COURSE CONTENT

ELECTRICAL MACHINES-II								
II Semester: EEE								
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
2540227	**Core**	3	0	0	3	40	60	100
Contact Classes:45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes:45**		
Prerequisites: **Electrical Circuits-I &II and Electrical Machines –I.**								

Course Overview:

This course provides comprehensive knowledge of electrical machines, focusing on the analysis, operation, and performance of induction machines, synchronous generators, and synchronous motors. Students study constructional features, equivalent circuits, characteristics, testing methods, speed control, voltage regulation, and parallel operation. The course also introduces single-phase machines and their applications, equipping students with the theoretical foundation required for power generation and industrial drive systems.

Course Objectives:

- To understand the construction, operation, torque characteristics, and performance parameters of three-phase induction motors.
- To study the equivalent circuit, performance characteristics, starting methods, speed control, and induction generator principle.
- To understand the construction, armature windings, EMF equation, harmonics, armature reaction, and synchronous reactance of synchronous generators.
- To study regulation methods, phasor diagrams, and parallel operation of synchronous generators, including load sharing and excitation effects.

Course Outcomes: After Completion of the Course, Students should be able to

- Apply their knowledge to the operation, torque, and performance of cage and wound rotor induction machines.
- Examine the performance, starting, and speed control methods of induction machines.
- Evaluate the operation, EMF, and phasor characteristics of synchronous generators.
- Analyze the regulation, parallel operation, and load sharing of synchronous generators.
- Explain the operation, performance, and applications of synchronous motors and single-phase machines.

UNIT - I: Three Phase Induction Machines: Constructional details of cage and wound rotor machines-production of a rotating magnetic field - principle of operation - rotor EMF and rotor frequency - rotor reactance, rotor current and Power factor at standstill and during operation. Rotor power input, rotor copper loss and mechanical power developed and their inter relation. Torque equation-expressions for maximum torque and starting torque – torque-slip characteristics.

UNIT - II: Characteristics of Induction Machines: Equivalent circuit - phasor diagram - crawling and cogging, No-load Test and Blocked rotor test –Predetermination of performance-Methods of starting and starting current and Torque calculations, Applications.

Speed Control Methods: Change of voltage, change of frequency, voltage/frequency, injection of an EMF into rotor circuit (qualitative treatment only)-induction generator-principle of operation.

UNIT - III: Synchronous Generator (Alternator): Constructional Features of round rotor and salient pole machines –Armature windings – Integral slot and fractional slot windings; Distributed and concentrated windings –distribution, pitch and winding factors – EMF Equation. Harmonics in generated EMF – suppression of harmonics – armature reaction - leakage reactance – synchronous reactance and impedance – phasor diagram – load characteristics.

UNIT - IV: **Regulation of Synchronous Generator:** Synchronous impedance method, MMF method, ZPF method and ASA methods – two reaction theory– Determination of Xd and Xq (Slip test) Phasor diagrams – Regulation of salient pole alternators. Parallel Operation of Synchronous Generator: Synchronizing Alternators with infinite bus bars – synchronizing power torque – parallel operation and load sharing - Effect of change of excitation and mechanical power input.

UNIT - V: Synchronous Motors: Theory of operation – phasor diagram – Variation of current and power factor with excitation – synchronous condenser – Mathematical analysis for power developed. Hunting and its suppression – Methods of starting.
Single Phase Machines: Single phase induction motor – Constructional Features-Double revolving field theory – split-phase motors – AC series motor- Universal Motor- Shaded pole motor and Applications.

TEXT BOOKS:

1. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
2. I.J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.

REFERENCE BOOKS:

1. Prithwiraj Purkait, Indrayudh Bandyopadhyay, "Electrical Machines", Oxford, 2017.
2. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
3. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013.
4. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.

ELECTRONIC RESOURCES:

1. https://www.electrical4u.com/three-phase-induction-motor/
2. https://www.electricaltechnology.org/2012/02/speed-control-of-induction-motor.html
3. https://www.electrical4u.com/synchronous-generator/
4. https://www.electricaltechnology.org/2013/02/voltage-regulation-of-alternator.html
5. https://www.electrical4u.com/synchronous-motor/
6. https://archive.nptel.ac.in/courses/108/105/108105066/

MATERIALS ON LINE:

1. Course template
2. Tutorial question bank
3. Tech talk and Concept Video topics
4. Open-ended experiments
5. Definitions and terminology
6. Assignments
7. Model question paper–I
8. Model question paper–II
9. Lecture notes
10. E-Learning Readiness Videos (ELRV)