications, New Delhi – 2011.
3. Prof. J.V. Prabhakara rao, Prof. P. Venkatarao. ‘Managerial Economics and Financial Analysis’, Ravindra Publication.

Reference books:
1. V. Maheswari : Managerial Economics, Sultan Chand. 2. Suma Damodaran : Managerial Economics, Oxford 2011. 3. Dr. B. Kuberudu and Dr. T. V. Ramana : Managerial Economics & Financial Analysis, Himalaya Publishing House 2011. 4. Vanitha Agarwal : Managerial Economics, Pearson Publications 2011. 5. Sanjay Dhameja : Financial Accounting for Managers, Pearson. 6. Maheswari: Financial Accounting, Vikas Publications. 7. S. A. Siddiqui & A. S. Siddiqui: Managerial Economics and Financial Analysis, New Age International Publishers, 2012.

CO-PO mapping

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations **(High: 3, Medium: 2, Low: 1)**												
	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	-	-	-
CO 2	-	-	-	-	-	1	-	2	1	2	2	2
CO 3	-	-	-	-	-	1	-	-	1	-	-	-
CO 4	-	-	-	-	-	1	-	2	1	2	2	-
CO 5	-	-	-	-	-	1	-	2	1	2	3	3

III Year II Semester

L	**T**	**P**	**C**
0	0	3	1.5

MICROPROCESSORS AND MICROCONTROLLERS LAB

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 8051 microcontroller.
3. To interface 8255 and 8279 using 8086Objective.

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

1. ARITHMETIC OPERATIONS
    a. Multi byte addition and subtraction, multiplication and division
    b. ASCII – addition and subtraction, multiplication and division.
2. LOGIC OPERATIONS
    a. Packed BCD to Unpacked BCD
    b. BCD to ASCII
    c. Find the number of elements in the array having “1” in their 5th position.
3. STRING OPERATIONS
    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. PORT OPERATIONS
    a. Read data from port 1 and increment it by 1 and transfer it to port 2.
    b. Transfer 1 to 10 continuously port 1.
5. TIMER IN DIFFERENT MODES USING 8051
    a. Produce 1khz square wave with 50% duty cycle using timer 0 in mode 0.
    b. Produce 1khz square wave with 50% duty cycle using timer 0 in mode 1
    c. Produce 1khz triangular wave with 50% duty cycle using timer 0 in mode 1
6. SERIAL DATA COMMUNICATION
    a. Receive data serially.
    b. Transfer “HELLO” serially at 9600 band, 8 bit data and 1 stop bit.
7. Addition & Subtraction using 8086 Kit
8. Interfacing 8279 – Keyboard Display.
9. Interfacing 8255–PPI
10. Stepper motor control using 8253/8255

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 using 8255.

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									

Note: Strength of correlations is High: 3, Medium: 2, Low: 1

III Year II Semester

L	**T**	**P**	**C**
0	0	3	1.5

ELECTRICAL MEASUREMENTS &INSTRUMENTATION LAB

Pre-Requisites: 1) Basic Circuit Analysis

Course objectives:

1. To know various methods to calibrate the instruments
2. To know various methods for measurments of electrical parametes
3. To select the suitable instrurments for measurements

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

1. Calibration of Electrodynamometer wattmeter UPF by phontom loading
2. Calibration of Electrodynamometer wattmeter LPF by direcet loading
3. Calibration of 3-Ph two element Electrodynamometer wattmeter UPF by direct loading
4. Calibration of electrodynamometer type Power factor meter
5. Calibration of 1-Ph induction type energy meter by direct loading
6. Measurement of Inductance by Andersons bridge
7. Measurement of capacitance by Schering bridge
8. Measurement of voltage by DC Cromptons potentiometer
9. Measurement of 3-Ph reactive power using single phase wattmeter for balanced load
10. Measurement of strain using resistance strain gauge
11. Characteristics of LVDT.
12. Dielectric oil testing using H.T test kit.

1.

List of Additional Experiments: Any 2 of the following experiments are to be conducted

1. Measurement of 1-phase power using 3-voltmeter and 3-ammeter method.
2. Estimation of iron losses from B-H curve using CRO.
3. Dielectric oil testing using H.T test kit.
4. Determination of transformer ration and phase angle error using current transformer.

Course Outcomes:

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

CO1	Calibrate various electrical measuring instruments{Analyzing level, KL4}
CO2	Measure various electrical parameters{Apply level, KL3}
CO3	Choose suitable instrument for given measurement{Evaluating level, KL5}

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.
e- Resources & other digital material

1.	https://sl-coep.vlabs.ac.in/LinearVariableDifferntialTransformer/Theory.html?domain=Electrical%20Engineering&lab=Welcome%20to%20Sensor%20Lab!
2.	http://vlabs.iitkgp.ernet.in/asnm/exp23/index.html
3.	http://vlabs.iitkgp.ernet.in/asnm/exp21/index.html

CO-PO mapping

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

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IV Year I Semester

L	T	P	C
3	0	0	3

Management Science

Prerequisites: Basic Sciences and Humanities

Course Objective:

1. To familiarize with the process of management, principles, and basic concepts of Organization.
2. To understand the tools of operations and Materials Management.
3. To provide conceptual knowledge on functional management like Human resource management and Marketing management.
4. To impart knowledge on project management.
5. To provide basic insight into selected contemporary management practices and Strategic Management.

Course Outcomes:

After completion the Course, Student will be able to:

CO 1: Apply management and motivation theories to renovate the practice of management.

CO 2: Explain concepts of quality management and use process control charts, concepts and tools of quality engineering in the design of products and process controls.

CO 3: Appraise the functional management challenges associated with high levels of change in the organizations.

CO 4: Identify activities with their interdependency and use scheduling techniques of project management PERT/CPM.

CO 5: Develop global vision and management skills both at strategic level and interpersonal level.

UNIT – I Introduction to Management: **12 Hrs**

Concept –nature and importance of Management –Generic Functions of Management – Principles and Types of Management –Evolution of Management thought- Theories of Motivation – Decision making process-Designing organization structure- Principles of organization – Organizational typology.

UNIT - II Operations Management: **12 Hrs**

Work study- Statistical Quality Control- Control charts (P-chart, R-chart, and C-chart) Simple problems- Material Management: Need for Inventory control- EOQ, ABC analysis (simple problems) and Types of ABC analysis (HML, SDE, VED, and FSN analysis), Justin- Time (JIT) system, Total Quality Management (TQM), Six sigma, Supply chain management.

UNIT – III Functional Management: **12 Hrs**

Concept of HRM, HRD and ER (Employee Relations) - Functions of HR Manager- Compensation Management plans – Job Evaluation and Merit Rating - Marketing Management: Functions of Marketing – Marketing strategies based on product Life Cycle, Channels of distributions.

UNIT – IV Project Management: **12 Hrs**

(PERT/CPM): Development of Network – Difference between PERT and CPM Identifying Critical Path- Probability- Project Crashing (Simple Problems).

UNIT - V Strategic Management: **12 Hrs**

Vision, Mission, Goals, Strategy – Elements of Corporate Planning Process – Environmental Scanning – SWOT analysis- Steps in Strategy Formulation and Implementation, Generic Strategy Alternatives, Basic concepts of MIS, ERP, Capability Maturity Model(CMM) Levels, Balanced Score Card.

Text Books:

1. Management Science, Aryasri, Tata McGraw Hill, 2014.
2. Dr. P. Vijaya Kumar & Dr. N. Appa Rao, 'Introduction to *Management Science'* Cengage, Delhi, 2012.
3. G Srinivasa Rao: 'Management Science', The Hi-Tech Publishers, 2004.

Reference Books:

1. 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.
2. Human Resource Management: Gary Dessler, 14th Edition, pearson 2015.
3. Production and Operations Management: S N Chary, TMH, 2019, 6e.
4. Project Planning and Control with PERT and CPM: Dr. B. C. Punmia, K. K Khandelwal, Laxmi Publication, 2017, 4th Edition.
5. Strategic Management: John A Pearce, Richard B Robinson, TMH 12th Edition, 2017.

Web links:

4. www.managementstudyguide.com
5. www.tutorialspoint.com
6. www.lecturenotes.in

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Micro Syllabus for Management Science

UNIT – I Introduction to Management:

Concept –nature and importance of Management –Generic Functions of Management – Principles and Types of Management -Evolution of Management thought- Theories of Motivation – Decision making process-Designing organization structure- Principles of organization – Organizational typology.

Unit	Module	Micro Content
Unit I	Introduction	What is Management
		Process of Management
		Nature and Characteristics of Management
		Importance of Management
	Generic Functions of Management	Five functions of Management
		Planning, Organizing, staffing, Directing, Controlling
		Principles of Management
		Types of Management
	Evolution of Management thought	1. Management awakening period
		2. Scientific management period
		3. The human relations period (also called behavioural science period)
		4. Modern management period
	Theories of Motivation	What is Motivation
		Importance of Motivation

		Nature of Motivation
		Types of Motivation 1. Maslow's hierarchy of needs 2. Herzberg's Two factor Theory 3. Mc Gregor's Theory X and Theory Y 4. Vroom's Theory of Expectancy
	Decision making process	What is Decision making
		Steps in Decision Making Process
	organization structure	What is Organization
		Features of Organization
		What is Organization Chart
		Principles of Organization
	Organizational typology	1. Line organisation 2. Functional organisation 3. Line and staff organisation 4. Committee organisation 5. Matrix organisation 6. Virtual organisation 7. Cellular organisation 8. Team structure 9. Boundary less organisation 10. Inverted pyramid structure

UNIT - II Operations Management:
Work study- Statistical Quality Control- Control charts (P-chart, R-chart, and C-chart) Simple problems- Material Management: Need for Inventory control- EOQ, ABC analysis (simple problems) and Types of ABC analysis (HML, SDE, VED, and FSN analysis), Justin- Time (JIT) system, Total Quality Management (TQM), Six sigma, Supply chain management.

Unit II	Introduction	What is Operations Management
		Nature and Importance of Operations Management
		Scope of Operations Management
	Work Study	Need for Study
		Objectives of work study
		Advantages and tools of work study
		Importance of work study
		Work study Procedure
	Statistical Quality Control	Quality Control, objectives of Quality control
		Steps in Quality control
		Techniques of SQC
		Product Control: Single Sampling, Double Sampling, Multiple Sampling
		Process Control: Control Charts, Advantages of control charts
		Types of control charts
		Variables: Mean ($\bar{x}$-Chart), Range chart (R-Chart) with standard deviation and without standard deviation simple problems
		Attributes: P-Chart, nP-Chart, C-Chart, simple problems

		Benefits of Statistical quality control
		Application of control charts
	Material Management	What is Materials Management
		Objectives of Material Management
		Functions of Materials Management
		Advantages of Materials Management
	Inventory Control	What is Inventory, Classification of Inventories, what is inventory control, need for inventory control, objectives, functions, advantages, Techniques of inventory control
	EOQ	What is EOQ, Simple Problems
	ABC Analysis	Types of ABC Analysis, HML, SDE, VED, and FSN analysis
	Contemporary Management Practices	Justin- Time (JIT) system, Total Quality Management (TQM), Six sigma, Supply chain management.
UNIT – III Functional Management: Concept of HRM, HRD and ER (Employee Relations) - Functions of HR Manager- Wage payment plans – Job Evaluation and Merit Rating - Marketing Management: Functions of Marketing – Marketing strategies based on product Life Cycle, Channels of distributions.		
Unit III	Concept of HRM, HRD and PMIR	What is HRM, Need, Objectives of HRM
		What is HRD
		What is IR/ER, Difference among HRM, HRD and IR/ER
	Functions HRM	Managerial Functions
		Operative Functions
		Procurement: Job Analysis, HRP, Recruitment, Selection, Placement, Induction, transfer, Promotion, Separation
		Development: Performance appraisal, Training and development, Career Planning and development
		Compensation: Job Evaluation, Wage and Salary Administration, Bonus and Incentives, Payroll
		Integration: Motivation, Job satisfaction, Grievance Redressel, collective bargaining, conflict management, employee participation, discipline
		Maintenance: Health and safety, HR audit, HRIS
	Job Evaluation	What is Job evaluation, Types
	Merit rating	What is Merit rating, Types, Difference Between Job evaluation and Merit Rating
	Compensation Management Plans	Types of Wage Payment Plans
	Marketing Management	What is Marketing Management, functions of Marketing Management
		Product Life Cycle
	Marketing strategies based on product Life Cycle	Introduction, Growth, Maturity, Decline
	Channels of Distribution	Features, Types of channels of distribution

UNIT – IV Project Management:
(PERT/CPM): Development of Network – Difference between PERT and CPM Identifying Critical Path- Probability- Project Crashing (Simple Problems).

