GOVERNMENT COLLEGE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University)
Coimbatore - 641 013

Curriculum For

Under Graduate
B. E. Electrical and Electronics Engineering
(Full Time)

2022

Regulations

OFFICE OF THE CONTROLLER OF EXAMINATIONS
GOVERNMENT COLLEGE OF TECHNOLOGY
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GOVERNMENT COLLEGE OF TECHNOLOGY

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION AND MISSION OF THE DEPARTMENT

VISION:

To be a premier department providing value based and enlightening education committed to excellence in Electrical Engineering and Technology professions.

MISSION:

To facilitate quality learning blended with practical engineering skills.

To prepare students to develop all round competitiveness.

To motivate Faculty and students to do impactful research on societal needs.

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The Programme Educational Objectives of Electrical and Electronics Engineering Graduates will be able:

PEO1:

To excel in technological advancements in Electrical and Electronics Engineering and allied Fields.

PEO2:

To design electrical, electronic and computing systems that are innovative and socially acceptable.

PEO3:

- To exhibit professionalism, ethics, communication skills and team work in their career.
- To adapt to current trends through lifelong learning and involved in application oriented research.

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

PROGRAMME OUTCOMES (POs)

Engineering Graduates will be able to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms ofthe engineering practice.
9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communication: Communicate effectively on complex engineering activities with the engineeringcommunity and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

PROGRAMME SPECIFIC OUTCOMES (PSOs)

Electrical and Electronics Engineering Graduates will be able to:

PSO1: Apply the knowledge of Mathematics and Science in Electrical and Electronics Engineering and adapt to a challenging environment through individual and team work.

PSO2: Design, analyze and evaluate the performance of Electrical system using latest tools and gain sufficient competence to solve the problems in the electrical energy sector with future perspective considering socio-economic aspects.

PSO3: Develop the expertise in the emerging technologies for efficient operation and control of Electrical system with ethical responsibility and effective communication to engage in lifelong learning for a successful career.

THIRD SEMESTER

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	22EES307	Data Structures (Common to EEE, ECE & CSE)	ES	40	60	100	3	0	0	3
2	22EPC301	Electric Circuit Theory	PC	40	60	100	3	1	0	4
3	22EPC302	Field Theory	PC	40	60	100	3	1	0	4
4	22EPC303	Electronic Devices and Circuits	PC	40	60	100	3	0	0	3
5	22EPC304	Electrical Machines-I	PC	40	60	100	3	0	0	3
6	22EPC305	Digital Circuits	PC	40	60	100	3	0	0	3
PRACTICAL										
7	22EPC306	Electric Circuits and Electronic Devices Laboratory	PC	60	40	100	0	0	3	1.5
8	22EPC307	Electrical Machines Laboratory – I	PC	60	40	100	0	0	3	1.5
TOTAL				**360**	**440**	**800**	**18**	**2**	**6**	**23**

FOURTH SEMESTER

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	22EBS407	Fourier Series and Transform Calculus (Common to EEE & EIE Branches)	BS	40	60	100	3	1	0	4
2	22EPC408	Linear Integrated Circuits	PC	40	60	100	3	0	0	3
3	22EPC409	Electrical Machines-II	PC	40	60	100	3	0	0	3
4	22EPC410	Power Generation, Transmissionand Distribution	PC	40	60	100	3	0	0	3
5	22EPC411	Principles of Signals and Systems	PC	40	60	100	3	0	0	3
THEORY WITH PRACTICAL COMPONENT										
6	22EPC412	Electrical and Electronic Measurements	PC	50	50	100	3	0	2	4
PRACTICAL										
7	22EES408	Engineering Exploration for Electrical Engineers	ES	100	-	100	0	0	3	1.5
8	22EPC413	Analog Circuits and Digital IC Laboratory	PC	60	40	100	0	0	3	1.5
9	22EPC414	Electrical Machines Laboratory –II	PC	60	40	100	0	0	3	1.5
TOTAL				**470**	**430**	**900**	**18**	**1**	**11**	**24.5**

22EES307	DATA STRUCTURES (Common to EEE, ECE & CSE Branches)	III SEMESTER

PREREQUISITES	CATEGORY	L	T	P	C
Programming In C	PC	3	0	0	3

Course Objectives	The objective of the course is to enable the students to analyze the time complexity of an algorithm, Understand and Use List, Stack, Queue, Tree and graph Data structures and effectively use sorting and searching Techniques.	
UNIT – I	**INTRODUCTION AND ABSTRACT DATA TYPES**	**(9 Periods)**
Algorithm Analysis: Calculation of Running Time – Abstract Data Type- List ADT: Array implementation of List, Linked Lists, Doubly Linked List, Circularly Linked Lists- Cursor implementation of Linked List		
UNIT – II	**STACK AND QUEUE ADT**	**(9 Periods)**
Stack ADT: Stack Model, Implementation of stacks, Applications: Balancing Symbols, Postfix expression evaluation, Infix to postfix conversion, Function Calls – Queue ADT: Queue Model, Implementation of Queues, Applications.		
UNIT – III	**TREE ADT**	**(9 Periods)**
Preliminaries – Implementation of Trees – Tree Traversals – Binary Tree: Implementation, Expression Tree – Search Tree ADT – AVL Trees - BTrees – Red Black Trees.		
UNIT – IV	**GRAPH ALGORITHMS**	**(9 Periods)**
Definitions – Representation of Graphs – Traversal- Topological sort – Shortest Path Algorithms: Dijkstra's Algorithm – Network Flow Problem – Minimum Spanning Tree: Prim's and Kruskal's algorithm.		
UNIT – V	**SORTING AND SEARCHING**	**(9 Periods)**
Sorting: Insertion Sort – Shell Sort – Heap Sort – Merge Sort – Quick Sort – Bucket Sort – External Sorting: Simple Algorithm, Multi way merge, Poly Phase Merge – Searching : Linear Search – Binary Search – Hashing : Hash Functions– Collision Resolution: Separate Chaining – Open Addressing – Linear Probing– Quadratic Probing – Double Hashing – Rehashing.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*Mark Allen Weiss* ***"Data Structures and Algorithm Analysis in C"*** *Second Edition, Pearson Education Limited, 2002.*

REFERENCES:

1	*Thomas H. Cormen , Charles E. Leiseron, Ronald L.Rivest, Clifford Stein,* ***"Introduction to Algorithms",*** *Third Edition, PHI learning Pvt. Ltd., 2011.*
2	*Sartaj Sahni, "****Data Structures, Algorithms and applications in C++",*** *Second Edition, Universities Press, 2005.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyze the time complexity of various algorithms	K4
CO2	Define and use list, stack and queue Data Structures	K3
CO3	Define and use Tree Data Structure	K3
CO4	Define and use Graph Data Structure	K4
CO5	Use appropriate sorting and searching Techniques	K4

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping															
Cos/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	1	2	1	-	-	-	-	-	-	-	1	2	2	1
CO2	2	2	2	2	2	2	-	-	-	1	-	1	2	1	1
CO3	2	2	2	2	2	2	-	-	-	1	-	1	2	1	1
CO4	2	2	2	2	2	2	-	-	-	1	-	1	2	1	1
CO5	2	2	1	1	-	-	-	-	-		-	1	2	2	2
22EES 307	2	2	2	2	2	2	-	-	-	1	-	1	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1,1.3.1,1.4.1,2.1.2,2.2.2,2.3.1,2.4.1,3.1.6,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,4.2.2,4.3.1,12.2.2.
CO2	1.3.1,1.4.1,2.1.1,2.1.2,2.2.2,2.2.3,2.4.2,2.4.4,3.1.1.,3.1.3,3.1.6,3.2.3,3.3.1,3.4.1,4.1.2,4.1.3,4.2.2, 4.3.4,5.1.2,5.2.2,5.3.2,6.1.1,7.2.2,10.2.2,11.3.1,12.1.1,12.2.2,12.3.2
CO3	1.3.1,1.4.1,2.1.1,2.1.2,2.2.2,2.2.3,2.4.2,2.4.4,3.1.1.,3.1.3,3.1.6,3.2.3,3.3.1,3.4.1,4.1.2,4.1.3,4.2.2, 4.3.4,5.1.2,5.2.2,5.3.2,6.1.1,7.2.2,10.2.2,11.3.1,12.1.1,12.2.2,12.3.2
CO4	1.3.1,1.4.1,2.1.1,2.1.2,2.2.2,2.2.3,2.4.2,2.4.4,3.1.1.,3.1.3,3.1.6,3.2.3,3.3.1,3.4.1,4.1.2,4.1.3,4.2.2, 4.3.4,5.1.2,5.2.2,5.3.2,6.1.1,7.2.2,10.2.2,11.3.1,12.1.1,12.2.2,12.3.2
CO5	1.3.1,1.4.1,2.1.2.2.1,2.2.3,2.3.1,2.4.4,3.1.3,3.1.6, 3 .2.3, 3.3.2, 4.1.2, 4.2.1,4.3.1,6.1.1, 10.3.1,11.2.1, 12.1.1,12.2.2,12.3.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	-	20	30	50	-	-	100
CAT2	-	10	80	10	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	-	80	20	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	-	80	20	-	-	100
ESE	-	30	50	20	-	-	100

22EPC301	ELECTRIC CIRCUIT THEORY	III SEMESTER

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	1	0	4

Course Objectives	To gain knowledge in basic concepts of circuit theory and finally be able to analyze and synthesize electric circuits	
UNIT – I	**DC AND AC CIRCUIT ANALYSIS**	**(12 Periods)**
Ohm's law and Kirchhoff's Laws – Waveform representation – Form Factor and Peak Factor derivation for alternating waveforms - R, L, C series-parallel circuits - Star-delta transformation - Source transformations - Mesh and nodal methods – Phase relation in R, L and C - Power factor - Real, reactive and apparent powers – Problems in AC and DC circuits.		
UNIT – II	**NETWORK THEOREMS AND POLYPHASE CIRCUITS**	**(12 Periods)**
Superposition theorem – Thevenin's and Norton's theorems - Maximum power transfer theorem - Reciprocity theorem. Three phase system – Interconnection of three- phase sources and loads - Balanced and unbalanced circuits - Power measurement		
UNIT – III	**RESONANCE, COUPLED CIRCUITS AND TRANSIENTS**	**(12 Periods)**
Resonance in series and parallel circuits – frequency response - derivation of bandwidth - Introduction to coupled circuits – Mutual inductance – Coefficient of coupling - Dot rule - Single and double tuned circuits - Problems. Transient response – DC response of RL, RC, R L C circuits – Sinusoidal response of RL, RC, RLC circuits.		
UNIT – IV	**TWO PORT NETWORKS**	**(12 Periods)**
Two port networks - Open circuit impedance and short circuit admittance parameters – Transmission and inverse transmission parameters – Hybrid and inverse hybrid parameters- Image parameters - Applications.		
UNIT – V	**FILTERS DESIGN AND SYNTHESIS OF CIRCUITS**	**(12 Periods)**
Classification of filters - Low pass and high pass filters - Band pass and Band stop filters- Constant K and m-derived filters. Hurwitz Polynomials – Positive Real Function – Synthesis of reactive one port RL, RC networks using Foster and Cauer methods.		
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60 Periods**		

