ELECTRICAL MACHINES – I

III Semester: EEE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
AEEB11	Core	3	1	-	4	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		

OBJECTIVES:

The course should enable the students to:

I. Understand the concepts of magnetic circuits and illustrate the theory of electromechanical energy conversion and the concept of co-energy.
II. Understand the operation of DC machines.
III. Analyze the differences in operation of different DC machine configurations
IV. Analyze single phase and three phase transformers circuits

COURSE OUTCOMES (COs):

CO 1: Describe the basic concepts of electro-mechanical energy conversion, energy balance, energy stored in magnetic field, co-energy, single and multi excited systems.
CO 2: Discuss the working principle, losses, efficiency, characteristics and various tests of DC generator.
CO 3: Analyze the working principle, losses, efficiency, characteristics and various tests of DC motor.
CO 4: Describe the working principle, EMF equation, phasor diagram, losses, efficiency, regulation, characteristics and various tests of single phase transformer.
CO 5: Analyze the working principle, various connections of three phase transformer. Auto transformer, Scott connection, on load and off load tap changing transformer, cooling methods.

COURSE LEARNING OUTCOMES (CLOs):

1. Describe the basic electromagnetic energy conversion process, energy storage and energy balance.
2. Solve simple and complex problems related to electromagnetic circuits.
3. Derive the force and torque produced in singly excited, multi excited magnetic systems.
4. Outline the construction, operation, windings used, concept of armature reaction, commutation and types of DC generators.
5. Discuss the characteristics, losses, regulation, efficiency, characteristics and applications of DC generators.
6. Examine the parallel operation of DC generators, importance of equalizer bars and load sharing.
7. Study the operation, construction, significance of back EMF, torque, characteristics and speed control methods of DC motors.
8. Classify the different types of losses, condition for maximum power and efficiency and starters used for DC motors.
9. Determine the efficiency of DC machines by conducting direct and indirect tests.
10. Discuss the principles of operation, construction, types, EMF equation and equivalent circuit of single phase transformers.
11. Explain the operation of single phase transformer under no-load and on-load along with its phasor diagrams.

12. Calculate the efficiency and regulation of single phase transformers by conducting different tests.
13. Examine the parallel operation of single phase transformers and analyze the load sharing.
14. Explain the operation, construction and different types of connections of three phase transformers.
15. Demonstrate the operation of open delta connection and Scott connection with two single phase transformers, tap changing transformer, auto transformer and cooling methods.
16. Explain the functioning of autotransformers, tap changing transformers and off-load, on-load tap changers.
17. Explore the knowledge and skills of employability to succeed in national and international level competitive examinations

MODULE-I	MAGNETIC FIELDS AND MAGNETIC CIRCUITS	Classes: 09

Review of magnetic circuits: MMF, flux, reluctance, inductance; Visualization of magnetic fields produced by a bar magnet and a current carrying coil through air and through a combination of iron and air, influence of highly permeable materials on the magnetic flux lines; Electromechanical energy conversion: Forces and torque in magnetic systems, energy balance, energy and force in a singly excited and multi excited magnetic field systems, determination of magnetic force, co- energy.

MODULE -II	DC GENERATORS	Classes: 09

DC generators: Principle of operation, construction, armature windings, lap and wave windings, simplex and multiplex windings, problems, use of laminated armature, commutator, EMF equation, types of DC generators, voltage buildup, critical field resistance and critical speed, causes for failure to self-excite and remedial measures; Armature reaction: Cross magnetization and demagnetization, ampere turns per pole, compensating winding, commutation, reactance voltage, methods of improving commutation; Characteristics: Open circuit characteristics, critical field resistance and critical speed. Load characteristics of shunt, series and compound generators; Parallel operation: Principle of parallel operation, load sharing, and use of equalizer bars, cross connection of field windings, problems.

MODULE -III	DC MOTORS AND TESTING	Classes: 09

DC motors: Principle of operation, back EMF, torque equation, condition for maximum power developed, types of DC motors, armature reaction and commutation, characteristics, methods of speed control, types of starters, numerical problems; Losses and efficiency: Types of losses, calculation of efficiency, condition for maximum efficiency.

Testing of DC machines: Swinburne's test, brake test, Hopkinson's test, field's test, retardation test and separation of stray losses, problems.

MODULE -IV	SINGLE PHASE TRANSFORMERS	Classes: 09

Single phase transformers: Principle of operation, construction, types of transformers, EMF equation, concept of leakage flux and leakage reactance, operation of transformer under no load and on load, phasor diagrams, equivalent circuit, efficiency, regulation and all day efficiency; Testing of transformers: objective of testing, polarity test, measurement of resistance, OC and SC tests, back to back test, heat run test, parallel operation, problems.

MODULE -V	POLY PHASE TRANSFORMERS	Classes: 09

Three phase transformer: Principle of operation, star to star, delta to delta, star to delta, delta to star, three phase to six phase, open delta connection, Scott connection; Auto transformers: Principles of operation, equivalent circuit, merits and demerits, no load and on load tap changers, harmonic reduction in phase voltages, cooling methods of transformers problems.

Text Books:

1. A E Fitzgerald and C Kingsley, "Electric Machinery", New York, McGraw Hill Education, 1st Edition, 2013.
2. A E Clayton and N N Hancock, "Performance and design of DC machines", CBS Publishers, 1st Edition, 2004.
3. M G Say, "Performance and design of AC machines", CBS Publishers, 1st Edition, 2002.
4. P S Bimbhra, "Electrical Machinery", Khanna Publishers, 1st Edition, 2011.
5. I J Nagrath and D P Kothari, "Electric Machines", McGraw Hill Education, 1st Edition, 2010.

Reference Books:

1. M G Say, E O Taylor, “Direct Current Machines”, Longman Higher Education, 1st Edition, 1985.
2. M V Deshpande, “Electrical Machines”, PHI Learning Private Limited, 3rd Edition, 2011.
3. Ian McKenzie Smith, Edward Hughes, “Electrical Technology”, Prentice Hall, 10th Edition, 2015.

Web References:

1. https://www.electrical4u.com/working-or-operating-principle-of-dc-motor
2. https://freevideolectures.com/
3. https://www.ustudy.in/electrical machines
4. https://www.freeengineeringbooks.com/

E-Text Books:

1. https://www.textbooksonline.tn.nic.in/
2. https://www.freeengineeringbooks.com/
3. https://www.eleccompengineering.files.wordpress.com/
4. https://www.books.google.co.in/