Unit IV	Project Management	Introduction, what is Net work diagram: features, advantages, limitations, objectives, applications of network analysis
	Terminology in network analysis	Activity, Event: Burst event - Merge event - dual event, dummy activity,
		Rules for drawing network diagram, rules for numbering
	PERT	What is a PERT, feature, advantages, steps in use of PERT, Terminology used in PERT, EST, EFT, LST, LFT, Probability, Slack and floats, problems.
	CPM	What is CPM, Features, objectives, advantages, limitations, steps in use of CPM, difference between PERT & CPM, problems.
	Project analysis & crashing	Project cost analysis, direct cost, indirect cost, total cost,
		Project crashing, terms in crashing, cost slope, crashing procedure.
		Simple Problems

UNIT - V Strategic Management:
Vision, Mission, Goals, Strategy – Elements of Corporate Planning Process – Environmental Scanning – SWOT analysis- Steps in Strategy Formulation and Implementation, Generic Strategy Alternatives, Basic concepts of MIS, ERP, Capability Maturity Model(CMM) Levels, Balanced Score Card.

Unit V	Strategic Management	Introduction, features
		significance, advantages
	Corporate Planning	Features, objectives
		Corporate planning procedure, elements, vision
		Mission, goal, strategy
	Environmental scanning	Internal environment and external environment
	Strategy formulation and implementation	Steps
	Strategy alternatives	Types
	SWOT analysis	Types
	Contemporary Management Practices	Basic concepts of MIS, ERP, Capability Maturity Model(CMM) Levels, Balanced Score Card.

Co- Po mapping

	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		3	3	3		2
CO 2						1		3	3	3	3	2
CO 3						1		3	3	3	3	2
CO 4						1		3	3	3	3	2
CO 5						1		3	3	3		2

IV Year I Semester

L	T	P	C
3	0	0	3

Switchgear and Protection

PRE-REQUISITES: 1) Power Systems

Course objectives: The student should be able to

1. Study the basic aspects of protection system and operation of circuit breakers.
2. Study the classification, operation and application of different types ofelectromagnetic protective relays.
3. Learn about the various protection schemes generators and transformers.
4. Know the various protection schemes applied for transmission lines and neutral grounding
5. Study the reasons for Over voltages, protection schemes and latest trends in Protection schemes

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction to Power system protection(12 hrs)** **Power system protection:**Faults in power system, characteristics of short circuit and open circuit faults and harmful effects, necessity of protection system, basic requirements, classification, protection system terminology. **(02 hrs)** **Fuse:** Introduction to fuse, fuse materials, characteristics of fuse and ratings; HRC fuse**(02 hrs)** **Circuit Breakers:** Elementary principles of arc phenomenon -Principle of operation of air, oil, vacuum and SF6 circuit breakers (Elementary treatment only) - Specification of circuit breakers, ratings and auto re-closures**. (08 hrs)**	**CO1**
II	**Fundamentals of Protectiverelays(12 hrs)** Protective Relays:**Relay connection – Principle of operation Balanced beam type attracted armature relay - induction disc andinduction cup relays–Torque equation –PSM, TSM - Relays classification–Instantaneous– DMT andIDMT types (06 hrs)** Applications of relays**:Over current and under voltage relays– Directionalrelays– Differential relays and percentage differential relays– Universal torque equation– Distance relays**: **Impedance– Reactance– Mho and offset mho relays– Characteristics ofdistance relays and comparison** **(06 hrs)**	**CO2**
III	**Protection of AC generators and Transformer(12 hrs)** **Protection of AC generators**: **Protection of generators against stator faults– Rotor faults and abnormal conditions–restricted earth fault and inter turn fault protection– Numerical example**. **(07 hrs)** Protection of transformers: **Percentage differential protection– Design of CT's ratio– Buchholz relay protection–Numerical examples**. **(05 hrs)**	**CO3**
IV	**Protection of Transmission lines and Neutral grounding(12 hrs)** Protection of lines: **Over current Protection schemes - Numerical examples –** Pilot	**CO4**

	wire protection - **Carrier current and three zone distance relay using impedance relays–Protection of bus barsby using Differential protection**.**(08 hrs)** **Neutral grounding:** Grounded and ungrounded neutral systems–Effects of ungrounded neutral on system performance– Methods of neutral grounding: Solid–resistance–Reactance–Arcing grounds and grounding Practices **(04 hrs)**	
V	**Protection against Over voltages and Advancements in Protection systems (12 hrs)** Over Voltage Protection**: Causes of over voltages in power systems – internal causes - Protection against lightning over voltages: Rod gap and horn gap arrester–Valve type and expulsion type lighting arresters and ground wires (elementary treatment only) – Selection of lightning arresters - Insulation coordination (10 hrs)** **Advancements in Protection systems:** Advancements in protective relays: Static relays, digital relays block diagram - Preliminaries of Synchro Phasor, Phasor measuring units, Wide Area Monitoring **(02 hrs)**	**CO5**
Content Beyond the syllabus: **Advancements in Circuit breakers:**MCB, MCCB, RCCB, ELCB. (Elementary treatment only) **Advancements in relays:** Static, Microprocessor based relays, Numerical relays and applications.(Elementary treatment only) **Recent trends in Protection systems:** AI applications in Power System Protection (Elementary treatment only).		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Acquire** the knowledge of protection systems and operation of circuit breakers **{Understand level, KL2}**
CO2	**Describe** the operating principles of various types of relays.**{ Understand level, KL2}**
CO3	**Select** appropriate protection scheme for AC generator and transformer **{Apply level, KL3}**
CO4	**Choose** appropriate protection scheme for transmission lines and **know** about different neutral grounding techniques**{ Apply level, KL3}**
CO5	**Understand** the reasons behind over voltages and operation of lightning arrester along with latest trends in protection system**{ Understand level, KL2}**

Learning Resources
Text books:
7. A text book on Power System Engineering by M.L. Soni, P.V.Gupta, U.S. Bhatnagar and A. Chakrabarti, DhanpatRai& Co Pvt. Ltd. 8. Electrical power systems by C.L.Wadhwa, New Age International (P) Ltd, Publishers, 1998.
Reference books:
8. Fundamentals of Power System Protection by Paithankar Y.G and Bhide S.R. PHI, 2007 9. Switchgear and protection by Sunil S. Rao Khanna Publications. 10. Switchgear and Protection by J.B.Gupta, S.K.Kataria and sons .Publications, 2nd edition, 2004 11. Power System Protection and Switchgear by B.Ram and D.N.Viswakarma, Tata McGraw Hill, 2ndEdition, 2011 12. A. G. Phadke and J. S. Thorp, “Computer Relaying for Power Systems”, John Wiley &Sons, 1988

e- Resources & other digital material	
11.	https://nptel.ac.in/courses/108101039
12.	https://nptel.ac.in/courses/108105167
13.	https://nptel.ac.in/courses/108107167
14.	https://nptel.ac.in/courses/117107148
15.	https://www.youtube.com/playlist?list=PLBVJZMfxcrJn3p03lxsOP_ivHXzFLysYE

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Micro-Syllabus- Switchgear and Protection

Unit – 1: Introduction to Power system protection (12 hrs)

Power system protection: Faults in power system, characteristics of short circuit and open circuit faults and harmful effects, necessity of protection system, basic requirements, classification, protection system terminology. **(02 hrs)**

Fuse: Introduction to fuse, fuse materials, characteristics of fuse and ratings; HRC fuse **(02 hrs)**

Circuit Breakers: Elementary principles of arc phenomenon -Principle of operation of air, oil, vacuum and SF6 circuit breakers (Elementary treatment only) - Specification of circuit breakers, ratings and auto re-closures**. (08 hrs)**

Unit No	Module	Micro content
1 Introduction to Power system protection	**Power system protection**	Faults and abnormal conditions
		Classification and characteristics of faults: Short circuit fault and Open circuit fault
		Harmful effects of faults, necessity of protection system
		Basic requirements of relays: Selectivity, speed, sensitivity, reliability, simplicity and economy
		Classification of relaying equipment
		protection system terminology: Definitions of Relay, pickup level, reset level, operating time, reset time, primary and secondary relays, auxiliary relays, Reach, Under reach, over reach, maximum torque angle
	Fuse	Fuse and its desirable characteristics, fuse element materials
		Terms related to fuse: Current rating, fusing current, fusing factor, prospective current, cut off current, pre arcing time, arcing time, operating time, breaking capacity
		HRC fuse construction, operation and its applications
	Circuit Breakers	Circuit Breaker operation
		Arc Phenomenon, principles of arc extinction
		Methods of arc extinction: High Resistance method and Current zero method
		Arc voltage, Re-striking Voltage, Recovery Voltage, RRRV and numerical problems
		Current Chopping and Resistance Switching
		Principle of operation of Air, Oil, Vacuum and SF6 gas circuit breaker and applications (elementary treatment only)

		Circuit breaker ratings: Breaking capacity, Making capacity, Short time rating.

Unit-2: Fundamentals of Protective relays (12 hrs)
Protective Relays: **Relay connection – Principle of operation Balanced beam type attracted armature relay - induction disc andinduction cup relays–Torque equation –PSM, TSM - Relays classification–Instantaneous– DMT andIDMT types(06 hrs)**
Applications of relays**:Over current and under voltage relays– Directionalrelays– Differential relays– Universal torque equation–Distance relays**: **Impedance– Reactance– Mho and offset mho relays– Characteristics ofdistance relays and comparison(06 hrs)**

Unit No	Module	Micro content
2 Fundamentals of Protective relays	**Protective relays**	Basic relays: Electromagnetic attraction and Electromagnetic induction
		Electromagnetic attraction relays: Attracted armature type, solenoid type, balanced beam type
		Electromagnetic induction relays: Shaded pole structure, Watt-hour meter structure and induction cup structure
		Relay classification based on time of operation: Instantaneous OC relay, DMT OC relay, IDMT OC relay
		Pickup current, Current setting, Plug setting multiplier (PSM) and Time setting multiplier (TSM)
	Applications of relays	Functional relay types: Induction type OC relay – directional and non-direction relay
		Induction type directional power relay
		Differential relays: Current differential and Voltage balance differential relay
		Distance relay
		Universal torque equation of relay
		Realization of impedance, reactance and mho relay from universal torque equation
		Characteristics of impedance, reactance and mho relay on R-X diagram and applications to various faults

Unit-3:**Protection of AC generators and Transformer (12 hrs)**
Protection of AC generators: **Protection of generators against stator faults– Rotor faults and abnormal conditions–restricted earth fault and inter turn fault protection– Numerical example**. **(07 hrs)**
Protection of transformers: **Percentage differential protection– Design of CT's ratio–Buchholz relay protection–Numerical examples(05 hrs)**

Unit No	Module	Micro content
3. Protection of AC generators and Transformer	**Protection of AC generators**	Various types of faults occurs on the generator: Stator faults, Rotor faults and abnormal conditions
		Rotor earth fault protection
		Protection from unbalanced loading
		Overload protection
		Over voltage protection