TEXT BOOK:

1	*Sudakar A. and Shyam Mohan S.Palli* ***"Circuits and Networks (Analysis and Synthesis)"*** *Tata Mc Graw Hill Book Co., New Delhi, III Ed., 2017*
2	*Charles K. Alexander, Matthew N.O. Sadiku* ***"Fundamentals of Electric Circuits"*** *McGraw Hill Book Co., 7 Ed. 2020*

REFERENCES:

1	*Hayt W.H and Kemmerley J.E,* ***"Engineering Circuit Analysis"****, Tata McGraw Hill Book Co., V Ed., 2019*
2	*C.P. Kuriakose* ***"Circuit Theory: Continuous and Discrete – time systems – Elements of Network Synthesis"*** *PHI, Delhi, 2018*
3	*Gangadhar K.A.,* ***"Circuit Theory"****, Khanna Publishers, II Ed., 2019*
4	*M.E.Van Valkenburg,* ***"Network Analysis"****, PHI, Delhi, 2019*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply electric circuit laws to DC and AC circuits and solve problems	K3
CO2	Analyze complex circuits using theorems and solve three phase circuits	K4
CO3	Understand the concepts of resonance, coupled circuits and transients and solve problems	K2
CO4	understand two port networks and solve the networks using different parameters	K2
CO5	Design filter circuits and Synthesize electric networks.	K6

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	1	3	-	-	-	-	-	-	-	-	2	1	1
CO2	3	3	1	3	-	-	-	-	-	-	-	-	3	3	1
CO3	3	3	1	3	-	-	-	-	-	-	-	-	3	3	1
CO4	3	3	1	3	-	-	-	-	-	-	-	-	3	2	2
CO5	3	3	1	3	-	-	-	-	-	-	-	-	2	2	2
22EPC301	3	3	1	3	-	-	-	-	-	-	-	-	3	2	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.2.1,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.2.1,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.2.1,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.2.1,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.2.1,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	40	-	30	-	100
CAT2	10	20	30	10	30	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	-	40	40	20	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	20	40	40	-	-	100
ESE	10	20	30	-	30	10	100

22EPC302	FIELD THEORY	III SEMESTER

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	1	0	4

Course Objectives	To learn the concepts of static and dynamics of charges, understand electromagnetic fields and work on problem solving and application of these ideas for design	
UNIT – I	**ELECTROSTATIC POTENTIAL AND FIELD**	**(12 Periods)**
Types of charges - Charge distribution - Coulomb's Law - Gauss' law - their applications - Potential - Electric field intensity - Boundary Conditions - Laplace and Poisson's equations – Dielectrics – Capacitance - Electrostatic energy- Problems		
UNIT – II	**MAGNETIC POTENTIAL AND FIELD**	**(12 Periods)**
Biot - Savart's law - Ampere's law - Their applications - Scalar and Vector magnetic potentials - Magnetic torque - Force - Boundary conditions – Energy density in magnetic field – Lifting power of electromagnet – Problems		
UNIT – III	**ELECTRO MAGNETIC FIELDS**	**(12 Periods)**
Problems in divergence and curl of vector fields in various coordinates - Faraday's laws - Maxwell's equations - Current densities - Time harmonics fields - Problems		
UNIT – IV	**ELECTROMAGNETIC WAVES**	**(12 Periods)**
Wave equations – Uniform plane waves in free space - Uniform plane waves in lossless dielectrics – Uniform plane waves in lossy dielectrics – Uniform plane waves in good conductor - Poynting's theorem - Problems.		
UNIT – V	**FIELD MODELING, EMI AND EMC**	**(12 Periods)**
Field plotting - Laplace equation in rectangular coordinates – Separation of variables - Finite difference method - Finite element method - Infinite square through with lid – Infinite square through with different potentials on four sides – Moment method – EMI and EMC – Sources – Conducted and Radiated EMI – Elimination methods - Problems.		
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60 Periods**		

TEXT BOOK:

1	*John D. Kraus and Daniel A. Fleisch **"Electromagnetics with Applications",** Mc Graw Hill International Ed., 2018.*
2	*William H.Hayt **"Engineering Electromagnetics"**, Mc Graw Hill Book Co., 2020.*

REFERENCES:

1	*AshutoshPramanik **"Electromagnetism"** Prentice Hall of India Pvt. Ltd, 2018.*
2	*Gangadhar K.A., **"Field Theory"**, Khanna Publishers, 2017.*
3	*Joseph Edminister, **"Electromagnetics"**, 2nd Ed., Tata McGraw Hill Book Co., 2019.*
4	*Mathew N.D Sadiku, **"Elements of Electromagnetics"**, Oxford university press, Fourth Edition., 2021.*
5	*Dr.Dhananjayan.P. **"Engineering Electromagnetics"**, Lakshmi Publications, 2021.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the basics of electric field	K2
CO2	Ascertain the concepts of magnetic field	K3
CO3	Master the fundamentals of electromagnetic field	K3
CO4	Illustrate the knowledge gained to analyze electromagnetic waves	K3
CO5	Estimate the field parameters for a given problem based on field modeling	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	1	2	-	-	-	-	-	-	2	1	1
CO2	3	3	3	3	1	2	-	-	-	-	-	-	3	3	1
CO3	3	3	3	3	1	2	-	-	-	-	-	-	3	3	1
CO4	3	3	3	3	1	2	-	-	-	-	-	-	3	2	2
CO5	3	3	3	3	1	2	-	-	-	-	-	-	2	2	2
22EP C302	3	3	3	3	1	2	-	-	-	-	-	-	3	2	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,4.1.1,4.1.2,4.1.4, 4.2.1,4.3.1,5.1.1,5.1.2,6.1.1
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,4.1.1,4.1.2,4.1.4, 4.2.1,4.3.1,5.1.1,5.1.2,6.1.1
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,4.1.1,4.1.2,4.1.4, 4.2.1,4.3.1,5.1.1,5.1.2,6.1.1
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,4.1.1,4.1.2,4.1.4, 4.2.1,4.3.1,5.1.1,5.1.2,6.1.1
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,4.1.1,4.1.2,4.1.4, 4.2.1,4.3.1,5.1.1,5.1.2,6.1.1

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	40	-	30	-	100
CAT2	10	20	20	20	30	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	-	40	40	20	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	-	40	40	20	-	100
ESE	10	20	20	20	30	-	100

22EPC303	ELECTRONIC DEVICES AND CIRCUITS	III SEMESTER

PREREQUISITES :	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To impart knowledge about various electronic devices and circuits and to identify the suitability of electronic devices for real time applications.	
UNIT – I	**DIODES AND APPLICATIONS**	**(9 Periods)**
PNdiode: VIcharacteristics – transition and diffusion capacitance – reverse recovery time – diodemodels – Applications : Half-wave and Full-wave rectifiers and filters – power supply regulators – Clipping and clamping circuits – Avalanche and Zener break down – Zenerdiodes – varactor and optical diodes.		
UNIT – II	**BI-POLAR JUNCTION TRANSISTORS AND AMPLIFIERS**	**(9 Periods)**
BJT: Structure–operation and characteristics – as an amplifier and switch– DC operating point – base, emitter and voltage-divider bias –Miller's theorem –BJT amplifier : operation –AC equivalent circuits–CE, CC, CB configurations - multistage – RC coupled – transformer coupled– Darlington and differential amplifiers.		
UNIT – III	**FIELD-EFFECT TRANSISTOR AND BIASING**	**(9 Periods)**
JFET: Structure, operation and characteristics with parameters – biasing configurations – MOSFET: Structure – types (Depletion and Enhancement) – operation and characteristics– biasing configurations – V MOSFET – CMOS technology.		
UNIT – IV	**AMPLIFIERS ANALYSIS AND FEEDBACK TECHNIQUES**	**(9 Periods)**
BJT and FET amplifiers – basics of frequency response – Low–high and total Frequency response –Power amplifiers –operation – characteristics– parameters of Class A, AB, B and C amplifiers – Operational Amplifier : inverting and non inverting amplifiers –concepts of feedbacks –Negative feedback: shunt and series feedback- Positive feedback: WienBridge and RC phase shift oscillators.		
UNIT – V	**OTHER SEMICONDUCTOR DEVICES**	**(9 Periods)**
Basic constructions, characteristics curves, parameters and applications : SCR – DIAC – TRIAC - Unijunction Transistors - programmable Unijunction Transistors –IGBT –photo transistors and optical couplers–New semiconductor materials –SiliconCarbide- GalliumArsenide.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	*Thomas L.Floyd, **"Electronic Devices"**, 9th Edition. ,Prentice Hall Inc. 2012*
2	*Robert Boyle stad, **"Electronic Devices and Circuit Theory"**, 9th Edition, Pearson, 2010*

REFERENCES:

1	*Jacob Millman, Christos C Halkias and SatyabrataJIT ,**"Electron Devices and Circuits"**, 2nd Ed.,Tata Mc GrawHill, 2008.*
2	*Allen Mottershead, "**Electronic Devices and Circuits, An Introduction**", Eastern Economy Ed.,Prentice-HallofIndia,2009*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the construction and working of semiconductor devices	K2
CO2	Analyze the characteristics of the devices and their equivalent circuit models	K4
CO3	Design of electronic circuits using devices and components	K3
CO4	Explore the suitability the device for various applications	K5
CO5	Study the special semiconductor and power electronic devices	K2