		Failure of prime mover protection
		Loss of excitation protection
		Stator protection: by Differential protection, biased differential protection
		Inter turn fault protection
		Restricted earth fault protection
		Numerical problems on protected winding of stator
	Protection of Transformer	Transformer Differential protection
		Combined leakage and over load protection
		Harmonic restraint relay
		Restricted earth fault protection
		Buchholz relay
		Numerical problems on design of CT ratio for differential protection scheme
Unit-4:Protection of Transmission lines and Neutral grounding (12 hrs) Protection of lines: **Over current Protection schemes - Numerical examples –** Pilot wire protection - **Carrier current and three zone distance relay using impedance relays–Protection of bus barsby using Differential protection**.**(08 hrs)** **Neutral grounding:** Grounded and ungrounded neutral systems–Effects of ungrounded neutral on system performance– Methods of neutral grounding: Solid–resistance–Reactance–Arcing grounds and grounding Practices **(04 hrs)**		
Unit No	**Module**	**Micro content**
4. Protection of Transmission lines and Neutral grounding	Protection of Transmission lines	Protection of bus bars: differential protection and fault bus protection
		Protection of feeders: Time graded protection, Current graded protection, pilot wire scheme
		Protection of parallel feeders
		3-zone protection scheme for transmission lines
		Carrier current protection scheme for transmission lines
	Neutral grounding	Effectively grounded systems and ungrounded system
		Resonant grounding: Peterson coil
		Methods of neural grounding: solid grounding
		Resistance and reactance grounding-Peterson coil-Numerical problems
		Voltage transformer and zig zag transformer grounding
Unit-5: Protection against Over voltages and Advancements in Protection systems (12 hrs) Over Voltage Protection**: Causes of over voltages in power systems – internal causes - Protection against lightning over voltages: Rod gap and horn gap arrester–Valve type and expulsion type lighting arresters and ground wires (elementary treatment only) – Selection of lightning arresters - Insulation coordination (10 hrs)** **Advancements in Protection systems:** Advancements in protective relays: Static relays, digital relays - Preliminaries of Synchro Phasor, Phasor measuring units, Wide Area Monitoring **(02 hrs)**		
Unit No	**Module**	**Micro content**

5. Protection against Over voltages and Advancements in Protection systems	Over Voltage Protection	Causes of over voltages in power system
		Internal causes and external causes of over voltage
		Protection against lightning over voltages: ground wires
		Lightning arresters: Rod gap, Horn gap arrester
		Expulsion type and valve type arrester
		Selection of rating of lightning arrester
		Insulation coordination
	Advancements in Protection systems	Developments in relays: electromechanical, static, microprocessor based, Numerical relays
		Static and digital relay: Block diagram approach (Over current relay only)
		Advantages and disadvantages above relays
		Preliminaries of Synchro phasor, Phasor Measuring Unit (PMU)
		Wide Area Monitoring Systems

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	3	3	1											
CO4	3	3	1											
CO5	2		1									1	1	

IV Year I Semester

L	T	P	C
3	0	0	3

FACTS

PRE-REQUISITES: 1) Power Electronics and Power Systems

Course Objectives: The student should be able to

1. Study the basics of power flow control in transmission lines using FACTS controllers
2. Explain operation and control of voltage source and current source converter.
3. Understand Shunt compensation methods to improve stability and reduce power oscillations of a power system.
4. Know the methods of compensation using Series compensators.
5. Study the operation and control of Unified Power Flow Controller (UPFC) and Interline Power Flow Controller (IPFC).

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction to FACTS and High Power Electronic Devices(12 hrs)** **Introduction to FACTS (08 hrs)** Power flow in an AC System – Loading capability limits – Dynamic stability considerations – Importance of controllable parameters – Basic types of FACTS controllers – Benefits from FACTS controllers. **Introduction to High Power Electronic Devices(04 hrs)** Requirements and characteristics of high power devices – Voltage and current rating – Losses and speed of switching – Parameter trade–off devices.	**CO1**
II	**Voltage source and Current source converters (12 hrs)** **Voltage source converters:** Concept of voltage source converter (VSC) – Single phase bridge converter – Square wave voltage harmonics for a single–phase bridge converter – Three–phase full wave bridge converter. **(09 hrs)** **Current source converters**– Concept of current source converter(CSC) -Comparison of current source converter with voltage source converter. **(03 hrs)**	**CO2**
III	**Shunt Compensators (14 hrs)** **Shunt Compensators–1 (07 hrs)** Objectives of shunt compensation – Mid–point voltage regulation for line segmentation – End of line voltage support to prevent voltage instability – improvement of transient stability – Power oscillation damping. **Shunt Compensators–2 (07 hrs)** Thyristor Switched Capacitor (TSC) – Thyristor Switched Reactor (TSC–TCR) - Static VAR compensator (SVC) and Static Compensator (STATCOM)- comparisons between SVC and STATCOM.	**CO3**
IV	**Series Compensators (12 hrs)** Static series compensators**:** Concept of series capacitive compensation – Improvement of transient stability – Power oscillation damping – Functional requirements. GTO thyristor controlled Series Capacitor (GSC) – Thyristor Switched Series Capacitor (TSSC), Thyristor Controlled Series Capacitor (TCSC) and Static Synchronous Series Compensator (SSSC)	**CO4**
V	**Combined Controllers (10 hrs)** Schematic and basic operating principles of Unified Power Flow Controller (UPFC) and Interline Power Flow Controller(IPFC),real time applications of these controllers on transmission lines.	**CO5**

Content Beyond the syllabus:
Shunt compensators: Operating point control and summary of compensation control.
Combined Controllers : Conventional transmission control capabilities,Mathematical modelling of UPFC and IPFC

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the power flow control in transmission lines using FACTS controllers. **{Understand level, KL2}**
CO2	**Explain** the operation and control of voltage source and current source converters. .**{Apply level, KL3}**
CO3	**Analyze** the compensation methods to improve stability and reduce power oscillations in the transmission lines.**{Analyze level, KL4}**
CO4	**Understand**the methods of compensations using series compensators. . **{Understand level, KL2}**
CO5	**Explain** operation and control of Unified Power Flow Controller (UPFC) and Interline Power Flow Controller(IPFC).**{Apply level, KL3}**

Learning Resources

Text books:

1. "Understanding FACTS" N.G.Hingorani and L.Guygi, IEEE Press.Indian Edition is available:— Standard Publications, 2001.

Reference books:

1 "Flexible AC transmission system (FACTS)" Edited by YONG HUE SONG and ALLAN T JOHNS, Institution of Electrical Engineers, London.
2 Flexible AC Transmission Systems: Modeling and Control by Zhang Rehtanz Bikash Pal, SPRINGER INDIA.
3 Facts Controllers In Power Transmission and Distribution by K.R.Padiyar, New Age International Pvt Ltd; Second edition (1 January 2016)

e- Resources & other digital material

1. https://nptel.ac.in/courses/108/102/108102047/
2. https://www.coursera.org/learn/electric-power-systems
3. http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=00634216
4. https://www.electronicshub.org/flexible-ac-transmission-systemfacts/
5. https://www.electrical4u.com/facts-on-facts-theory-and-applications/
6. https://link.springer.com/book/10.1007%2F978-3-642-28241-6

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Micro-Syllabus-FACTS

Unit-1: Introduction to FACTS and High Power Electronic Devices(12 hrs)

Introduction to FACTS (08 hrs)

Power flow in an AC System – Loading capability limits – Dynamic stability considerations – Importance of controllable parameters – Basic types of FACTS controllers – Benefits from FACTS controllers.

Introduction to High Power Electronic Devices(04 hrs)

Requirements and characteristics of high power devices – Voltage and current rating – Losses and speed of switching – Parameter trade–off devices.

Unit No	Module	Micro content
1a. Introduction to FACTS	**Introduction to FACTS**	Power flow in an AC System
		Loading capability limits
		Dynamic stability considerations
		Importance of controllable parameters
		Basic types of FACTS controllers and benefits of facts controllers.
1b. Introduction to High Power Electronic Devices	**Introduction to High Power Electronic Devices**	Requirements and characteristics of high power devices
		Voltage and current rating
		Losses and speed of switching
		Parameter trade–off devices.
		Advantages and Disadvantages.

Unit-2:Voltage source and Current source converters (12 hrs)

Voltage source converters: Concept of voltage source converter (VSC) – Single phase bridge converter – Square wave voltage harmonics for a single–phase bridge converter – Three–phase full wave bridge converter. **(09 hrs)**

Current source converters– Concept of Current source converter (CSC) -Comparison of current source converter with voltage source converter. **(03 hrs)**

Unit No	Module	Micro content
2a. Voltage source converters	**Voltage source converters**	Concept of voltage source converter (VSC)
		Single phase bridge converter
		Square wave voltage harmonics for a single–phase bridge converter
		Three–phase full wave bridge converter.
2b. Current source converters	**Current source converter**	Concept of Current source converter (CSC)
		Comparison of current source converter with voltage source converter.

Unit-3:Shunt Compensators (14 hrs)

Shunt Compensators–1 (07 hrs)

Objectives of shunt compensation – Mid–point voltage regulation for line segmentation – End of line voltage support to prevent voltage instability – improvement of transient stability – Power oscillation damping.

Shunt Compensators–2 (07hrs)

Thyristor Switched Capacitor (TSC) – Thyristor Switched Reactor (TSC–TCR) - Static VAR compensator (SVC) and Static Compensator (STATCOM) - Comparisons between SVC and STATCOM.

Unit No	Module	Micro content
3a. Shunt Compensators–1	**Shunt Compensators–1**	Objectives of shunt compensation
		Mid–point voltage regulation for line segmentation
		End of line voltage support to prevent voltage instability
		Improvement of transient stability
		Power oscillation damping.

3b. Shunt Compensators–2	**Shunt Compensators–2**	Thyristor Switched Capacitor (TSC)
		Thyristor Switched Reactor
		Static VAR compensator (SVC)
		Static Compensator(STATCOM)
		Comparisons between SVC and STATCOM.

Unit-4:Series Compensators (12 hrs)

Static series compensators**:** Concept of series capacitive compensation – Improvement of transient stability – Power oscillation damping – Functional requirements. GTO Thyristor controlled Series Capacitor (GSC) – Thyristor Switched Series Capacitor (TSSC), Thyristor Controlled Series Capacitor (TCSC) and Static Synchronous Series Compensator (SSSC)

Unit No	**Module**	**Micro content**
4. Series Compensators	**Series Compensators**	Concept of series capacitive compensation
		Improvement of transient stability and Power oscillation damping.
		GTO Thyristor controlled Series Capacitor (GSC).
		Thyristor Switched Series Capacitor (TSSC)
		Thyristor Controlled Series Capacitor (TCSC).
		Static Synchronous Series Compensator (SSSC)

Unit-5: Combined Controllers (10 hrs)

Schematic and basic operating principles of Unified Power Flow Controller (UPFC) and Interline Power Flow Controller(IPFC),real time applications of these controllers on transmission lines.