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	2	2	2	2	2	2	-	-	1	1	-	3	3	1
CO2	3	3	1	2	2	-	-	-	-	-	-	2	2	3	1
CO3	3	3	1	2	2	-	-	-	-	2	3	2	2	3	2
CO4	3	2	2	2	2	-	2	-	-	1	2	-	3	2	3
CO5	3	2	2	2	2	-	2	2	-	1	3	3	2	2	2
22EPC303	3	2	2	2	2	2	2	2	-	1	2	2	2	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping		
CO1	1.2.1,1.3.1,1.4.1,2.3.1,2.3.2,2.4.4,3.1.3,3.1.6,3.2.1,4.1.4,4.2.1,4.3.4,5.1.1,5.3.1,6.1.1,7.1.1,7.2.2,10.1.1,10.3.1,11.1.1	
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.6,3.2.1,3.2.2,3.2.3,4.1.1,4.1.3,4.1.4,5.1.1,5.2.1,5.3.1,12.1.2,12.2.2,12.3.2	
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.6,3.2.1,3.2.2,3.2.3,4.1.1,4.1.3,4.1.4,5.1.1,5.2.1,5.3.1,12.1.2,12.2.2,12.3.2,10.1.1,10.2.2,10.3.1,11.1.1,11.2.1,11.3.1,11.3.2,12.3.1,12.3.2	
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.3,2.2.4,2.4.2,2.4.3,2.4.4,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.3.1,4.1.2,4.1.4,4.2.1,5.1.2,5.2.2,5.3.2,7.1.1,7.2.2,10.1.1,10.3.1,11.2.1,11.1.2, 11.3.2	
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.3,2.2.4,2.4.2,2.4.3,2.4.4,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.3.1,4.1.2,4.1.4,4.2.1,5.1.2,5.2.2,5.3.2,7.1.1,7.2.2,10.1.1,10.3.1,11.2.1,11.1.2, 11.3.2,8.2.1,8.2.2,11.1.1,11.1.2,11.2.1,12.1.2,12.2.1,12.3.1,12.3.2	

ASSESSMENT PATTERN							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	30	20	10	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	30	20	20	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	30	20	20	-	100
ESE	10	30	30	20	10	-	100

22EPC304	ELECTRICAL MACHINES-I	SEMESTER III

PREREQUISITES :	CATEGORY	L	T	P	C
Engineering Physics, Field theory	PC	3	0	0	3

Course Objectives	To obtain knowledge about energy in the magnetic system, the working principle of DC generators, DC motors and Transformers. Also to perform testing in various DC machines and transformers.	
UNIT – I	**PRINCIPLES OF ELECTROMECHANICAL ENERGY CONVERSION**	**(9 Periods)**
Energy in magnetic system – Field energy- co energy - Force -torque equations- eddy currents - eddy current losses – flux distribution curve in the air gap – Singly-multiply excited magnetic field systems - mmf of distributed ac windings – Winding Inductances - Rotating Magnetic Field- mmf waves - Magnetic saturation - leakage fluxes.		
UNIT – II	**DC GENERATORS**	**(9 Periods)**
Constructional details- principle of operation – Armature winding -Emf equation – Types of dc generators - Armature reaction: Effects of armature reaction - demagnetizing & cross magnetizing ampere-turns – compensating windings – interpoles : commutation – Characteristics of DC generators - losses - efficiency - Parallel operation of dc generators- applications.		
UNIT – III	**DC MOTORS**	**(9 Periods)**
Constructional details - principle of operation- back emf – Types -Torque equation losses - efficiency – power flow diagram – Electrical - mechanical characteristics of different types of DC motors – Starters – Speed control methods – Types of Electric braking		
UNIT – IV	**TRANSFORMERS**	**(9 Periods)**
Principle of operation – Types-constructional features of single phase -three phase transformers –EMF equation - Phasor diagram – Transformers on load - Equivalent circuit – Voltage Regulation - efficiency- All day efficiency Three phase transformer connections – Scott connection – Parallel operation of three phase transformers – Inrush current phenomenon - its prevention - Auto transformers, Off-load - on-load tap changing transformer-Isolation Transformer.		
UNIT – V	**TESTING OF DC MACHINES AND TRANSFORMERS**	**(9 Periods)**
DC machines: Brake test, field test, Retardation test - Swinburne's test - Hopkinson's test. Transformers: Open Circuit -Short Circuit Tests-– Phasing, Identification -Polarity of transformer winding - Sumpner's test.		
Contact Periods: **Lecture:45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*Nagrath J. and D. P. Kothari, **"Theory of Electric Machines"**, Tata McGraw Hill, 2006*
2	*Fitzgerald A. E., C. Kingsley and S. Umans, **"Electric Machinery"**, 7/e, McGraw Hill, 2020*

REFERENCES:

1	*Bimbra P. S., **"Electrical Machinery"**, 7/e, Khanna Publishers, 2021.*
2	*BL. Theraja, AK, Theraja, **"A Textbook of Electrical Technology"** Volume II : AC And DC Machines" , S.Chand Publications, Multicolour Illustrative Edition, 2005.*
3	*Abhijith Chakrabarti, Sudipta Debnath, **"Electrical Machines"**, McGraw Hill Education, NewDelhi 2015.*
4	*Deshpande M. V., **"Electrical Machines"**, Prentice Hall India, New Delhi, 2011.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply basic laws of electromagnetic principles for static and dynamic electric machines.	K1
CO2	Analyze the performance of electrical machines for the different level of utilization in Industries.	K4
CO3	Identify suitable machines for any specific application.	K6
CO4	Perform testing of the electrical machines.	K3
CO5	Evaluate the performance of electrical machines.	K5

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	2	2	1	-	-	-	-	1	1	2	3	2	2
CO2	3	3	3	3	1	-	-	-	-	1	1	1	3	3	3
CO3	3	2	2	2	2	-	-	-	-	-	1	1	3	2	2
CO4	2	2	2	3	1	-	-	-	-	1	1	1	2	2	2
CO5	2	2	1	3	1	-	-	-	-	-	1	2	2	2	1
22EPC 304	3	2	2	3	1	-	-	-	-	1	1	1	3	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.4,2.4.1,2.4.2,3.1.1,3.1.3,3.1.6,3.2.2,3.2.3,3.3.1,3.4.1,4.1.1,4.1.2,4.2.2,4.3.4,5.1.2,5.3.2,10.1.3,10.3.2,11.1.2,12.1.1,12.2.1,12.3.1,
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.2.1,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.6,3.2.1,3.2.2,3.3.1,3.3.2,3.4.2,4.1.2,4.1.3,4.1.4,4.2.1,4.3.1,4.3.2,4.3.4,5.1.1,5.3.1,10.2.1,10.3.2,11.1.1,12.1.2,
CO3	1.1.1,1.1.2,1.2.1,1.3.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.3,2.4.4,3.1.2,3.1.4,3.1.5,3.2.1,3.2.3,3.3.1,3.3.2,3.4.2,4.1.1,4.2.1,4.2.2,5.1.1,5.2.1,5.2.2,11.3.1,12.2.1,12.2.2,
CO4	1.1.1,1.3.1,2.1.2,2.2.1,2.2.3,2.2.4,2.3.1,3.1.3,3.1.6,3.2.1,3.2.2,3.4.1,4.1.1,4.1.2,4.1.3,4.2.1,4.3.1,4.3.2,4.3.4,5.1.2,10.1.2,10.3.1,11.3.1,12.1.1,12.3.1,
CO5	1.1.2,1.2.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.4,3.3.2,3.4.1,4.1.1,4.1.2,4.1.4,4.2.2,4.3.3,4.3.4,5.3.2,11.1.2,12.1.1,12.2.1,12.3.2,

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	30	20	10	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	30	20	20	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	30	20	20	-	100
ESE	10	30	30	20	10	-	100

22EPC305	DIGITAL CIRCUITS	SEMESTER III

PREREQUISITES :	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To learn the concepts and design techniques used in digital electronics and also to familiarize the Hardware description language in the design of digital circuits	
UNIT – I	**NUMBER SYSTEMS AND DIGITAL LOGIC FAMILIES**	**(9 Periods)**
Number system- error detection, corrections & codes conversions- Boolean Algebra and Logic gates – Boolean functions - Canonical and Standard Forms - Digital Logic gates – Gate level minimization - NAND and NOR Implementation- minimization using K-maps & Quine McCluskey Digital Logic Families - comparison of RTL, DTL, TTL, ECL and MOS families - operation, characteristics of digital logic family.		
UNIT – II	**COMBINATIONAL CIRCUITS**	**(9 Periods)**
Combinational circuits - Analysis and Design Procedure- Binary adder subtractor - Decimal adder – Binary multiplier – Magnitude comparator – Multiplexers - Demultiplexers - code converters- Encoders and Decoders.		
UNIT – III	**SYNCHRONOUS SEQUENTIAL CIRCUITS**	**(9 Periods)**
Sequential circuits- Latches – Flip flops – Analysis of Clocked Sequential Circuits – State Reduction and Assignment - Design Procedure- Moore and Mealy models - Registers, Shift Registers, Ripple Counters, Synchronous Counters.		
UNIT – IV	**ASYNCHRONOUS SEQUENTIAL CIRCUITS AND PROGRAMMABLE LOGIC DEVICES**	**(9 Periods)**
Asynchronous Circuits - Analysis Procedure - Circuits with Latches – Reduction of State Flow Tables – Race Free State Assignment – Hazards - Design Example. Programmable Logic Devices: PROM – PLA –PAL, CPLD-FPGA.		
UNIT – V	**HARDWARE DESCRIPTION LANGUAGE**	**(9 Periods)**
Introduction to Verilog: Structure of Verilog module, Operators, data types, Styles of description- Data flow description, Implement logic gates, half adder and full adder using Verilog data flow description. Behavioral description: Structure, variable assignment statement, sequential statements, Verilog behavioral description of Multiplexers (2:1,4:1,8:1) and De-multiplexers - Encoders (8 to 3), Decoders (2 to 4). Latches - flip flops.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*Morris Mano.M **"Digital Design"** Pearson Education, New Delhi, 6th Ed., 2018.*
2	*Samir Palnitkar, **"Verilog HDL- A guide to Digital Design and Synthesis"** Pearson Education, New Delhi, 2ndEd., 2003.*

REFERENCES :

1	*Ronald J. Tocci, Neal S Widmer, Gregory L Moss, **"Digital Systems: Principles and Applications",** Prentice Hall, 12thEd., 2017*
2	*Floyd Thomas L.,**"Digital fundamentals"** Pearson Education, New Delhi, 11thEd.,2015.*
3	*Charles H.Roth, **"Fundamentals of Logic Design"** 7th Ed., Cl-Engineering, 2013.*
4	*Nazeih M. Botros , **"HDL Programming VHDL and Verilog",** Dreamtech press ,2009.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the fundamentals of digital electronics and logic families.	K2
CO2	Illustrate reduction of logical expressions using Boolean algebra and k-map.	K4
CO3	Use the procedures for the analysis and design of combinational circuits	K3
CO4	Analyze the design capability in synchronous and asynchronous sequential circuits	K4
CO5	Design digital logic circuits in different types of modeling using HDL	K6

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	2	2	-	-	-	-	-	-	-	2	3	2	2
CO2	3	3	2	3	-	-	-	-	-	-	-	-	2	2	2
CO3	3	3	3	3	-	-	-	-	-	-	-	1	3	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2	3	3	2
CO5	3	3	3	3	3	-	-	-	-	-	-	2	3	3	3
22EPC 305	3	3	3	3	3	-	-	-	-	-	-	2	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.4,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.1.3,3.1.6,3.2.1,3.2.3,4.1.1,4.1.4,4.2.2,4.3.4,12.2.1,12.2.2,12.3.1,12.3.2
CO2	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.3, 3.1.6, 3.2.1, 3.2.3, 3.3.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.3.1, 4.3.3, 4.3.4
CO3	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.4, 3.1.1, 3.1.3, 3.1.3, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.3, 4.3.4, 12.1.2
CO4	1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.3,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.3,4.3.4,12.1.2,12.2.2,12.3.2
CO5	1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.3,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.3,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,12.1.2,12.2.2,12.3.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	40	30	-	-	100
CAT2	10	20	30	30	10	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	-	50	50	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	-	40	40	20	-	100
ESE	10	20	30	30	-	10	100

22EPC306	ELECTRIC CIRCUITS AND ELECTRONIC DEVICES LABORATORY	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	0	0	3	1.5

Course Objectives	To enable the students to gain experimental skill.on the concepts learned in Electrical and Electronic circuits

List of Experiments:

1. Study of measuring instruments
2. Verification of Ohm's Law and Kirchhoff's laws.
3. Verification of network theorems.
4. Analysis of First order R-L and R-C Circuits/.Second order RLC Circuits
5. Measurement of average, rms, form and peak factor of time varying signals
6. Study of Fluorescent lamp circuit
7. Three phase power measurement
8. Semiconductor diode characteristics.
9. Zener diode characteristics and voltage regulation.
10. Transistor characteristics - common emitter mode and common base mode.
11. Characteristics of UJT and generation of sawtooth waveforms.
12. Characteristics of FET.
13. Circuit analysis using technical software
14. IV and PV characteristics of PV panel.

Contact Periods:
Lecture: 0 Periods Tutorial: 0 Periods Practical: 45 Periods Total: 45 Periods

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Verify the basic laws of circuit theory and various network theorems.	K4
CO2	Infer the characteristics of basic semiconductor devices.	K4
CO3	Measure the real and reactive power in three phase network	K4
CO4	Analyze the circuits and devices using simulation tool.	K4
CO5	Determine the parameters of electronic circuits.	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping															
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	2	2	3	-	-	-	3	1	1	-	3	3	3
CO2	3	3	2	2	3	-	-	-	3	1	1	-	3	3	3
CO3	3	3	2	2	3	-	-	-	3	1	1	-	3	3	3
CO4	3	3	2	2	3	-	-	-	3	1	1	-	3	3	3
CO5	3	3	2	2	3	-	-	-	3	1	1	-	3	3	3
22EPC306	3	3	2	2	3	-	-	-	3	1	1	-	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.22.4.1,2.4.2,2.4.3,2.4.4,3.2.1,3.2.2,3.2.3,3.4.1,3.4.2,4.1.3,4.1.4,4.2.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,9.1.1,9.1.2,9.2.19.2.2,9.2.3,9.2.4,9.3.1,10.3.1,10.3.2,11.1.1
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.22.4.1,2.4.2,2.4.3,2.4.4,3.2.1,3.2.2,3.2.3,3.4.1,3.4.2,4.1.3,4.1.4,4.2.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,9.1.1,9.1.2,9.2.19.2.2,9.2.3,9.2.4,9.3.1,10.3.1,10.3.2,11.1.1
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.22.4.1,2.4.2,2.4.3,2.4.4,3.2.1,3.2.2,3.2.3,3.4.1,3.4.2,4.1.3,4.1.4,4.2.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,9.1.1,9.1.2,9.2.19.2.2,9.2.3,9.2.4,9.3.1,10.3.1,10.3.2,11.1.1
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.22.4.1,2.4.2,2.4.3,2.4.4,3.2.1,3.2.2,3.2.3,3.4.1,3.4.2,4.1.3,4.1.4,4.2.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,9.1.1,9.1.2,9.2.19.2.2,9.2.3,9.2.4,9.3.1,10.3.1,10.3.2,11.1.1
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.22.4.1,2.4.2,2.4.3,2.4.4,3.2.1,3.2.2,3.2.3,3.4.1,3.4.2,4.1.3,4.1.4,4.2.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,9.1.1,9.1.2,9.2.19.2.2,9.2.3,9.2.4,9.3.1,10.3.1,10.3.2,11.1.1

22EPC307	ELECTRICAL MACHINES LABORATORY – I	SEMESTER III

PREREQUISITES :	CATEGORY	L	T	P	C
NIL	PC	0	0	3	1.5

Course Objectives	To give hands on training for evaluating the performance and characteristics of DC Machines and Transformers.

List of Experiments:

1. Swinburne's test and Speed control of d.c. shunt motor.
2. Open circuit characteristics and load test on d.c. shunt generator.
3. Open circuit characteristics and load test on d.c. compound generator.
4. Open circuit characteristics and load test on separately excited d.c. generator
5. Load test on d.c. shunt motor.
6. Load test on d.c. series motor.
7. Load test on d.c. compound motor.
8. Hopkinson's Test
9. OC and SC tests on single phase transformers.
10. Load test on single phase transformer.
11. Sumpner's test.
12. Separation of losses in transformers.
13. Separation of losses in dc machines
14. Three phase transformer connections.

Contact Periods:
Lecture: 0 Periods Tutorial:0 Periods Practical: 45 Periods Total: 45 Periods

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyze the electrical / mechanical / performance characteristics of DC machines/transformers.	K4
CO2	Illustrate the different speed control methods for DC Motors..	K4
CO3	Develop the transformer model and analyze the performance.	K5
CO4	Interpret component of iron loss of DC machine / transformer.	K5
CO5	Study practically the losses occurring in DC machines and transformers.	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping															
COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	3	3	3	-	-	-	3	3	-	-	2	1	1
CO2	3	3	3	3	3	-	-	-	3	3	-	-	3	3	1
CO3	3	3	3	3	3	-	-	-	3	3	-	-	3	3	1
CO4	3	3	3	3	3	-	-	-	3	3	-	-	3	2	2
CO5	3	3	3	3	3	-	-	-	3	3	-	-	2	2	2
22EPC 307	3	3	3	3	3	-	-	-	3	3	-	-	3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1, 4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1, 6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,9.1.1,9.1.2,9.2.1,9.2.2,9.2.3,9.2.4,9.3.1,10.1.1,10.1.2,10.1.3, 10.2.1,10.2.2,10.3.1,10.3.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1, 4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1, 6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,9.1.1,9.1.2,9.2.1,9.2.2,9.2.3,9.2.4,9.3.1,10.1.1,10.1.2,10.1.3, 10.2.1,10.2.2,10.3.1,10.3.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1, 4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1, 6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,9.1.1,9.1.2,9.2.1,9.2.2,9.2.3,9.2.4,9.3.1,10.1.1,10.1.2,10.1.3, 10.2.1,10.2.2,10.3.1,10.3.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1, 4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1, 6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,9.1.1,9.1.2,9.2.1,9.2.2,9.2.3,9.2.4,9.3.1,10.1.1,10.1.2,10.1.3, 10.2.1,10.2.2,10.3.1,10.3.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1, 4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1, 6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,9.1.1,9.1.2,9.2.1,9.2.2,9.2.3,9.2.4,9.3.1,10.1.1,10.1.2,10.1.3, 10.2.1,10.2.2,10.3.1,10.3.2

22EBS407	FOURIER SERIES AND TRANSFORM CALCULUS (Common to branches EEE & EIE)	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	BS	3	1	0	4

Course Objectives	The main objective of this course is to provide students with the foundations of Fourier series and transforms methods and analysis techniques mostly used in various applications in engineering and technology.	
UNIT – I	**FOURIER SERIES**	**(9+3 Periods)**
Dirichlet's Conditions – General Fourier series –Odd and even functions- Half range Sine and Cosine series – Parseval's Identity on Fourier series–Harmonic Analysis.		
UNIT – II	**BOUNDARY VALUE PROBLEMS**	**(9+3 Periods)**
Classification of partial differential equations – Method of separation of variables–One dimensional wave equation–One dimensional heat equation–Transient and Steady state conditions–Fourier series solution.		
UNIT–III	**LAPLACE TRANSFORMS**	**(9+3 Periods)**
Laplace Transform, Properties of Laplace Transform, Laplace transform of periodic functions. Inverse Laplace transform. Convolution theorem. Evaluation of integrals by Laplace transform, solving ordinary differential equations by Laplace Transform method		
UNIT – IV	**FOURIER TRANSFORMS**	**(9+3 Periods)**
Statement of Fourier integral Theorem–Fourier transform pair–Fourier Sine and Cosine Transforms–Properties –Transforms of Simple functions-Convolution Theorem–Parseval's Identity-Finite Fourier transforms.		
UNIT – V	**Z-TRANSFORMS**	**(9+3 Periods)**
Z-transforms - Elementary properties-Inverse Z-transforms - Initial and Final value theorems - Convolution theorem – Formation of difference equations-Solution to difference equations of second order with constant coefficients using Z- transform.		
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60 Periods**		