Unit No	**Module**	**Micro content**
5. Combined Controllers	**Combined Controllers**	Schematic and basic operating principle of Unified Power Flow Controller (UPFC)
		Schematic and basic operating principle of Interline Power Flow Controller (IPFC)
		Application of combined controllers on transmission lines

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	3												1	
CO3	2													
CO4	2	2												1
CO5	3													1

IV Year I Semester

L	T	P	C
3	0	0	3

Cyber Security

PRE-REQUISITES: NIL

Course objectives: The student should be able

1. To familiarize various types of cyber-attacks and cyber-crimes.
2. To give an overview of the cyber laws and cyber forensic.
3. To study the defensive techniques against these attack in mobile and wireless devices.
4. To understand the security and privacy implications in organization.
5. To know the data privacy issues.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction to Cyber Security:** Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, Internet Governance – Challenges and Constraints, Computer Criminals, CIA Triad, Assets and Threat, motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc., Comprehensive Cyber Security Policy.	**CO1**
II	**Cyberspace and the Law & Cyber Forensics:** Introduction, Cyber Security Regulations, Roles of International Law. The INDIAN Cyberspace, National Cyber Security Policy. Introduction, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics.	**CO2**
III	**Cybercrime: Mobile and Wireless Devices:** Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Organizational Security Policies and Measures in Mobile Computing Era, Laptops.	**CO3**
IV	**Cyber Security: Organizational Implications:** Introduction, cost of cybercrimes and IPR issues, web threats for organizations, security and privacy implications, social media marketing: security risks and perils for organizations, social computing and the associated challenges for organizations.	**CO4**
V	**Privacy Issues:** Basic Data Privacy Concepts: Fundamental Concepts, Data Privacy Attacks, Data linking and profiling, privacy policies and their specifications, privacy policy languages, privacy in different domains- medical, financial, etc.	**CO5**

Content Beyond the syllabus:

Cyber security: Spectrum of attacks, Taxonomy of various attacks, IP spoofing, Methods of defense, Security Models, risk management.

Cybercrime and Cyber terrorism: Introduction, intellectual property in the cyberspace, the ethical dimension of cybercrimes the psychology, mindset and skills of hackers and other cyber criminals.

Course Outcomes	
Upon successful completion of the course, the student will be able	
CO1	To understand cyber-attacks.
CO2	To know the cyber laws and cyber forensic.
CO3	To protect them self and ultimately the entire Internet community from such attacks.
CO4	To understand the security and privacy implications in organization.
CO5	To know the data privacy issues.

Learning Resources

Text books:

1. Nina Godbole and Sunit Belpure, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley
2. B. B. Gupta, D. P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335, 2018.

Reference books:

1. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press.
2. Introduction to Cyber Security, Chwan-Hwa(john) Wu,J. David Irwin, CRC Press T&F Group

e- Resources & other digital material

1. https://onlinecourses.swayam2.ac.in/nou19_cs08/preview

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Micro-Syllabus- Cyber Security

Unit – 1: Introduction to Cyber Security: (13 hrs) Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, Internet Governance – Challenges and Constraints, Computer Criminals, CIA Triad, Assets and Threat, motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc., Comprehensive Cyber Security Policy.

Unit No	Module	Micro content
1a.Cyber Security	**Cyber Security**	Basic Cyber Security Concepts
		layers of security
		Vulnerability, threat, Harmful acts, Internet Governance – Challenges and Constraints
		CIA Triad, Assets and Threat, motive of attackers, active attacks, passive attacks
		Software attacks, hardware attacks
1b.Cyber Crime	**Cyber Crime**	Cyber Threats-Cyber Warfare
		Cyber Crime
		Cyber terrorism, Cyber Espionage, etc.,
		Comprehensive Cyber Security Policy.

Unit-2. Cyberspace and the Law & Cyber Forensics: : (11 hrs) Introduction, Cyber Security Regulations, Roles of International Law. The INDIAN Cyberspace, National Cyber Security Policy. Introduction, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics.

Unit No	Module	Micro content
2a. Cyberspace and the Law	**Cyberspace and the Law**	Cyber Security Regulations
		Roles of International Law
		The INDIAN Cyberspace
		National Cyber Security Policy
2b. Cyber Forensics	**Cyber Forensics**	Historical background of Cyber forensics
		Digital Forensics Science
		The Need for Computer Forensics
		Cyber Forensics and Digital evidence
		Forensics Analysis of Email, Digital Forensics Lifecycle,
		Forensics Investigation, Challenges in Computer Forensics.

Unit-3:Cybercrime: Mobile and Wireless Devices: : (11 hrs) Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Organizational Security Policies and Measures in Mobile Computing Era, Laptops.

Unit No	Module	Micro content
Unit-3:Cybercrime: Mobile and Wireless Devices	**Cybercrime: Mobile and Wireless Devices**	Proliferation of Mobile and Wireless Devices,
		Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era
		Security Challenges Posed by Mobile Devices,
		, Registry Settings for Mobile Devices
		Authentication service Security,
		, Attacks on Mobile/Cell Phones,
		Attacks on Mobile/Cell Phones
		Organizational Security Policies and Measures in Mobile Computing Era, Laptops.

Unit-4: Cyber Security: Organizational Implications: : (10 hrs) Introduction, cost of cybercrimes and IPR issues, web threats for organizations, security and privacy implications, social media marketing: security risks and perils for organizations, social computing and the associated challenges or organizations

Unit No	Module	Micro content
Unit-4: Cyber Security: Organizational Implications	**Organizational Implications**	Introduction
		cost of cybercrimes and IPR issues
		web threats for organizations
		security and privacy implications
	Social media marketing	social media marketing: security risks and perils for organizations

		social computing and the associated challenges for organizations
Unit-5: Privacy Issues: : (10 hrs)Basic Data Privacy Concepts: Fundamental Concepts, Data Privacy Attacks, Data linking and profiling, privacy policies and their specifications, privacy policy languages, privacy in different domains- medical, financial, etc.		
Unit No	**Module**	**Micro content**
Unit-5: Privacy Issues	**Privacy Issues**	Basic Data Privacy Concepts
		Fundamental Concepts
		Data Privacy Attacks
		Data linking and profiling
		privacy policies and their specifications
		privacy policy languages
		privacy in different domains- medical, financial, etc.

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	3					2							2	
CO3	2					1								
CO4	3							1					2	
CO5	2											2	2	

IV Year I Semester

L	T	P	C
3	0	0	3

Electric Drives

PRE-REQUISITES:

1) Power Electronics
2) Electric motors

Course objectives: The student should be able to

1. To learn the fundamentals of electric drive and different electric braking methods.
2. To analyze the operation of single phase converter controlled dc motors and four quadrant operation of dc motors using dual converters.
3. To understand the concept of speed control of induction motor by using AC voltage controllers and voltage source inverters.
4. To learn the principles of static rotor resistance control and various slip power recovery schemes.
5. To understand the speed control mechanism of synchronous motors

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Fundamentals of Electric Drives** Electric drive – Fundamental torque equation – Load torque components – Nature and classification of load torques – Steady state stability – Load equalization– Four quadrant operation of drive (hoist control) – Braking methods**:** Dynamic – Plugging – Regenerative methods.	**CO1**
II	**Controlled Converter Fed DC Motor Drives** 1-phase half and fully controlled converter fed separately and self-excited DC motor drive –Output voltage and current waveforms – Speed-torque expressions – Speed-torque characteristics –– Principle of operation of dual converters and dual converter fed DC motor drives -Numerical problems.	**CO2**
III	**DC–DC Converters Fed DC Motor Drives** Single quadrant – Two quadrant and four quadrant DC-DC converter fed separately excited and self-excited DC motors – Continuous current operation– Output voltage and current waveforms – Speed–torque expressions – Speed–torque characteristics –Four quadrant operation – Closed loop operation (qualitative treatment only).	**CO3**
IV	**Stator side control of 3-phase Induction motor Drive** Stator voltage control using 3-phase AC voltage regulators – Waveforms –Speed torque characteristics– Variable Voltage Variable Frequency control of induction motor by PWM voltage source inverter – Closed loop v/f control of induction motor drives (qualitative treatment only). **Rotor side control of 3-phase Induction motor Drive** Static rotor resistance control – Slip power recovery schemes – Static Scherbius drive – Static Kramer drive – Performance and speed torque characteristics – Advantages – Applications.	**CO4**
V	**Control of Synchronous Motor Drives** Separate control & self-control of synchronous motors – Operation of self-controlled synchronous motors by VSI– Closed Loop control operation of synchronous motor drives (qualitative treatment only).–Variable frequency control–Pulse width modulation.	**CO5**

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the fundamentals of electric drive and different electric braking methods.
CO2	**Analyze** the operation of three phase converter fed dc motors and four quadrant operations of dc motors using dual converters.
CO3	**Describe** the converter control of dc motors in various quadrants of operation
CO4	**Know** the concept of speed control of induction motor by using AC voltage controllers and Differentiate the stator side control and rotor side control of three phase induction motor.
CO5	**Explain** the speed control mechanism of synchronous motors

Learning Resources

Text books:

1. Fundamentals of Electric Drives – by G K DubeyNarosa Publications
2. Power Semiconductor Drives, by S.B.Dewan, G.R.Slemon, A.Straughen, Wiley-India Edition.

Reference books:

1. Electric Motors and Drives Fundamentals, Types and Apllications, by Austin Hughes and Bill Drury, Newnes.
2. Thyristor Control of Electric drives – VedamSubramanyam Tata McGraw Hill Publications.
3. Power Electronic Circuits, Devices and applications by M.H.Rashid, PHI
4. Power Electronics handbook by Muhammad H.Rashid, Elsevier.

e- Resources & other digital material

1. Four Quadrant Operation of DC Motor – Motoring and Breaking Operation (tutorialspoint.com)
2. Chopper Control of DC Motors: Operation and Set-Up | Electrical Engineering (engineeringenotes.com)

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Micro-Syllabus- Electric Drives

Unit – 1: Fundamentals of Electric Drives

Electric drive – Fundamental torque equation – Load torque components – Nature and classification of load torques – Steady state stability – Load equalization– Four quadrant operation of drive (hoist control) – Braking methods**:** Dynamic – Plugging – Regenerative methods.

Unit No	Module	Micro content
Fundamentals of Electric Drives	Electric drive	Introduction to Electric Drives
		Fundamental torque equation
		Load torque components
		Nature and classification of load torques
		Steady state stability
		Load equalization
		Four quadrant operation of drive (hoist control)
	Braking methods**:**	Dynamic method
		Plugging method
		Regenerative method
		Numerical Problems

Unit-2: Controlled Converter Fed DC Motor Drives

<table>
<tr><td colspan="3">1-phase half and fully controlled converter fed separately and self-excited DC motor drive –Output voltage and current waveforms – Speed-torque expressions – Speed-torque characteristics –– Principle of operation of dual converters and dual converter fed DC motor drives -Numerical problems.</td></tr>
<tr><th>Unit No</th><th>Module</th><th>Micro content</th></tr>
<tr><td rowspan="7">Controlled Converter Fed DC Motor Drives</td><td rowspan="7">Controlled Converter Fed DC Motor Drives</td><td>1-phase half controlled converter fed separately excited DC motor drive.</td></tr>
<tr><td>1-phase fully controlled converter fed separately excited DC motor drive.</td></tr>
<tr><td>1-phase half controlled converter fed self excited DC motor drive.</td></tr>
<tr><td>1-phase fully controlled converter fed self excited DC motor drive.</td></tr>
<tr><td>principle of operation of dual converters</td></tr>
<tr><td>Dual converter fed DC motor drives</td></tr>
<tr><td>Numerical problems</td></tr>
<tr><td colspan="3">Unit-3: DC–DC Converters Fed DC Motor Drives
Single quadrant – Two quadrant and four quadrant DC-DC converter fed separately excited and self-excited DC motors – Continuous current operation– Output voltage and current waveforms – Speed–torque expressions – Speed–torque characteristics –Four quadrant operation – Closed loop operation (qualitative treatment only).</td></tr>
<tr><th>Unit No</th><th>Module</th><th>Micro content</th></tr>
<tr><td rowspan="7">DC–DC Converters Fed DC Motor Drives</td><td rowspan="7">DC–DC Converters Fed DC Motor Drives</td><td>Single quadrantDC-DC converter fed separately excited DC motors.</td></tr>
<tr><td>Single quadrant DC-DC converter fedself-excited DC motors</td></tr>
<tr><td>Two quadrantDC-DC converter fed separately excited DC motors.</td></tr>
<tr><td>Two quadrant DC-DC converter fedself-excited DC motors</td></tr>
<tr><td>Four quadrantDC-DC converter fed separately excited DC motors.</td></tr>
<tr><td>Four quadrant DC-DC converter fedself-excited DC motors</td></tr>
<tr><td>Closed loop operation (qualitative treatment only).</td></tr>
<tr><td colspan="3">Unit-4: Stator side control of 3-phase Induction motor Drive
Stator voltage control using 3-phase AC voltage regulators – Waveforms –Speed torquecharacteristics– Variable Voltage Variable Frequency control of induction motor by PWM voltage source inverter – Closed loop v/f control of induction motor drives(qualitative treatment only).
Rotor side control of 3-phase Induction motor Drive
Static rotor resistance control – Slip power recovery schemes – Static Scherbius drive – Static Kramer drive – Performance and speed torque characteristics – Advantages –Applications.</td></tr>
<tr><th>Unit No</th><th>Module</th><th>Micro content</th></tr>
<tr><td rowspan="2">Speed control of 3-phase Induction motor Drive</td><td rowspan="2">Stator side control of 3-phase Induction motor Drive</td><td>Stator voltage control using 3-phase AC voltage regulators</td></tr>
<tr><td>Variable Voltage Variable Frequency control of</td></tr>
</table>

		induction motor by PWM voltage source inverter
		Closed loop v/f control of induction motor drives(qualitative treatment only).
	Rotor side control of 3-phase Induction motor Drive	Static rotor resistance control
		Slip power recovery schemes – Static Scherbius drive
		Static Kramer drive

Unit-5: Control of Synchronous Motor Drives

Separate control & self-control of synchronous motors – Operation of self-controlledsynchronous motors by VSI– Closed Loop control operation of synchronous motor drives (qualitative treatment only).–Variable frequency control–Pulse width modulation.