TEXT BOOK:

1	*Kandasamy, Thilagavathy and Gunavathy.,* ***"Engineering Mathematics"****, for III Semester, S.Chand&Co, Ramnagar, New Delhi. Revised edition 2017.*
2	*Veerarajan.T.,****"Transforms and partial Differential equations"****, Tata Mc Graw Hill Publishing Co.,New Delhi.2015*

REFERENCES:

1	*J.Ray Hanna And John H. Rowland,* ***"Fourier Series, Transforms and Boundary Value Problems"****, Dover Publication Inc, Mineola, New York, Second Edition , 2008.*
2	*B.S.Grewal,* ***"Higher Engineering Mathematics"****, Khanna Publishers, New Delhi, 44th Edition, 2018.*
3	*Ray Wylie C and Louis C Barrett,* ***"Advanced Engineering Mathematics"****, McGraw Hill Education(India)Pvt Ltd., New Delhi, 6th Edition 2014.*
4	*N.P.Bali and Manish Goyal.,* ***"Transforms and partial Differential equations"****, University Science Press, New Delhi, 2010.*
5	*S. Larsson, V. Thomee,* ***"Partial Differential Equations with Numerical Methods"****, Springer, 2003.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Express the periodic functions arising in the study of engineering problems as trigonometric series.	K5
CO2	Solve the partial differential equation arising in engineering problems as wave and heat flow in steady state (Cartesian coordinate) using Fourier series.	K5
CO3	Apply Laplace Transform technique to solve the given integral equation s and ordinary differential equations.	K5
CO4	Find Fourier transforms, finite and infinite Fourier sine and cosine transforms.	K5
CO5	Apply the Z transform methods to find solutions of difference equations in engineering problem.	K5

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	3	-	-	-	-	-	-	-	1	2	-	-
CO2	3	2	2	3	-	-	-	-	-	-	-	1	2	-	-
CO3	3	2	2	3	-	-	-	-	-	-	-	1	2	-	-
CO4	3	2	2	3	-	-	-	-	-	-	-	1	2	-	-
CO5	3	2	2	3	-	-	-	-	-	-	-	1	2	-	-
22EBS407	3	2	2	3	-	-	-	-	-	-	-	1	2	-	-

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 3.1.1, 3.1.6, 3.2.2, 3.2.3, 3.3.1, 3.4.2 4.1.1, 4.1.2, 4.1.4, 4.2.2, 4.3.2, 4.3.3, 4.3.4, 11.2.1, 11.3.1, 12.1.2, 12.3.2.
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 3.1.1, 3.1.6, 3.2.2, 3.2.3, 3.3.1, 3.4.2 4.1.1, 4.1.2, 4.1.4, 4.2.2, 11.2.1, 11.3.1, 12.1.2, 12.3.2.
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 3.1.1, 3.1.6, 3.2.2, 3.2.3, 3.3.1, 3.4.2 4.1.1, 4.1.2, 4.1.4, 4.2.2, 4.3.2, 4.3.3, 4.3.4, 11.2.1, 11.3.1, 12.1.2, 12.3.2.
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 3.1.1, 3.1.6, 3.2.2, 3.2.3, 3.3.1, 3.4.2 4.1.1, 4.1.2, 4.1.4, 4.2.2, 4.3.2, 4.3.3, 4.3.4, 11.2.1, 11.3.1, 12.1.2, 12.3.2.
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 3.1.1, 3.1.6, 3.2.2, 3.2.3, 3.3.1, 3.4.2 4.1.1, 4.1.2, 4.1.4, 4.2.2, 4.3.2, 4.3.3, 4.3.4, 11.2.1, 11.3.1, 12.1.2, 12.3.2.

ASSESSMENT PATTERN							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	45	35	-	-	-	100
CAT2	15	45	40	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	45	35	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	25	40	35	-	-	-	100
ESE	25	40	35	-	-	-	100

22EPC408	LINEAR INTEGRATED CIRCUITS	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
Electronic Devices and Circuits	PC	3	0	0	3

Course Objectives	1.To learn the concept of IC fabrication technology and applications. 2.To study the OPAMP characteristics. 3.To design and develop real time OPAMP applications.	
UNIT – I	**IC FABRICATION AND REALIZATION**	**(9 Periods)**
IC Classification - fundamental of monolithic IC technology: epitaxial growth, masking and etching, diffusion of impurities - Realization of monolithic ICs and packaging - Fabrication of diodes, capacitance, resistance and FETs.		
UNIT – II	**OPERATIONAL AMPLIFIERS CHARACTERISTICS**	**(9 Periods)**
Functional block diagram - Ideal op-amp - Open loop and closed loop operation – CMRR - Input bias and offset currents - Input and output offset voltages - Compensation techniques - Frequency response of op-amp – Transfer characteristics - Slew rate - Bandwidth.		
UNIT – III	**APPLICATIONS OF OPERATIONAL AMPLIFIERS**	**(9 Periods)**
Inverting and Non Inverting amplifiers – Differential amplifiers - Integrator and differentiator - V/I & I/V converters - Log and Antilog Amplifiers - Active Filters – Voltage to frequency converters – Sample and Hold circuits – Instrumentation amplifiers – Comparators – Clippers - Clampers - Zero crossing detectors – Square and triangular waveform generator		
UNIT – IV	**555 TIMERS, A/D AND D/A CONVERTERS**	**(9 Periods)**
555 timer – Functional block diagram - Astable and monostable operation of 555 timer – Applications – Frequency counters – A/D converters(Flash and successive approximation types) - D/A converters(R- 2R ladder and weighted resistor types		
UNIT – V	**APPLICATION ICs**	**(9 Periods)**
Positive and negative voltage regulators (IC723) Adjustable voltage regulators (LM117/LM317) – Dual tracking regulators (78xx & 79xx Series) – Phase Locked loop (IC565)- Programmable supply – SMPS - LM 380 power amplifier - ICL 8038 function generator IC.		
Contact Periods : **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*Roy Choudhry D. and Shail Jain "**Linear Integrated Circuits**" New Age international, New Delhi,4th Ed., 2017*
2	*David A.Bell **"Op-amp & Linear ICs"**" Oxford, 3rd Ed., 2021*

REFERENCES:

1	*RamakantA.Gayakwad, "**OPAMPs and Linear Integrated Circuits**", Prentice Hall of India Pvt.Ltd. New Delhi, 4th Ed. 201*
2	*Jacob Millman, Christos C.Halkias, Integrated Electronics - Analog and Digital circuits.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the fabrication of semiconductor devices and circuits	K2
CO2	Analyze working of circuits in practical conditions	K4
CO3	Identification of suitable solutions to real time problems	K2
CO4	Application of circuits for interfacing and generation of waveforms	K3
CO5	Use of general purpose circuits to specific applications and Utility of devices in regulated supply for electronic circuits	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	1	1	1	-	2	-	-	-	-	-	1	2	1	1
CO2	3	2	1	2	-	2	-	-	-	-	-	1	3	3	1
CO3	3	3	3	2	-	-	-	-	-	-	-	2	3	3	1
CO4	3	2	3	2	-	-	-	-	-	-	-	2	3	2	2
CO5	2	2	3	2	-	2	-	-	-	-	-	2	2	2	2
22EPC408	3	2	2	2	-	2	-	-	-	-	-	2	3	2	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.2.1, 1.3.1, 2.2.2, 2.2.4, 2.3.1, 2.4.4, 3.1.5, 3.1.6, 3.2.3, 4.1.2, 6.1.1, 12.1.1, 12.3.1,
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.3, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 3.3.2, 3.4.1, 4.1.1, 4.1.2, 4.1.4, 6.1.1, 12.1.1,
CO3	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.3, 2.3.1, 2.3.2, 2.4.1,2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 4.1.1, 4.1.2, 4.1.4, 4.2.1, 4.2.2, 12.1.1, 12.1.2, 12.2.1
CO4	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.4, 2.3.1, 2.4.1, 2.4.2, 3.1.2, 3.1.3, 3.1.4, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 4.1.3, 4.2.1, 4.2.2, 4.3.1, 7.2.2, 12.2.1, 12.2.2, 12.3.2
CO5	1.1.1, 1.1.2, 1.3.1, 2.1.3, 2.2.2, 2.2.4, 2.3.1, 2.4.2, 3.1.2, 3.1.3, 3.1.4, 3.1.6, 3.3.1, 3.3.2, 3.4.2, 4.1.3, 4.2.1, 4.2.2, 4.3.1, 6.2.1, 7.1.1, 7.2.2, 12.2.1, 12.2.2, 12.3.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	20	30	30	-	-	100
CAT2	-	20	30	30	20	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	20	40	40	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	20	40	40	-	-	100
ESE	10	20	30	30	-	10	100

22EPC409	ELECTRICAL MACHINES-II	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
Concept of Electromechanical Energy Conversion	PC	3	0	0	3

Course Objectives	To acquire the knowledge of working principles and performance of rotating AC machinery and special machines.	
UNIT – I	**SYNCHRONOUS GENERATOR**	**(9 periods)**
Construction – Rotor types – emf equation – Synchronous reactance – Armature reaction-Voltage regulation – EMF, MMF, ZPF –Synchronizing and parallel operation – Synchronizing torque-Change of excitation and mechanical input – Two reaction theory – Determination of direct and quadrature axis synchronous reactance using slip test – Operating characteristics.		
UNIT – II	**SYNCHRONOUS MOTOR**	**(9 periods)**
Principle of operation – Torque equation – Operation on infinite bus bars - V and inverted V curves – Power input and power developed equations – Starting methods – Current loci for Constant power input, constant excitation and constant power developed - Necessity of Damper windings - Applications.		
UNIT – III	**THREE PHASE INDUCTION MOTOR**	**(10 periods)**
Construction – Principle –Rotor types - Slip – Equivalent circuit – Slip-torque characteristics - Condition for maximum torque – Losses and efficiency – Load test - No load and blocked rotor tests -Separation of no load losses – Double cage rotors – Induction generator – Synchronous induction motor. Types of starters – Rotor resistance, Autotransformer and Star-delta starters – Speed control - Voltage control, Frequency control and pole changing – Cascaded Connection-V/f control – Slip power recovery Scheme-Braking of three phase induction motor: Plugging, dynamic braking and regenerative braking.		
UNIT – IV	**SINGLE PHASE INDUCTION MOTOR AND STARTING METHOD**	**(9 periods)**
Constructional details of single phase induction motor – Double revolving field theory and operation – Equivalent circuit – No load and blocked rotor test – Performance analysis – Starting methods of single-phase induction motors - Shaded pole induction motor - Capacitor-start capacitor run induction motor.		
UNIT – V	**SPECIAL MACHINES**	**(8 periods)**
Linear induction motor - Hysteresis motor - AC series motor-Switched Reluctance Motor-Stepper motor –Permanent magnet A.C motor (BLDC and PMSM) (Qualitative treatment only)- Magnetic levitation.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOKS :

1	*Kothari D. P. and Nagrath I. J., "**Electric Machines**" Tata McGraw Hill, 5th Ed., 2017.*
2	*Fitzgerald A.E., Charles Kingsly C. Stephen D. Umans., "**Electric Machinery**" Tata McGrawHill, 6th Ed., 2013.*

REFERENCES :

1	*Sahdev, S. K.. "**Electrical Machines**", Cambridge University Press, United Kingdom, 2017.*
2	*Melkebeek, Jan A., "**Electrical Machines and Drives: Fundamentals and Advanced Modelling**", Springer International Publishing, Germany, 2018.*
3	*E.G. Janardanan, "**Special electrical machines**", PHI learning Private Limited, Delhi, 2014.*
4	*Ghosh, Smarajit, "**Electrical Machines**", Pearson Education India,, 2012.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the operating principle of rotating AC machines.	K2
CO2	Familiarize the characteristics of synchronous and induction machines.	K2
CO3	Apply the knowledge of Induction and Synchronous machines for specific applications	K3
CO4	Execute speed control and starting methods for various AC motors.	K3
CO5	Familiarize special electrical machines and their applications	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	3	3	2	-	-	-	-	-	-	2	2	3	2
CO2	3	3	3	3	3	-	-	-	-	-	-	2	2	3	3
CO3	3	3	3	2	2	-	-	-	-	-	-	1	3	3	3
CO4	3	3	3	2	2	-	-	-	-	-	-	2	1	3	1
CO5	3	3	3	2	2	-	-	-	-	-	-	1	1	2	3
22EPC409	3	3	3	2	2	-	-	-	-	-	-	2	2	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.4,2.3.1,2.4.1,2.4.2,2.4.3,2.4.4, 3.1.1,3.1.3,3.1.4,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.1,4.1.2,4.1.4,4.2.1,4.3.1,4.3.3, 5.1.1,5.1.2,5.2.2,12.1.1,12.2.1, 12.2.2,12.3.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.2,2.4.1,2.4.2,2.4.3,3.1.1, 3.1.3,3.1.4,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.2,4.1.2,4.1.4,4.2.1,4.3.1,4.3.2,4.3.3,5.1.2, 5.2.1,5.2.2,5.3.1,5.3.2,12.2.1,12.2.2,12.3.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3, 3.1.1,3.1.3,3.1.4,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.3,4.2.1,4.2.2,4.3.1,4.3.3,5.1.1, 5.2.2,5.3.1,12.2.2,12.3.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.4.1,2.4.2,2.4.3, 3.1.1,3.1.3,3.1.4,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.2,4.1.2,4.2.1,4.3.1,4.3.3,5.2.1,5.2.2, 5.3.1,12.1.1, 12.2.1,12.2.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3, 2.4.4,3.1.1,3.1.3,3.1.4,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.1,4.1.2,4.2.1,4.3.1,4.3.3, 5.2.1,5.2.2, 5.3.1,12.3.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	40	30	-	-	100
CAT2	10	30	30	30	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	-	50	40	10	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	-	40	40	20	-	100
ESE	10	20	30	40	-	-	100

22EPC410	POWER GENERATION, TRANSMISSION AND DISTRIBUTION	SEMESTER: IV

PREREQUISITES :	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To know the various components of Power Systems and design an electric power network in electrical and mechanical point of view.	
UNIT – I	**GENERATION OF ELECTRICAL ENERGY**	**(9 Periods)**
Structure of electric power system – Working and Site Selection of: Conventional Energy Generation- Thermal, Hydro, Pumped storage plant, Nuclear, Diesel and Gas turbine power plant- Non-Conventional Energy Generation- Wind, Tidal, Solar, GeoThermal, Biogas and Fuel Cell. Comparison of different types of power plants.		
UNIT – II	**TRANSMISSION LINE PARAMETERS AND DESIGN**	**(9 Periods)**
Types of conductor- conductor materials, Line Resistance, inductance and capacitance of solid, stranded and bundled conductors-configuration –Symmetrical and unsymmetrical spacing – Transposition of lines – Concept of GMR and GMD –Skin and proximity effect – Interference with neighboring communication circuits. Mechanical design of transmission line-Line supports- Sag and tension calculations considering the effect of ice and wind loading-stringing chart		
UNIT – III	**MODELLING AND PERFORMANCE OF TRANSMISSION LINES**	**(9 Periods)**
Classification of Transmission lines-regulation and efficiency-short Transmission lines effect of load power factor on transmission efficiency and regulation of line-Medium Transmission line: end condenser method, nominal-T and π methods. Ferranti effect-Long Transmission line: Analysis by Rigorous method, Surge Impedance Loading- Power flow through a Transmission line- Concept of Power circle diagram- Corona: Phenomenon-Corona loss –methods of reducing Corona		
UNIT – IV	**LINE INSULATORS AND POWER CABLES**	**(9 Periods)**
Insulator materials-types of insulators- potential distribution across string of suspension insulators- string efficiency and methods of improving string efficiency. Cables: general construction of cables-insulation resistance of power cables-capacitance and insulation stress in cables, sheathing-grading of cables, tan **δ** and power factor- heating of cable-breakdown of cables.		
UNIT – V	**SUBSTATION AND DISTRIBUTION SYSTEM**	**(9 Periods)**
Substation: Classification-Bus-Bar Arrangements in substation. Distribution system: Design consideration-classification of DS. DC distributor fed at one end, both ends, ring main- 3-wire DC distribution system A.C. Distribution: A.C. Distributors with concentrated loads- 3-phase 4-wire star connected load circuits- consequence of disconnecting neutral in a 3-phase 4- wire system.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	*S.N.Singh **"Electric Power Generation, Transmission and Distribution"** Prentice Hall of India Pvt.Ltd, New Delhi, second edition, 2011.*
2	*D.P.Kothari and I.J.Nagrath, "**Power System Engineering**", 2nd edition, Tata McGraw Hill, Third edition, 2019*
3	*C.L.Wadwa, **"Electrical Power Systems",** New Age International, Seventh Edition, 2022.*

REFERENCES :

1	*J.B.Gupta, **"Transmission and Distribution of Electrical Power",** S.R.Kataria & Sons, 2014*
2	*Luces M. Fualkenberry, Walter Coffer, **"Electrical Power Distribution and Transmission"**, Pearson Education, 2007*
3	*A. Chakrabarti, Soni Ml, P. V. Gupta, U.S. Bhatnagar, **"A Text Book On Power System Engineering"** , Dhanpat Rai Publishing Company, 2008.*
4	*Mehta V.K., Rohit Mehta.,**"Principles of Power Systems"**, S.Chand and Co., 2013.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the structure of the power system and different energy sources.	K2
CO2	Evaluate the parameters of the transmission line for different configurations.	K4
CO3	Develop a model and assess the performance of overhead lines.	K3
CO4	Classify different types of distribution systems and evaluate the performance of the Distribution network.	K5
CO5	Analyze transmission and distribution network with respect to electrical and mechanical aspects.	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	2	2	2	3	3	-	-	-	-	-	2	1	-	-
CO2	3	3	2	2	3	3	-	-	-	-	-	2	2	2	-
CO3	3	3	2	2	3	3	-	-	-	-	-	2	2	2	2
CO4	3	3	2	2	3	3	-	-	-	-	-	2	2	2	-
CO5	3	3	2	2	3	3	-	-	-	-	-	2	2	2	-
22EPC410	3	3	2	2	3	3	-	-	-	-	-	2	2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.2.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 12.1.1, 12.1.2, 12.2.1
CO2	1.1.2, 1.2.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 12.1.1, 12.1.2, 12.2.1
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.4, 3.1.5, 3.1.6, 3.2.2, 3.2.3, 3.3.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.4, 4.2.2, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 6.1.1, 6.2.1, 12.1.1, 12.1.2, 12.2.1
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.4, 3.1.5, 3.1.6, 3.2.2, 3.2.3, 3.3.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.4, 4.2.2, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 6.1.1, 6.2.1, 12.1.1, 12.1.2, 12.2.1
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.4, 3.1.5, 3.1.6, 3.2.2, 3.2.3, 3.3.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.4, 4.2.2, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 6.1.1, 6.2.1, 12.1.1, 12.1.2, 12.2.1

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	25	40	25	-	-	100
CAT2	10	20	40	30	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	-	40	30	30	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	-	35	35	30	-	100
ESE	10	20	35	25	10	-	100

22EPC411	PRINCIPLES OF SIGNALS AND SYSTEMS	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To understand the basic properties of signal and systems and characterization of systems in time and frequency domains and to analyze continuous, linear time-invariant systems using state variable formulation and solve the resulting state equations.	
UNIT – I	**CLASSIFICATION OF SIGNALS AND SYSTEMS**	**(9 Periods)**
Standard signals : Step – Ramp –Pulse –Impulse – Sinusoids –Classification of signals : Continuous time (CT) and Discrete Time (DT) signals–Periodic and Aperiodic signals – Deterministic and Random signals –Energy and Power signals –Classification of systems :CT systems and DT systems –Linear and Nonlinear –Time-variant and Time-invariant –Causal and Non-causal –Stable and Unstable.		
UNIT – II	**ANALYSIS OF CONTINUOUS TIME SIGNALS**	**(9 Periods)**
Fourier series : Spectrum of Continuous Time signals – Properties -Fourier transform: continuous time aperiodic signals and periodic signals- properties– Fourier and Laplace Transform in signals Analysis		
UNIT – III	**LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS**	**(9 Periods)**
Differential Equation :CT system representations– Frequency response of systems characterized by Differential Equations -Block diagram representation – Impulse response, convolution integrals – State space representation		
UNIT – IV	**ANALYSIS OF DISCRETE TIME SIGNALS**	**(9 Periods)**
Z transforms – Properties - Inverse Z transforms - Initial and final value theorems - Convolution theorem Baseband Sampling of CT signals – Aliasing, Reconstruction of signal from DT signal, Discrete Time Fourier series representation of DT periodic signals – Properties – Representation of DT aperiodic signals by Discrete Time Fourier Transform (DTFT) – Fast Fourier Transform (FFT)– Properties		
UNIT – V	**LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS**	**(9 Periods)**
Difference Equations – Block diagram representation – Impulse response – Convolution sum – DTFT and Z Transform analysis of Recursive and Non-Recursive systems – Frequency response of systems characterized by Difference Equations – State space representation		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Alan V. Oppenheim, Alan S. Willsky and S. Hamid Nawab, "**Signals and Systems**", Pearson Publication, 2015*
2	*Simon Haykin and Barry Van Veeh, "**Signals and Systems**", Wiley India, New Delhi, 2021*