Unit No	Module	Micro content
Control of Synchronous Motor Drives	**Control of Synchronous Motor Drives**	Separate control of synchronous motors
		self-control of synchronous motors
		Operation of self-controlled synchronous motors by VSI
		Closed Loop control operation of synchronous motor drives
		Variable frequency control–Pulse width modulation.

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

IV Year I Semester

L	T	P	C
3	0	0	3

Power System Reliability

PRE-REQUISITES:

1) Power Systems- I
2) Power Systems- II
3) Probability and Stochastic Methods

Course objectives: The student should be able to

1. Study various methods and measure for determining reliability of a system
2. Compute failure frequencies and duration for components failure.
3. Study models for reliability determination and identify probable failures in electrical generation system.
4. Compute outage and identify contingency in power transmission system
5. Identify the reliability models for radial distribution system

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Network Modelling and Reliability Analysis (12 hrs)** **Reliability concepts** – exponential distributions – meantime to failure – series and parallel system – MARKOV process – recursive technique - Bathtub curve **(07 hrs)** **Reliability Measures** MTTF, MTTR, MTBF**(05 hrs)**	**CO1**
II	**Frequency & Duration Techniques(12 hrs)** Frequency and duration concept – Evaluation of frequency of encountering state, mean cycle time for one and two component repairable models **(06 hrs)** evaluation of cumulative probability and cumulative frequency of encountering of merged states**(06 hrs)**	**CO2**
III	**Generation System Reliability Analysis(12 hrs)** **Reliability model of a generation system:** recursive relation for unit addition and removal – load modelling - Merging of generation load model **(07 hrs)** evaluation of transition rates for merged state model – cumulative Probability, cumulative frequency of failure evaluation – LOLP, LOLE**(05 hrs)**	**CO3**
IV	**Transmission System Reliability Analysis(12 hrs)** Deterministic contingency analysis-Determination of reliability indices like LOLP and expected value of demand not served.	**CO4**
V	**Distribution System Reliability Analysis(12 hrs)** Basic Concepts – Additional interruption indices - Evaluation of Basic and performance reliability indices of radial networks.	**CO5**
Content Beyond the syllabus: Reliability under preventive maintenance, Energy index of reliability, Applications of reliability indices in power system planning, Applications of reliability indices in power system interconnection		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Demonstrate** basic reliability measures**{Understand level, KL2}**
CO2	**Apply** failure frequency and duration for power system applications **{Apply level, KL3}**
CO3	**Analyze** the failure probability of generation system **{Analyze level, KL4}**
CO4	**Analyze** the outage and contingency of transmission system. **{Analyze level, KL4}**
CO5	**Analyze** the reliability of radial distribution networks. **{Analyze level, KL4}**

Learning Resources	
Text books:	
9. R. Billinton, R.N.Allan, "Reliability Evaluation of Power systems" second edition, Springer. 10. Charles E. Ebeling, "An Introduction to Reliability and Maintainability Engineering", TATA Mc Graw - Hill – Edition.	
Reference books:	
13. R. Billinton, R.N.Allan, "Reliability Evaluation of Engineering System", Plenum Press, New York. 14. Eodrenyi, J., "Reliability modelling in Electric Power System", John Wiley, (1980)	
e- Resources & other digital material	
16.	https://ieeexplore.ieee.org/abstract/document/8614407
17.	https://www.sciencedirect.com/science/article/abs/pii/095183209090007A
18.	https://ekeeda.com/degree-courses/electrical-engineering/power-system-planning-and-reliability
19.	https://www.intechopen.com/chapters/57936

Micro-Syllabus

Unit I: Network Modelling and Reliability Analysis (12 hrs)

Reliability concepts – exponential distributions – meantime to failure – series and parallel system – MARKOV process – recursive technique - Bathtub curve **(07 hrs)**

Reliability Measures MTTF, MTTR, MTBF**(05 hrs)**

Unit No	Module	Micro content
1a. Reliability concepts	**Reliability concepts**	Exponential distributions - Meantime to Failure
		Series and Parallel System
		MARKOV process
		Recursive technique
		Bathtub curve
1b. Reliability Measures	**Reliability Measures**	MTTF
		MTTR
		MTBF

Unit-2:Frequency & Duration Techniques (12 hrs)

Frequency and duration concept – Evaluation of frequency of encountering state, mean cycle time for one and two component repairable models **(08 hrs)**

evaluation of cumulative probability and cumulative frequency of encountering of merged states**(04 hrs)**

Unit No	Module	Micro content
2a. Frequency &	**Frequency & Duration**	Frequency and duration concept

Duration		Evaluation of frequency of encountering state
		mean cycle time for one component repairable model
		mean cycle time for two components repairable model
2b. Cumulative probability and frequency determination	**Cumulative probability and frequency determination**	evaluation of cumulative probability of encountering of merged states
		evaluation of cumulative frequency of encountering of merged states

Unit-3: **Generation System Reliability Analysis (12 hrs)**

Reliability model of a generation system: recursive relation for unit addition and removal – load modelling - Merging of generation load model **(07 hrs)**

Evaluation of transition rates for merged state model – cumulative Probability, cumulative frequency of failure evaluation – LOLP, LOLE**(05 hrs)**

Unit No	Module	Micro content
3a. Reliability model of a generation system	**Reliability model of a generation system**	recursive relation for unit addition
		recursive relation for unit removal
		load modelling
		Merging of generation load model
3b. Evaluation of transition rates for merged state model	**Evaluation of transition rates for merged state model**	cumulative Probability
		cumulative frequency of failure evaluation – LOLP
		cumulative frequency of failure evaluation- LOLE

Unit-IV. Transmission System Reliability Analysis (12 hrs)

Deterministic contingency analysis-Determination of reliability indices like LOLP and expected value of demand not served.

Unit No	Module	Micro content
4a. Contingency analysis	**Contingency analysis**	Deterministic contingency analysis
		Load flow contingency
		Multiple Contingency problem
4b. Determination of reliability indices	**4b. Determination of reliability indices**	LOLP
		Expected value of demand not served
		Improving reliability indices

Unit-5: Distribution System Reliability Analysis (12 hrs)

Basic Concepts – Additional interruption indices**(04 hrs)**

Evaluation of Basic and performance reliability indices of radial networks**(08 hrs)**

Unit No	Module	Micro content
5a. Interruption indices	**Interruption indices**	Basic Concepts
		Additional interruption indices
5b. Reliability Indices	Reliability Indices of Radial Networks	Evaluation of Basic reliability indices of radial networks

of Radial Networks		Evaluation of performance reliability indices of radial networks.

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	3													
CO3		3		2										
CO4		3		2										
CO5		3		2										

IV Year I Semester

L	T	P	C
3	0	0	3

Programmable Logic Controller

Course objectives: The student should be able to

1. To have knowledge on PLC.
2. To acquire the knowledge on programming of PLC.
3. To understand different PLC registers and their description.
4. To have knowledge on data handling functions of PLC.
5. To know how to handle analog signal and converting of A/D in PLC.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**INTRODUCTION (5 hrs)** **PLC Basics:** PLC systems, I/O modules and interfacing, CPU processor, programming equipment, programming formats, constraints of PLC ladder diagrams, devices connect modules.**(05 hrs)**	**CO1**
II	**PLC Programming(7 hrs)** **PLC Programming:** Input instructions ,output operations procedures, programming using contacts and coils. Digital logic gates, programming in the Boolean algebra conversion example, ladder diagram and sequence listings, ladder diagram**(07 hrs)**	**CO2**
III	**Programmable Timers and Counters (6hrs)** Timer Instructions ,on delay time instruction, off delay timer instruction, counter instructions, Up counter, Down counter, Cascading counters, Incremental Counter applications, Combing counter and timer functions.	**CO3**
IV	**Program Control Instructions & Other Instructions (8hrs)** Master control reset instruction, Jump instructions and sub routines, Immediately instructions. Data manipulation, Data transfer operation, Data compare instruction, Data programs, Numerical data I/O interfaces, Math instructions, Addition, Subtraction and division instruction, Sequential instructions, Sequence programs, Shift Registers.	**CO4**
V	**Applications (4hrs)** Control of water level indicator, Alarm monitor, Conveyor motor control, Ladder diagram for process control, PID Controller.	**CO5**

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the PLC's and their I/O modules**{Understand level, KL2}**
CO2	**Explain** Develop control algorithms to PLC using ladder logic**{Apply level, KL3}**
CO3	**Analyze** Manage PLC registers for effective utilization in different applications. **{Analyze level, KL4}**
CO4	**Evaluate** Design PID controller with PLC**{Evaluate level, KL5}**

Learning Resources

Text books:

1. Programmable logic controller by Frank D.Petruzella-McGraw Hill-3^{rd} Edition
2. Programmable logic controller –Principle and applications by John w.Web Reiss ,fifth edition, PHI.

Reference books:

1. Programmable logic controllers-Programming method and applications by and F.D Hackworth Jr. Pearson,2004.
2. Introduction to Programmable logic controllers-Gary Dunning.
3. Programmable logic controllers-W.Bolton _Elsevier Publisher.