REFERENCES :

1	*H P Hsu, Rakesh Ranjan, "**Signals and Systems**", Schaum's Outlines, Tata McGraw Hill, 7th Reprint, 2010*
2	*John Alan Stuller, "**An Introduction to Signals and Systems**", Thomson, 2008*
3	*Edward W Kamen & Bonnie's Heck, "**Fundamentals of Signals and Systems**",Pearson Education, 2007.*
4	*Rodger E. Ziemer, William H. Tranter, D. Ronald Fannin. "**Signals & systems**", Fourth Edition, Pearson Education, 2002.*
5	*S.Salivahanan, A. Vallavaraj, C. Gnanapriya, "**Digital Signal Processing**", McGraw Hill International/TMH, 2007.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Acquire knowledge about various test signals	K2
CO2	Investigate properties of signals and corresponding systems	K4
CO3	Review of mathematical concepts for analyzing systems	K2
CO4	Analyze continuous and discrete time signals in frequency domain	K4
CO5	Modelling of time invariant systems using different methodologies	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping															
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	2	2	3	-	-	-	3	1	1	-	3	3	3
CO2	3	3	2	2	3	-	-	-	3	1	1	-	3	3	3
CO3	3	3	2	2	3	-	-	-	3	1	1	-	3	3	2
CO4	3	3	2	2	3	-	-	-	3	1	1	-	3	3	2
CO5	3	3	2	2	3	-	-	-	3	1	1	-	3	3	3
22EPC 411	3	3	2	2	3	-	-	-	3	1	1	-	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping		
CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.22.4.1,2.4.2,2.4.3,2.4.4,3.2.1,3.2.2,3.2.3,3.4.1,3.4.2,4.1.3,4.1.4,4.2.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,9.1.1,9.1.2,9.2.19.2.2,9.2.3,9.2.4,9.3.1,10.3.1,10.3.2,11.1.1	
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.22.4.1,2.4.2,2.4.3,2.4.4,3.2.1,3.2.2,3.2.3,3.4.1,3.4.2,4.1.3,4.1.4,4.2.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,9.1.1,9.1.2,9.2.19.2.2,9.2.3,9.2.4,9.3.1,10.3.1,10.3.2,11.1.1	
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.22.4.1,2.4.2,2.4.3,2.4.4,3.2.1,3.2.2,3.2.3,3.4.1,3.4.2,4.1.3,4.1.4,4.2.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,9.1.1,9.1.2,9.2.19.2.2,9.2.3,9.2.4,9.3.1,10.3.1,10.3.2,11.1.1	
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.22.4.1,2.4.2,2.4.3,2.4.4,3.2.1,3.2.2,3.2.3,3.4.1,3.4.2,4.1.3,4.1.4,4.2.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,9.1.1,9.1.2,9.2.19.2.2,9.2.3,9.2.4,9.3.1,10.3.1,10.3.2,11.1.1	
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.22.4.1,2.4.2,2.4.3,2.4.4,3.2.1,3.2.2,3.2.3,3.4.1,3.4.2,4.1.3,4.1.4,4.2.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,9.1.1,9.1.2,9.2.19.2.2,9.2.3,9.2.4,9.3.1,10.3.1,10.3.2,11.1.1	

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	30	20	-	-	100
CAT2	20	25	35	20	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	25	25	25	25	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	25	25	25	25	-	-	100
ESE	25	25	20	30	-	-	100

22EPC412	ELECTRICAL AND ELECTRONIC MEASUREMENTS	SEMESTER IV

PREREQUISITES :	CATEGORY	L	T	P	C
NIL	PC	3	0	2	4

Course Objectives	To learn the construction, operation and its importance of instruments in measurements and provide practical experience to supplement the theoretical knowledge gained in the field of measurements.	
UNIT – I	**MEASUREMENTS OF ELECTRICAL QUANTITIES AND ERROR ANALYSIS**	**(9 Periods)**
Functional elements of Instruments, -Standards and calibrations - Principle of operation of permanent magnet moving coil, moving iron, dynamometer, induction, thermal and rectifier instruments - Extension of instrument ranges Limiting errors of instruments - Combination of limiting errors – Gross, systematic and random errors in measurements - Statistical analysis of errors		
UNIT – II	**MEASUREMENTS USING BRIDGES**	**(9 Periods)**
Wheatstone, Kelvin, Wein, Hay's, Maxwell, Anderson and Schering bridges - Q meter - Measurement of self and mutual inductances - Wagner earthing device - Megger.		
UNIT – III	**MEASUREMENTS OF MAGNETIC QUANTITIES AND INSTRUMENT TRANSFORMERS**	**(9 Periods)**
Flux meters – B-H curve and permeability measurements on ring and bar specimens – Iron loss measurement by magnetic squares – Instrument transformers - types and errors - Instruments for measurement of frequency and power factor - maximum demand Indicator		
UNIT – IV	**ELECTRONIC INSTRUMENTATION**	**(9 Periods)**
Sensors and Transducers – Signal Conditioning - Digital voltmeter – DMM – Digital Clamp meter - True RMS meter - Standard signal generators - Function generator - Spectrum analyzer - Power Quality analyzer- Introduction to virtual Instrumentation		
UNIT – V	**DISPLAY DEVICES AND RECORDERS**	**(9 Periods)**
Digital storage oscilloscope – Active and passive probes - Errors in measurement – calibration of probes - Seven segment display – Dot matrix, LED, LCD - Concepts of Smart meters – Net metering - Data logger.		
LIST OF EXPERIMENTS		**(30 Periods)**
1. Calibration of Ammeter, Voltmeter, Wattmeter and Energy meter. 2. Measurement of High Resistance by Loss of Charge method. 3. Burden Characteristics of Current Transformers. 4. Measurement of Sequence Impedances of Synchronous Machines. 5. Instrumentation Amplifier. 6. Study of DSO. 7. Study of smart meter and data logging. 8. Creating Virtual Instrumentation for simple applications.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 30 Periods Total: 75 Periods**		

TEXT BOOKS :

1	*Sawhney A.K.,* ***"A Course in Electrical and Electronics Measurements and Instrumentation"*** *DhanpatRai & Sons, 19th edition 2015*
2	*David A Bell,* ***"Electronic Instrumentation and Measurements"****, Third Edition, Ox for University Press, 2013*

REFERENCES:

1	*Golding E.W. and Widdis F.G.,* ***"Electrical Measurements and Measuring Instruments",*** *A.H. Wheeler & Co., Ahmedabad , 2003*
2	*A.D. Helfrick and W.D. Cooper,* ***"Modern Electronic Instrumentation and Measurement Techniques",*** *Prentice Hall India Private Ltd., New Delhi, 2010*
3	*H.S. Kalsi,* ***"Electronic Instrumentation",*** *Tata McGraw-Hill, New Delhi, 2010.*
4	*Jovitha Jerome* ***"Virtual Instrumentation Using LabVIEW"*** *PHI Learning Pvt. Ltd 1st Ed., 2010*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the standards, characteristics and errors of measurements	K2
CO2	Demonstrate the operation of electrical and electronics measuring instruments	K3
CO3	Identify the kind of instrument for measurement of different quantities.	K3
CO4	Test and measure electrical and electronic parameters using instruments.	K4
CO5	Analyse and calculate all the parameters related to measurements	K4

a) CO and PO Mapping

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	2	2	1	2	1	2	1	-	-	2	3	3	3
CO2	3	3	3	2	2	-	-	-	1	-	-	-0	3	2	2
CO3	3	2	2	2	2	-	-	-	1	-	-	1	3	3	2
CO4	3	3	3	3	3	2	2	2	2	-	-	2	3	3	3
CO5	3	3	3	3	2	-	1	2	1	-	-	2	3	3	3
22EPC412	3	3	3	2	2	2	1	2	1	-	-	2	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping		
CO1	1.1.1,1.1.2,1.3.1,1.4.1,2.1.1,2.1.3,2.2.2,2.3.1,2.3.2,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.3,4.1.2,4.1.3,4.1.4,4.2.2,4.3.2,5.3.1,5.3.2,6.2.1,7.1.2,8.1.1,8.2.1,9.2.1, 12.2.1,12.2.2,12.3.1,12.3.2	
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.5,3.1.6,3.2.1,3.2.3,3.3.1,3.4.1,3.4.2,4.1.2,4.1.3,4.1.4, 4.2.1,4.2.2,5.1.1,5.1.2,5.2.1,9.2.1,	
CO3	1.1.1,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.4,2.3.1,2.3.2,2.4.3,3.1.2,3.1.3,3.1.4,3.1.6,3.2.1,3.2.3,3.3.1,3.3.2,3.4.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,5.1.1,5.1.2,5.2.1,5.2.2, 9.2.1,12.1.2	
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.1, 4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.2,6.2.1,7.1.1,7.1.2,8.1.1,8.2.1,9.1.1,9.1.2,9.2.1,9.3.1,12.1.2,12.2.2,12.3.2	
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.2,2.4.3,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.2,4.1.1,4.1.2,4.1.3, 4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,5.1.1,5.1.2,5.2.1,7.1.1,8.1.1,8.2.1,9.2.1,9.3.1,12.1.2,12.2.2,12.3.2	

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	40	30	20	-	-	100
CAT2	10	40	30	20	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	40	20	10	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	-	40	30	-	100
ESE	10	40	30	20	-	-	100