IV Year I Semester

L	T	P	C
3	0	0	3

Reactive power compensation and Management

PRE-REQUISITES: 1) Power Systems-II

Course objectives: The student should be able to

1. Identify the necessity of reactive power compensation.
2. Describe load compensation.
3. Select various types of reactive power compensation in transmission systems
4. Contrast reactive power coordination system.
5. Characterize distribution side and utility side reactive power management.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Load Compensation(11 hrs)** Load Compensation: Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing – Load compensator as a voltage regulator – phase balancing and power factor correction of unsymmetrical loads- examples.	**CO1**
II	**Steady – State Reactive Power Compensation in Transmission System(13 hrs)** Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation –examples Transient state reactive power compensation in transmission systems: Characteristic time periods – passive shunt compensation – static compensations- series capacitor compensation – compensation using synchronous condensers – examples	**CO2**
III	**Reactive Power Coordination(12 hrs)** Objective – Mathematical modelling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances- steady –state variations – effects of under voltages – frequency –Harmonics, radio frequency and electromagnetic interferences.	**CO3**
IV	**Demand Side Management(12 hrs)** Load patterns – basic methods load shaping – power tariffs- KVAR based tariffs penalties for voltage flickers and Harmonic voltage levels Distribution side Reactive power Management: System losses –loss reduction methods – examples – Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banks.	**CO4**
V	**User Side Reactive Power Management(12 hrs)** KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations Reactive power management in electric traction systems and are furnaces: Typical layout of traction systems – reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements – remedial measures –power factor of an arc furnace	**CO5**
Content Beyond the syllabus: **Reactive power control in Microgrid:** Basic understanding of Microgrid, Reactive power control of grid connected microgrid. (Elementary treatment only).		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Distinguish** the importance of load compensation in symmetrical as well as un symmetrical loads**{Distinguish level, KL4}**
CO2	**Observe** various compensation methods in transmission lines. **{Observe level, KL2}**
CO3	**Construct** model for reactive power coordination**{Construct level, KL6}**
CO4	**Understand** Different load patterns, Different methods of load shaping, Various loss reduction methods **{Understand level, KL2}**
CO5	**Distinguish** demand side reactive power management & user side reactive power management. **{Distinguish level, KL4}**

Learning Resources

Text books:

1. Reactive power control in Electric power systems by T.J.E. Miller, John Wiley and sons, 1982.
2. Reactive power Management by D. M. Tagare, Tata McGraw Hill, 2004.

Reference books:

1. Wolfgang Hofmann, Jurgen Schlabbach, Wolfgang Just “Reactive Power Compensation: A Practical Guide, April, 2012, Wiely publication.

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Micro-Syllabus

Unit – 1: Load Compensation (11 hrs)

Load Compensation: Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing – Load compensator as a voltage regulator – phase balancing and power factor correction of unsymmetrical loads- examples.

Unit No	Module	Micro content
1a. LoadCompensation	**Load Compensation**	Objectives of load compensation.
		reactive power characteristics.
		inductive and capacitive approximate biasing.
1b. Load compensator as a voltage regulator	**Load compensator as a voltage regulator**	Load compensator as a voltage regulator.
		phase balancing.
		power factor correction

Unit-2:Steady – State Reactive Power Compensation in Transmission System (13 hrs)

Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation –examples Transient state reactive power compensation in transmission systems: Characteristic time periods – passive shunt compensation – static compensations- series capacitor compensation – compensation using synchronous condensers – examples

Unit No	Module	Micro content
2a. Steady – State Reactive Power Compensation in Transmission	**Steady – State Reactive Power Compensation in Transmission System**	VAR Compensation.
		Traditional methods of VAR compensation.
		Passive shunt and series and dynamic shunt compensation.

System		Advanced compensators
		Advanced compensators
2b. Transient state reactive power compensation in transmission system	Transient state reactive power compensation in transmission system	Characteristic time periods.
		series capacitor compensation
		compensation using synchronous condensers

Unit-3: **Reactive Power Coordination (12 hrs)**

Objective – Mathematical modelling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances- steady –state variations – effects of under voltages – frequency –Harmonics, radio frequency and electromagnetic interferences.

Unit No	Module	Micro content
3a. **Reactive Power Coordination**	**Reactive Power Coordination**	Objective of Reactive power coordination
		Mathematical modelling
		Operation planning
		transmission benefits
3b. **Basic concepts of quality of power supply**	Basic concepts of quality of power supply	Power quality terms
		Causes of low power quality
		Equipment to solve power quality problems
		Under voltage, electromagnetic interferences

Unit-4: Demand Side Management (12 hrs)

Load patterns – basic methods load shaping – power tariffs- KVAR based tariffs penalties for voltage flickers and Harmonic voltage levels Distribution side Reactive power Management: System losses – loss reduction methods – examples – Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banks.

Unit No	Module	Micro content
4a. **Load patterns**	Load patterns	basic methods load shaping
		➢ power tariffs- KVAR based tariffs ➢ penalties for voltage flickers and Harmonic voltage levels
4b. **Distribution side Reactive power Management**	Distribution side Reactive power Management	System losses
		loss reduction methods with examples
		Reactive power planning Objectives
		Economics Planning of capacitor placement
		retrofitting of capacitor banks.

Unit-5: User Side Reactive Power Management (12 hrs)

KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations Reactive power management in electric traction systems and are furnaces: Typical layout of traction systems – reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements – remedial measures –power factor of an arc furnace

Unit No	Module	Micro content
5a. KVAR requirements for domestic appliances	KVAR requirements for domestic appliances	Purpose of using capacitors
		selection of capacitors
		deciding factors in choosing capacitor
		types of available capacitor
		characteristics and Limitations
5b. Reactive power management in electric traction systems and are furnaces	Reactive power management in electric traction systems and are furnaces	Typical layout of traction systems
		reactive power control requirements
		distribution transformers
		Electric arc furnaces ➢ basic operations ➢ furnaces transformer ➢ filter requirements ➢ remedial measures ➢ power factor of an arc furnace

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	3													
CO3	2													
CO4	2													
CO5	3													

IV Year I Semester

L	T	P	C
0	0	3	1.5

Power Systems Laboratory

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 dispatchwithout transmission losses
8. Economic load dispatchwith 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. 1.Power System by V. K. Mehta. 2. 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	P05	P06	P07	P08	P09	P010	P011	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

IV Year I Semester

L	T	P	C
0	0	3	1.5

Big Data Analytics Laboratory

PRE-REQUISITES: 1) Operating Systems: Linux commands, Windows
2) Programming Knowledge in JAVA

Preamble:

Big Data Analytics Lab provides the essential facilities to the students to augment their concepts about the fundamentals of Data structures implementation using java , Collections frame work, Set interface and various operations on Big Data analytics. This lab is mainly deals with the various Big data applications using various analytical tools like Pig and Hive. The lab covers the concepts of Basic file management commands in Hadoop environment, word count program using Map Reduce, pig Latin Scripts, operations on Tables using Hive.

Course Objectives: The student should be able to

1. To understand the implementation of various data structures using the Java.
2. To introduce the terminology, technology and its applications.
3. To determine concepts of analytics for business.
4. To apply analytics on structured data.

LIST OF EXPERIMENTS

Any Seven of the following experiments are to be conducted:

1. Implementation of Stack Data Structure using JAVA
    a. Simple Stack implementation
    b. Using Arrays
3. Implementation of Queue Data Structure using JAVA
4. Implementation of Linked List using JAVA
5. Implementation of Collection framework, Set interface in JAVA
6. Installation of HADOOP
    a. CDH (Cloudera Distributed Hadoop) Installation & Configuration on Virtual Box
    b. In LINUX Environment
7. File Management Tasks in HDFS
8. Implementation of word count programs using Map Reduce programming to process the stored data in HDFS.
9. Install & Run Pig then write pig Latin scripts to sort, group, join, project and filter your data.
10. Install & Run Hive then use Hive to create, alter and drop data bases, tables, views.

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

1. Mining of Weather data using map Reduce concept by sensors. The dataset can be taken from National Climate Data Center (NCDC, http://www.ncdc.noaa.gov/).

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

Course Outcomes	
CO1	**Applying Java concepts required for developing MapReduce programs.** (**Apply**)
CO2	Able to understand the fundamental concepts of Big Data & Hadoop framework. (**Understand and Apply**)
CO3	**Demonstrate** the knowledge of big data analytics and implement different file management task in Hadoop. (**Apply**)
CO4	**Analyze** and perform different operations on data using Pig Latin scripts. (**Understand, Apply and Analyze**).
CO5	**Illustrate** and apply different operations on relations and databases using Hive. (**Understand, Apply and Analyze**).

Learning Resources
Text books:
1. Big Java 4th Edition, Cay Horstmann, Wiley John Wiley & Sons, INC. 2. Hadoop: the definitive guide by Tom white ,fourth edition O'reilly media 2015 3. Hadoop in Action by Chuck Lam, MANNING Publ.
Reference books:
1. Hadoop in Practice by Alex Holmes, MANNING Publ. 2. Hadoop MapReduce Cook Book, Srinath Perera, Thilina Gunarathne
e- Resources & other digital material
1. https://drive.google.com/drive/folders/0B8_ZAVB1cH_FOGh3VXltWVpPOFE?usp=sharing
2. https://freevideolectures.com/course/4233/nptel-big-data-computing/3
3. https://archive.nptel.ac.in/courses/106/104/106104189/

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	2	2	-	1	-	-	-	-	-	-	-	1	-	-
C02	2	-	-	1	-	-	-	-	-	-	-	1	-	-
C03	2	-	1	1	-	-	-	-	-	-	-	1	-	2
C04	2	3	3	-	3	-	-	-	-	1	-	2	3	-
C05	2	3	3	-	3	-	-	-	-	1	-	2	3	-

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IV Year II Semester

L	T	P	C
3	0	0	3

Digital Control Systems

PRE-REQUISITES: 1) Control Systems

Course objectives: The student should be able to

1. To understand the concepts of digital control systems and assemble various components associated with it. Advantages compared to the analog type.
2. The theory of z–transformations and application for the mathematical analysis of digital control systems.
3. To represent the discrete–time systems in state–space model and evaluation of state transition matrix, the design of state feedback control by “the pole placement method.”
4. To examine the stability of the system using different tests.
5. To study the conventional method of analyzing digital control systems in the w–plane.

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction and signal processing (06 hrs)** Introduction to analog and digital control systems – Advantages of digital systems – Typical examples – Continuous and Discrete Time Signals – Sample and hold devices – Frequency domain characteristics of zero order hold.	**CO1**
II	**z–transformations (12 hrs)** Z–Transforms – Theorems – Finding inverse z–transforms – Formulation of difference equations and solving – Block diagram representation – Pulse transfer functions and finding open loop and closed loop responses.	**CO2**
III	**Stability analysis (10 hrs)** Mappingbetweenthes–Planeandthez–Plane–PrimarystripsandComplementarystrips–Stabilitycriterion –Modified Routh’s stability criterion and Jury’s stability test.	**CO3**
IV	**StatespaceanalysisandtheconceptsofControllabilityandObservability (06 hrs)** Statespacerepresentationofdiscretetimesystems–SolvingDiscreteTimestatespaceequations – State transition matrix and its properties– Discretization of continuous time stateequations –Conceptsofcontrollabilityandobservability–Tests(withoutproof). StateFeedbackControllersandStateObservers **(06 hrs)** Designofstatefeedbackcontroller throughpoleplacement–Necessaryandsufficientconditions –Ackerman’sformula	**CO4**
V	**Design ofdiscrete–timecontrolsystemsbyconventionalmethods (08 hrs)** Transientandsteadystatespecifications–Designusingfrequencyresponseinthew–planefor lag andleadcompensators–Rootlocustechnique inthe z–plane.	**CO5**
Content Beyond the syllabus: Designofstateobservers(FullOrder andReducedOrder).		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Understand the advantages of discrete time control systems and the “knowhow” of various

	associated accessories.**{understand level, kL2}**
CO2	Applyz–transformationsandtheirroleinthemathematical analysisof differentsystems(like Laplacetransformsinanalogsystems).**{Apply level, KL3}**
CO3	Analyze thestabilitycriterionfordigitalsystemsandmethodsadoptedfortestingthesameare explained.**{analyze level, kL4}**
CO4	Evaluating theconventionalandstatespacemethodsofdesign. **{evaluate level, kL5}**
CO5	Applying the design procedure in the w-plane. **{Apply level, KL4}**

Learning Resources
Text books:
1. Discrete–TimeControlsystems–K. Ogata,PearsonEducation/PHI, 2ndEdition. 2. DigitalControlandStateVariableMethodsbyM.Gopal,TMH,4thEdition.
Reference books:
1. DigitalControlSystems, Kuo,OxfordUniversityPress, 2ndEdition,2003. 2. Digital Control Systems Analysis and Design- 3rd edition- Charles S Phillips, H.Troy Nagle - PHI
e- Resources & other digital material
1. https://nptel.ac.in/courses/108103008

Micro-Syllabus

Unit 1: Introductionandsignalprocessing (06 hrs)

Introduction to analog and digital control systems – Advantages of digital systems – Typicalexamples – Continuous and Discrete Time Signals – Sample and hold devices – Frequencydomaincharacteristicsofzeroorderhold.