22EES408	ENGINEERING EXPLORATION FOR ELECTRICAL ENGINEERS	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
	ES	0	0	3	1.5

Course Objectives	To Focus on Engineering Problem Solving, Multi-Disciplinary Engineering Skills, Engineering Design Process and Learning Through Exploration.	
UNIT – I	**INTRODUCTION**	**15 periods**
Engineering As a Profession - Common Traits of Good Engineers - Engineering Disciplines - Accreditation Board for Engineering and Technology (Abet)- Budgeting Your Time - Daily Studying and Preparation - Getting Involved with An Engineering Organization-Graduation Plans-Volunteer Work.		
UNIT – II	**ENGINEERING DESIGN AND SAFETY**	**15 periods**
Engineering Design Process - Sustainability in Design - Engineering Economics - Material Selection - Teamwork -Common Traits of Good Teams - Conflict Resolution - Project Scheduling and Task Chart - Evaluating Alternatives - Patent, Trademark, And Copyright - Health, Safety and The Law - Responsibilities of Employers and Employees –Employ Responsibility-Electrical Hazards - Fire Fighting - Fire Precautions and Prevention - Accidents - First Aid -Personal Protection - Hazards in The Workplace.		
UNIT – III	**ENGINEERING DISCIPLINES**	**15 periods**
Case Study and Technical Reports of The Following Topics : Study Of National Electricity Code 2023-Exploration Of ISO, IEEE and IEC Standards for Electrical Systems-Preparation of Infographics of The Above Standards and Writing Case Study About Electrical Hazards. Engineering Innovations and Technology -Ethics Case Studies - Electronics in Daily Life - History – Inventions - Device Exploration -Circuit Exploration – Application Electromagnetic Compatibility in Electronic Circuits, Wireless Power Transfer Technologies, Power Generation Scenario(Conventional & Non-Conventional)In India and Worldwide – Importance of Renewable Energy Resources Applications Of Internet of Things in Home Automation, – Need for Energy Conservation and Energy Efficient Practices, Design of Low-Power and Energy-Efficient Circuits, Energy-Efficient Lighting Systems.		
Contact Periods: **Lecture: 0 Periods Tutorial: 0 Periods Practical: 45 Periods Total: 45 Periods**		

REFERENCES :

1	*Roger Timings "**Engineering Fundamentals**", Newnes Publisher, First edition, 2002.*
2	*Saeed Moaveni, "**Engineering Fundamentals: An Introduction to Engineering**", Cengage learning, Fourth Edition, 2011.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain technological and engineering development , change and impacts of engineering	K2
CO2	Apply the concept of engineering fundamentals and explore the topics in the field in electrical engineering.	K3
CO3	Make use of technical expertise and problem-solving skills to gain broader understanding of the field of electrical engineering.	K3
CO4	Identify potential solutions for engineering design	K3
CO5	Communicate technical and financial interpretations through case studies and prepare project reports	K3

22EPC413	ANALOG CIRCUITS AND DIGITAL IC LABORATORY	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
Electron Devices and circuits, Digital circuits	PC	0	0	3	1.5

Course Objectives	To illustrate the different electronic circuits and their application in practice. To get practice in doing projects related to analog and digital systems.

LIST OF EXPERIMENTS:

1. Design of Rectifier for Filters.
2. Design of Oscillator circuits.
3. Design of Transistor amplifiers.
4. Instrumentation amplifier.
5. Applications of Operational Amplifiers.
6. Realization of a V-to-I & I-to-V converter using Op-Amps.
7. A/D and D/A Converters.
8. Study of VCO and PLL ICs.
9. Simulation of above circuits using software packages.
10. Design of Logic and Arithmetic Circuits.
11. Design of Registers ,Counters.
13. Multiplexer and Demultiplexer, Encoder and Decoder.
14. Synchronous / Asynchronous circuit design.
16. PAL / PLA implementation.
17. Design Entry and simulation of combinational and Sequential logic circuits (4 bit adders, Sequential Counter) using HDL.

Contact Periods:
Lecture: 0 Periods Tutorial: 0 Periods Practical: 45 Periods Total: 45 Periods

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Test various waveform generation circuits using Op Amps, Comparators and IC 's	K4
CO2	Realize the electronic circuit depends on applications	K3
CO3	Design and test various digital logic circuits.	K3
CO4	Build and debug analog and digital circuits implemented on breadboards	K4
CO5	Develop and demonstrate troubleshooting ability in real time applications	K5

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	3	3	-	1	-	-	-	-	-	3	3	2
CO2	3	3	3	2	2	2	-	-	-	-	-	2	3	3	3
CO3	3	3	3	2	2	-	-	-	-	-	-	2	3	3	3
CO4	3	2	2	3	2	-	-	-	-	-	-	-	2	3	2
CO5	2	2	2	3	2	2	2	-	-	-	-	2	2	3	2
22EPC413	3	3	2	3	2	2	2	-	-	-	-	2	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.2,2.4.3,3.1.1,3.1.6,3.2.1,3.2.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.2.1,4.2.2,4.3.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,7.1.1
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.2,2.4.4,3.1.1,3.1.3,3.1.4,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.4,4.2.1,4.2.2,4.3.1,5.1.2,5.2.1,5.3.2,6.1.1,12.1.2,12.2.2,12.3.1
CO3	1.1.1,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.2,2.4.4,3.1.1,3.1.3,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.4,4.2.1,4.2.2,4.3.1,5.1.2,5.2.1,5.3.2,12.1.2,12.2.2,12.3.1
CO4	1.1.1,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.4.2,2.4.3,3.1.1,3.1.3,3.1.5,3.1.6,3.2.3,3.3.1,3.3.2,3.4.2,4.1.1,4.1.2,4.1.3,4.2.1,4.2.2,4.3.1,4.3.2,4.3.4,5.1.2,5.2.1,5.2.2,5.3.1
CO5	1.1.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.4.2,2.4.3,3.1.1,3.1.3,3.1.5,3.1.6,3.2.3,3.3.1,3.3.2,3.4.2,4.1.1,4.1.2,4.1.3,4.2.1,4.3.1,4.3.2,4.3.4,5.1.2,5.2.1,5.2.2,5.3.1,6.1.1,7.1.1,7.2.1,12.1.2,12.2.2,12.3.1

22EPC414	ELECTRICAL MACHINES LABORATORY – II	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	0	0	3	1.5

Course Objectives	To provide hands-on training for evaluating the performance and characteristics of AC Machines and to identify the suitability of its applications.

LIST OF EXPERIMENTS:

1. Regulation of Alternator by EMF and MMF Methods.
2. Load test on three phase Alternator.
3. Regulation of salient pole Alternator by Slip Test.
4. Regulation of Alternator by ZPF method.
5. V and Inverted V curves of Synchronous Motor.
6. Equivalent Circuit of three phase Induction Motor.
7. Load Test on three phase Induction Motor.
8. Load Test and V curves of Synchronous Induction motor.
9. Performance characteristics of three phase Induction Motor by Circle Diagram.
10. Load Test on single phase Induction Motor.
11. Speed control of Slip Ring Induction Motor.
12. Study of different types of starters for Induction Motors.
13. Load test on three phase induction motor with eddy current loading.
14. Analysis of electromagnet parameters such as Electromagnetic force and Electromagnetic Induction using simulation softwares.

Contact Periods:
Lecture: 0 Periods Tutorial:0 Periods Practical: 45 Periods Total: 45 Periods

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the performance characteristics of different types of AC Machines.	K2
CO2	Suggest suitable test for performance determination of Rotating AC Machines.	K3
CO3	Analyze and evaluate the performance of A.C. rotating machines.	K5
CO4	Identify suitable speed control methods for rotating machines.	K2
CO5	Evaluate the electrical apparatus to identify the suitability for different applications.	K5

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	2	1	2	1	1	1	-	-	2	3	2	1
CO2	3	2	1	2	1	2	1	-	1	-	-	2	2	2	3
CO3	2	2	2	2	2	-	2	1	-	-	-	1	2	3	2
CO4	2	2	2	3	1	2	1	-	1	-	-	2	1	2	3
CO5	3	2	2	2	1	-	3	1	-	-	-	1	2	3	2
22EPC 414	3	2	2	3	2	2	2	1	1	-	-	2	2	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.3.1,2.1.2,2.2.1,2.2.4,2.3.1,2.4.2,2.4.4,3.1.1,3.1.3,3.1.5,3.2.1,3.2.2,3.2.3,3.3.2,4.1.1,4.2.1,4.3.1,4.3.2,4.3.3,5.1.1,5.2.2,6.2.1,7.1.2,8.1.1,9.2.2,12.1.1,12.2.1,12.3.1,
CO2	1.1.2,1.2.1,1.3.1,1.4.1,2.1.3,2.2.3,2.3.1,2.4.1,2.4.2,2.4.3,3.1.2,3.3.1,3.4.2,4.1.3,4.2.1,4.2.2,4.3.1,4.3.3,5.3.1,6.1.1,7.2.1,9.1.1,12.2.1,12.3.1,12.3.2,
CO3	1.1.1,1.3.1,2.1.1,2.2.1,2.2.2,2.4.2,2.4.4,3.1.1,3.1.4,3.1.6,3.2.2,3.3.2,3.4.1,4.1.1,4.1.4,4.3.1,4.3.4,5.1.2,5.2.2,5.3.2,7.1.2,7.2.1,8.1.1,12.1.2,12.2.2,
CO4	1.1.2,1.4.1,2.1.1,2.1.2,2.2.2,2.2.4,2.3.1,2.4.1,2.4.2,2.4.3,3.1.2,3.1.4,3.2.1,3.2.3,3.3.2,3.4.2,4.1.2,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,5.1.1,5.3.1,6.2.1,7.2.1,9.2.1,12.1.1,12.2.2,12.3.2,
CO5	1.1.1,1.2.1,1.3.1,1.4.1,2.1.2,2.2.1,2.2.2,2.2.3,2.3.1,2.3.2,2.4.2,2.4.4,3.1.2,3.1.4,3.1.5,3.2.1,3.3.1,3.4.1,4.1.4,4.2.2,4.3.3,5.2.1,5.3.2,7.1.1,7.2.1,7.2.2,8.2.1,12.1.1,12.3.1,