Unit No	Module	Micro content
1	**Introduction**	Introduction to analog and digital control systems
		Advantages of digital systems
		Typicalexamples
	Signalprocessing	Continuous and Discrete Time Signals
		Sample and hold devices
		Frequencydomaincharacteristicsofzeroorderhold.

Unit 2: z–transformations (12 hrs)

Z–Transforms – Theorems – Finding inverse z–transforms – Formulation of differenceequationsand solving – Block diagram representation – Pulse transfer functions and finding open loop andclosedloopresponses.

Unit No	Module	Micro content
2	**z–transformations**	Z–Transforms
		Theorems
		Finding inverse z–transforms
		Formulation of differenceequationsand solving
		Block diagram representation
		Pulse transfer functions and finding open loop andclosedloopresponses.

Unit 3: Stabilityanalysis (10 hrs)

Mappingbetweenthes–Planeandthez–Plane–PrimarystripsandComplementarystrips–Stabilitycriterion –ModifiedRouth’sstabilitycriterionandJury’sstabilitytest.

Unit No	Module	Micro content
3	**Stabilityanalysis**	Mappingbetweenthes–Planeandthez–Plane
		PrimarystripsandComplementarystrips
		PrimarystripsandComplementarystrips
		Jury’sstabilitytest
		ModifiedRouth’sstabilitycriterion

Unit 4: StatespaceanalysisandtheconceptsofControllabilityandObservability (06 hrs)

Statespacerepresentationofdiscretetimesystems–SolvingDiscreteTimestatespaceequations – State transition matrix and its properties– Discretization of continuous time stateequations – Conceptsofcontrollabilityandobservability–Tests(withoutproof).

StateFeedbackControllersandStateObservers **(06 hrs)**

Designofstatefeedbackcontroller throughpoleplacement–Necessaryandsufficientconditions – Ackerman’sformula.

Unit No	Module	Micro content
4.a	**State space analysis**	State space representation of discrete time systems
		Solving Discrete Time state space equations
		State transition matrix and its properties
		Discretization of continuous time stateequations
4.b	**The concepts of Controllability and Observability**	Conceptsofcontrollabilityandobservability–Tests (withoutproof).
		Designofstatefeedbackcontroller throughpoleplacement
		Necessaryandsufficientconditions
		Ackerman’sformula

Unit 5: Design ofdiscrete–timecontrolsystemsbyconventionalmethods (08 hrs)

Transientandsteadystatespecifications–Designusingfrequencyresponseinthew–planefor lag andleadcompensators–Rootlocustechnique inthe z–plane.

Unit No	Module	Micro content
5	**Design ofdiscrete–timecontrolsystemsbyconventional methods**	Transientandsteadystatespecifications
		Designusingfrequencyresponseinthew–planefor lag andleadcompensators
		Rootlocustechnique inthe z–plane

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	3												1	
CO3	2	1												
CO4	2	2	1											1
CO5	3	1												1

IV Year II Semester

L	T	P	C
3	0	0	3

Electric Vehicles

PRE-REQUISITES:

i. **Electric machines**
ii. **Power Electronics**

Course objectives: The students should be able to

1. To get exposed to EV system configuration and parameter
2. To know about electro mobility and environmental issues of EV
3. To understand about basic EV propulsion and dynamics
4. To understand about fuel cell technologies for EV
5. To know about basic battery charging and control strategies used in electric vehicles

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction to EV Systems and Parameters** Past, Present and Future EV, EV Concept, EV Technology, State-of-the Art EVs, EV configuration, EV system, Fixed and Variable gearing, single and multiple motor drive, in-wheel drives, EV parameters: Weight, size, force and energy, performance parameters. **(10 hrs)**	**CO1**
II	**EV and Energy Sources** Electro mobility and the environment, history of Electric power trains, carbon emissions from fuels, green houses and pollutants, comparison of conventional, battery, hybrid and fuel cell electric systems**(10 hrs)**	**CO2**
III	**EV Propulsion and Dynamics** Choice of electric propulsion system, block diagram, concept of EV Motors, single and multi-motor configurations, fixed and variable geared transmission, In-wheel motor configuration, classification, Electric motors used in current vehicle applications, Recent EV Motors, Vehicle load factors, vehicle acceleration**(12 hrs)**	**CO3**
IV	**Fuel cells** Introduction of fuel cells, basic operation, model, voltage, power and efficiency, power plant system –characteristics, sizing, Example of fuel cell electric vehicle. Introduction to HEV, brake specific fuel consumption, comparison of series, series-parallel hybrid systems, examples. **(10 hrs)**	**CO4**
V	**Battery Charging and control** Battery charging: Basic requirements, charger architecture, charger functions, wireless charging, power factor correction. Control: Introduction, modelling of electro mechanical system, feedback controller design approach, PI controllers designing, torque-loop, speed control loop compensation, acceleration of battery electric vehicle. **(12 hrs)**	**CO5**

Content Beyond the syllabus:

- Impact of different transportation technologies on environment and energy supply.
- Electric drives used in HEV/EVs

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand**about various configurations in parameters of EV systems **{Understand level, KL2}**
CO2	**Understand** about electro mobility and environmental issues of EVs**{ Understand level, KL2}**
CO3	**Analyze**about propulsion and dynamic aspects of EV **{Analyze level, KL4}**
CO4	**Understand** fuel cell technologies in EV systems. **{ Understand level, KL2}**
CO5	**Analyze**about battery charging and controls required of EVs **{Apply level, KL4}**

Learning Resources

Text books:

1. C.C Chan, K.T Chau: "Modern Electric Vehicle Technology", Oxford University Press Inc., New York 2001.
2. James Larminie, John Lowry, "Electric Vehicle Technology Explained", Wiley, 2003.

Reference books:

1. Iqbal Husain,, "Electric and Hybrid Vehicles Design Fundamentals",CRC Press 2005.
2. Ali Emadi, "Advanced Electric Drive Vehicles", CRC Press, 2015.
3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
4. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.

e- Resources & other digital material

1. https://archive.nptel.ac.in/courses/108/106/108106182/
2. https://nptel.ac.in/courses/108106170
3. https://archive.nptel.ac.in/content/syllabus_pdf/108103009.pdf
4. https://en.wikipedia.org/wiki/Electric_vehicle
5. https://afdc.energy.gov/vehicles/electric.html

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Micro-Syllabus

Unit – 1: Introduction to EV Systems and Parameters
Past, Present and Future EV, EV Concept, EV Technology, State-of-the Art EVs, EV configuration, EV system, Fixed and Variable gearing, single and multiple motor drive, in-wheel drives, EV parameters: Weight, size, force and energy, performance parameters.**(10 hrs)**

Unit No	Module	Micro content
1a. Introduction to EV Systems	**Introduction to EV**	Past, Present and Future EV
		EV Concept
		EV Technology
		State-of-the Art EVs
		EV configuration.
1b. EV Systems and Parameters	**EV Parameters**	Fixed and Variable gearing
		single and multiple motor drive
		in-wheel drives
		EV parameters: Weight, size, force and energy,

		performance parameters

Unit-2: EV and Energy Sources
Electro mobility and the environment, history of Electric power trains, carbon emissions from fuels, green houses and pollutants, comparison of conventional, battery, hybrid and fuel cell electric systems **(10 hrs)**

Unit No	Module	Micro content
2a. EV and Energy Sources	**Electric mobility**	Electro mobility
		history of Electric power trains
		carbon emissions from fuels
		green houses and pollutants
2b. EV and Energy Sources	**Energy Sources**	conventional, battery
		hybrid and fuel cell electric systems

Unit-3: **EV Propulsion and Dynamics**
Choice of electric propulsion system, block diagram, concept of EV Motors, single and multi motor configurations, fixed and variable geared transmission, In-wheel motor configuration, classification, Electric motors used in current vehicle applications, Recent EV Motors, Vehicle load factors, vehicle acceleration. **(12 hrs).**

Unit No	Module	Micro content
3a. EV Propulsion and Dynamics	**EV Propulsion and Dynamics**	Choice of electric propulsion system
		block diagram
		concept of EV Motors
		single configurations
		multi motor configurations
3b. EV Propulsion and Dynamics	**EV Propulsion and Dynamics**	fixed and variable geared transmission
		In-wheel motor configuration
		Electric motors used in current vehicle applications
		Recent EV Motors
		Vehicle load factors
		vehicle acceleration

Unit-4: Fuel cells
Introduction of fuel cells, basic operation, model, voltage, power and efficiency, sizing, Example of fuel cell electric vehicle. Introduction to HEV, brake specific fuel consumption, comparison of series, series-parallel hybrid systems, examples. **(10 hrs)**

Unit No	Module	Micro content
4a. Fuel cells	**Fuel cells**	Introduction of fuel cells,
		basic operation voltage, power and efficiency
		sizing
4b. Hybrid EV	**Hybrid EV**	Example of fuel cell electric vehicle.
		Introduction to HEV
		brake specific fuel consumption

		comparison of series system
		series-parallel hybrid systems, examples

Unit-5: Battery Charging and control

Battery charging: Basic requirements, charger architecture, charger functions, wireless charging, power factor correction.

Control: Introduction, modelling of electro mechanical system, feedback controller design approach, PI controllers designing, torque-loop, speed control loop compensation, acceleration of battery electric vehicle. **(12 hrs)**

Unit No	**Module**	**Micro content**
5a. Battery Charging and control	**Battery charging**	Basic requirements,
		charger architecture
		charger functions
		wireless charging
		power factor correction
5b. Charging Control	**Charging Control**	modelling of electro mechanical system
		feedback controller design approach
		PI controllers designing
		torque-loop, speed control loop compensation
		acceleration of battery electric vehicle.

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						1							
CO2	1						2							
CO3	2	2										2	1	
CO4	1													
CO5	2	1										2		1

IV Year II Semester

L	T	P	C
3	0	0	3

Electric Power Quality

PRE-REQUISITES: 1. Power Electronics
2. FACTS Devices

Preamble: An Enlarged utilization of Power Electronics loads gives the awareness on the power quality. A reasonable understanding on the basics of various power quality problems and their solutions to applied electricity is therefore important for an electrical engineer. This course covers different power quality problems occurring in power system and provides brief idea about their solutions with comparative study.

Course objectives: The main objectives are

1. Different types of power quality phenomena and identify sources for voltage sag, voltage swell, interruptions, transients, long duration over voltages and harmonics in a power system.
2. Power quality terms and study power quality standards.
3. The principle of voltage regulation, power factor improvement methods and study the effect the harmonic distortion and its solutions.
4. The relationship between distributed generation and power quality.
5. The power quality monitoring concepts and the usage of measuring instruments

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Introduction to Power Quality (12 Hrs)** Overview of power quality –Concern about the power quality –General classes of power quality and voltage quality problems –Transients –Long–duration voltage variations –Short–duration voltage variations –Voltage unbalance –Waveform distortion –Voltage fluctuation –Power frequency variations- Power quality terms –Voltage sags, Voltage swells, and harmonics interruptions, voltage flicker and voltage spikes –Sources of voltage sag, swell and interruptions –Nonlinear loads. Source of transient over voltages –Principles of over voltage protection, Devices for over voltage protection –Utility capacitor switching transients.	**CO1**
II	**Voltage Regulation and power factor improvement (12 Hrs)** Principles of regulating the voltage –Device for voltage regulation –Utility voltage regulator application –Capacitor for voltage regulation –Enduser capacitor application –Regulating utility voltage with distributed resources –Flicker –Power factor penalty –Static VAR compensations for power factor improvement.	**CO2**
III	**Harmonic distortion and solutions (12 Hrs)** Voltage distortion vs. Current distortion –Harmonics vs. Transients –Harmonic indices –Sources of harmonics –Effect of harmonic distortion –Impact of capacitors, transformers, motors and meters –Point of common coupling –Passive and active filtering –Numerical problems.	**CO3**
IV	**Distributed Generation and Power Quality (12Hrs)** Resurgence of distributed generation –DG technologies –Interface to the utility system –Power quality issues and operating conflicts –DG on low voltage distribution networks.	**CO4**

V	**Monitoring and Instrumentation (12 Hrs)** Power quality monitoring and considerations –Historical perspective of PQ measuring instruments –PQ measurement equipment –Assessment of PQ measuring data –Application of intelligent systems –PQ monitoring standards.	CO5
Content Beyond the syllabus: Total Harmonic Distortion and Total Demand Distortion.		

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Understand** the different types of power quality problems and analyze power quality terms and power quality standards. **{Apply level, KL2}**
CO2	**Explain** the principle of voltage regulation and power factor improvement methods. **{Evaluate level, KL3}**
CO3	**Analyze** the effect the harmonic distortion and its solutions. **{Analyze level, K34}**
CO4	**Demonstrate** the relationship between distributed generation and power quality**{Understand level, KL2}**
CO5	**Understand** the power quality monitoring concepts and the usage of measuring instruments. **{Explain level, KL2}**

Learning Resources

Text books:

1. Electrical Power Systems Quality, Dugan R C, McGranaghan M F, Santoso S, and
2. Beaty H W, Second Edition, McGraw-Hill, 2012, 3rd edition..
3. Electric power quality problems -M.H.J.Bollen IEEE series-Wiley India publications,2011.

Reference books:

1. Power Quality Primer, Kennedy B W, First Edition, McGraw-Hill, 2000.
2. Understanding Power Quality Problems: Voltage Sags and Interruptions, Bollen M HJ, First Edition,IEEE Press; 2000.
3. Power System Harmonics, Arrillaga J and Watson N R, Second Edition, John Wiley& Sons, 2003.
4. Electric Power Quality control Techniques, W. E. Kazibwe and M. H. Sendaula, VanNostradReinhold,New York.
5. Power Quality C.Shankaran, CRC Press, 2001
6. Harmonics and Power Systems -Franciso C.DE LA Rosa-CRC Press (Taylor &Francis

e- Resources & other digital material

1. https://www.digimat.in/nptel/courses/video/108107157/L01.html
2. https://nptel.ac.in/courses/108106025
3. https://onlinecourses.nptel.ac.in/noc20_ee10/preview
4. https://onlinecourses.nptel.ac.in/noc20_ee10/preview

Micro-Syllabus

Unit-1 Introduction to Power Quality (12 Hrs)

Overview of power quality -Concern about the power quality -General classes of power quality and voltage quality problems -Transients -Long-duration voltage variations -Short-duration voltage variations -Voltage unbalance -Waveform distortion -Voltage fluctuation -Power frequency variations- Power quality terms -Voltage sags, Voltage swells, and harmonics interruptions, voltage flicker and voltage spikes -Sources of voltage sag, swell and interruptions -Nonlinear loads. Source of transient over voltages -Principles of over voltage protection, Devices for over voltage protection -Utility capacitor switching transients.

Unit	Module	Micro content
1.a **Power quality classes & waveform distortion**	**Voltage Quality problems & Transients**	Overview of power quality
		General classes of power quality
		Transients
		Long-duration voltage variations
		Short-duration voltage variations
1.b **Voltage fluctuation and its sources**	**Voltage Sag, Swell and interruptions**	Voltage sags
		Voltage swell and interruptions
		Source of transient over voltages
		Principles of over voltage protection
		Devices for over voltage protection

Unit-2:Voltage Regulation and power factor improvement (12 Hrs)

Principles of regulating the voltage -Device for voltage regulation -Utility voltage regulator application -Capacitor for voltage regulation -Enduser capacitor application -Regulating utility voltage with distributed resources -Flicker -Power factor penalty -Static VAR compensations for power factor improvement.

Unit	Module	Micro content
3.a **Device for voltage regulation**	**Principles of regulating the voltage voltage regulation**	Principles of regulating the voltage
		Device for voltage regulation
		Utility voltage regulator application
		Capacitor for voltage regulation
3.b **Static VAR compensations**	**Regulating utility voltage with distributed resources power factor improvement**	Enduser capacitor application
		Distributed Resources
		Power factor penalty&Static VAR compensations

Unit-3: **Harmonic distortion and solutions (12 Hrs)**

Voltage distortion vs. Current distortion -Harmonics vs. Transients -Harmonic indices -Sources of harmonics -Effect of harmonic distortion -Impact of capacitors, transformers, motors and meters -Point of common coupling -Passive and active filtering -Numerical problems.

Unit	Module	Micro content
5.a Voltage distortion & Current distortion	**Harmonic indices, Sources of harmonics**	Voltage distortion vs. Current distortion
		Harmonics vs. Transients
		Harmonic indices
		Sources of harmonics
		Effect of harmonic distortion
5.b. **Concept of Filters**	**Passive and active filtering**	Point of common coupling
		Passive and active filtering
		Numerical problems.

Unit-4:Distributed Generation and Power Quality (12Hrs)

Resurgence of distributed generation –DG technologies –Interface to the utility system –Power quality issues and operating conflicts –DG on low voltage distribution networks.

Unit	Module	Micro content
7.a Distributed Generation	**DG technologies**	Introduction to DG
		DG technologies
		Interface to the utility system
		Challenges Interface to the utility system
7.b Operating conflicts	**Power quality issues and operating conflicts**	Power quality issues
		Quality issues and operating conflicts
		DG on low voltage distribution networks

Unit-5:Monitoring and Instrumentation (12 Hrs)

Power quality monitoring and considerations –Historical perspective of PQ measuring instruments –PQ measurement equipment –Assessment of PQ measuring data –Application of intelligent systems –PQ monitoring standards.

Unit	Module	Micro content
9.a Power quality monitoring	**Power quality monitoring and considerations**	Power quality monitoring and considerations
		Historical perspective of PQ measuring instruments
9.b PQ measurement equipment	**Assessment of PQ measuring data**	PQ measurement equipment
		Assessment of PQ measuring data
		Application of intelligent systems
		PQ monitoring standards

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

IV Year II Semester

L	T	P	C
3	0	0	3

SCADA Systems and Applications

PRE-REQUISITES: 1) Power systems and Power Electronics

Course objectives: The student should be able to

1. understand about Supervisory Control and Data Acquisition System (SCADA)
2. Know the SCADA communication and its functions
3. Get an insight into its application

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**Unit -I Introduction to SCADA(10hrs)** Data acquisition systems, Evolution of SCADA, Communication technologies..**(04hrs)** Monitoring and supervisory functions, SCADA applications in Utility Automation, Industries SCADA. **(06hrs)**	**CO1**
II	**Unit-II SCADA Components(11hrs)** Industries SCADA System Components, Schemes- Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED). **(05hrs)** Programmable Logic Controller (PLC), Communication Network, SCADA Server, SCADA/HMI Systems**(06hrs)**	**CO2**
III	**Unit-III SCADA Architecture(10hrs)** Various SCADA architectures, advantages and disadvantages of each System**(5 hrs)** single unified standard architecture -IEC 61850.**(5 hrs)**	**CO3**
IV	**Unit-IV SCADA Communication (12 hrs)** Various industrial communication technologies wired and wireless methods. **(06 hrs)** Fiberoptics, Open standard communication protocols. **(06 hrs)**	**CO4**
V	**Unit-V SCADA Applications**: **(12 hrs)** Utility applications, Transmission and Distribution sector operations, monitoring, analysis and improvement. **(06 hrs)** Industries - oil, gas and water, Case studies, Implementation, Simulation Exercises. **(06 hrs)**	**CO5**

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	**Describe** the basic tasks of SCADA **{Describe level, KL2}**
CO2	Acquire **knowledge** about SCADA architecture, various advantages and disadvantages of each System {**knowledge level, KL1}**
CO3	**Understand** about single unified standard architecture IEC 61850**{understand level, KL2}**
CO4	**Understand** about SCADA system components: remote terminal units, PLCs, intelligent electronic devices, HMI systems, SCADA server. **{Understand level, KL2}**
CO5	**Apply** SCADA systems in transmission and distribution sectors **{Apply level, KL4}**

Learning Resources
Textbooks:
1. Stuart A. Boyer: "SCADA-Supervisory Control and Data Acquisition", Instrument Society of America Publications, USA, 2004 2. Gordon Clarke, Deon Reynders: "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes Publications, Oxford, UK, 2004.
Reference books:
1. William T. Shaw, "Cybersecurity for SCADA systems", PennWell Books, 2006. 2. . David Bailey, Edwin Wright, "Practical SCADA for industry", Newnes, 2003. 3. Michael Wiebe, "A guide to utility automation: AMR, SCADA, and IT systems for electric power", PennWell 1999.

Micro-Syllabus

Unit – 1 Introduction to SCADA (10 hrs)

Data acquisition systems, Evolution of SCADA, Communication technologies. **(04 hrs)**

Monitoring and supervisory functions, SCADA applications in Utility Automation, Industries SCADA. **(06 hrs)**

Unit No	Module	Micro content
1a. Introduction to SCADA	**Introduction to SCADA**	Data acquisition systems
		Evolution of SCADA
		Communication technologies
1b. Introduction to SCADA	**Introduction to SCADA**	Monitoring and supervisory functions
		SCADA applications in Utility Automation
		SCADA applications in Industries SCADA

Unit-II SCADA Components (11 hrs)

Industries SCADA System Components, Schemes- Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED). **(05 hrs)**

Programmable Logic Controller (PLC), Communication Network, SCADA Server, SCADA/HMI Systems **(06 hrs)**

Unit No	Module	Micro content
2a. SCADA Components	**SCADA Components**	Industries SCADA System Components
		Industries SCADA System Schemes
		Remote Terminal Unit (RTU),
		Intelligent Electronic Devices (IED)
2b. SCADA Components	**SCADA Components**	Programmable Logic Controller (PLC)
		Communication Network
		SCADA Server
		SCADA/HMI Systems

Unit-III SCADA Architecture (10hrs)

Various SCADA architectures, advantages, and disadvantages of each System **(5 hrs)**

single unified standard architecture -IEC 61850.**(5 hrs)**

Unit No	Module	Micro content
3a SCADA Architecture	**SCADA Architecture**	Various SCADA architectures
		Advantage of each System

		Disadvantages of each System
3b. SCADA Architecture	**SCADA Architecture**	Single unified standard architecture -IEC 61850.

Unit-IV SCADA Communication(10hrs)
Various industrial communication technologies wired and wireless methods. **(06hrs)**
fiberoptics, Open standard communication protocols. **(04hrs)**

Unit No	Module	Micro content
4a. SCADA Communication	**SCADA Communication**	various industrial communication technologies
		wired methods
		wireless methods
4b. SCADA Communication	**SCADA Communication**	fiber optics
		Open standard communication protocols

Unit-V SCADA Applications: **(12 hrs)**
Utility applications, Transmission and Distribution sector operations, monitoring, analysis and improvement. **(06 hrs)**
Industries - oil, gas and water, Case studies, Implementation, Simulation Exercises. **(06 hrs)**

Unit No	Module	Micro content
5a. SCADA Applications	**SCADA Applications**	Utility applications
		Transmission and Distribution sector operations
		Transmission and Distribution system monitoring, analysis
		Transmission and Distribution system improvement
5b. SCADA Applications	**SCADA Applications**	Industries - oil, gas and water, Case studies
		Industries - oil, gas and water Implementation,
		Simulation Exercises

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

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