

25UEET401	ELECTRICAL MACHINES II	Category	L	T	P	R	Credit	Year of Introduction
		PCC	3	1	0	0	4	2025

Preamble: The objective of the course is to introduce learners to introduce the construction, operating principles, performance, and applications of synchronous and induction machines, including their characteristics, losses, efficiency, and testing in power and industrial systems.

Prerequisite: 25UEET302 ELECTRICAL MACHINES I.

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

CO	Course Outcomes	Knowledge Level (KL)
CO1	Apply the principles of construction and operation of three-phase induction motors to determine their working and performance characteristics.	K3 Apply
CO2	Explain the operating principles and characteristics of induction generators and single-phase induction motors.	K2 Understand
CO3	Apply the fundamentals of synchronous generators to assess their operation and performance characteristics.	K3 Apply
CO4	Implement the fundamentals of construction and operation of synchronous motors to determine their performance characteristics.	K3 Apply

Mapping of course outcomes with program outcomes and program specific outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	-	1	1	1	-	-	-	3	3	2
CO2	3	2	2	-	1	-	1	-	-	-	3	3	2
CO3	3	2	1	-	1	1	1	-	-	-	3	3	2
CO4	3	2	1	-	2	2	1	-	-	-	3	3	2
Avg	3	2	1.25	-	1.25	1.33	1	-	-	-	3	3	2

Mapping of course outcomes with Knowledge and Attitude Profile (WK)

	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	*	*	*	*	*	*	*	*	*
CO2	*	*	*	*	*	*	-	*	*
CO3	*	*	*	*	*	*	*	*	*
CO4	*	*	*	*	*	*	*	*	*

WKs Mapped with the course

WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
*	*	*	*	*	*	*	*	*

Mark Distribution:

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	40	60	2.5 Hours

Continuous Internal Evaluation Pattern:

Attendance	: 5 marks
Continuous Assessment Test	: 20 marks
Continuous Assessment Assignment/Industrial Visit report	: 15 marks

SYLLABUS

Module 1 (14 Hours)

3-phase Induction motor – constructional features, classification, principle of operation, torque equation, torque-slip characteristics, relation between starting torque, maximum torque and full-load torque, numerical problems. Phasor diagram – equivalent circuit, power flow diagram, losses and efficiency, numerical problems. No-load and blocked-rotor tests – circle diagram, numerical problems. Starting of induction motors – types of starters: DOL starter, autotransformer starter, star-delta starter, rotor resistance starter (no design). Braking of induction motors – plugging, dynamic braking, regenerative braking (concepts only). Speed control – stator voltage control, V/f control, rotor resistance control.

Module 2 (14 Hours)

Induction generator – line excited and self-excited induction generators (principle of operation only), torque-slip characteristics for braking, motoring and regeneration, phasor diagram. Single-phase induction motors – double revolving field theory, equivalent circuit, torque-slip characteristics. Types of single-phase induction motors – split-phase, capacitor-start induction-run, permanent capacitor type, shaded pole type – applications.

Module 3 (14 Hours)

Principle of operation of 3-phase alternators, classification, constructional features, types of armature windings, coil-span factor and distribution factor (sinusoidal flux distribution only), EMF equation, numerical problems. Cylindrical rotor synchronous generator – no-load and open-circuit characteristics. Synchronous generator on load – armature reaction, effect of armature reaction, synchronous impedance, equivalent circuit, phasor diagram. Voltage regulation – OC and SC tests, EMF and MMF methods, ZPF test, Potier method, numerical problems.

*One assignment is based on an industrial visit to a generating station. Evaluation is done through the IV report and presentation, focusing on understanding and theory–practice correlation.

Module 4 (14 Hours)

Parallel operation of synchronous generator on infinite bus-bar – conditions and methods of synchronization, V-curves, and inverted V-curves, numerical problems. Salient-pole synchronous generator – two reaction theory, phasor diagram, slip test for determination of X_d and X_q . Power developed (cylindrical rotor and salient-pole type) – power angle characteristics. Synchronous motor – rotating magnetic field, principle of operation, starting methods, losses and efficiency, V-curves, and inverted V-curves.

Text Books:

1. Bimbhra, P. S. (2017). *Electric machines* (2nd ed.). Khanna Publishers.
2. Kothari, D. P., & Nagrath, I. J. (2017). *Electric machines* (5th ed.). Tata McGraw-Hill.
3. Say, M. G. (2002). *The performance and design of AC machines* (3rd ed.). CBS Publishers.

Reference Books:

1. Deshpande, M. V. (2011). *Electrical machines* (Eastern Economy ed.). Prentice Hall India.
2. Gupta, B. R., & Singhal, V. (2010). *Fundamentals of electric machines*. New Age International.
3. Husain, A., & Ashfaq, H. (2002). *Electric machines* (3rd ed.). Dhanpat Rai & Co.
4. Gupta, J. B. (2013). *Theory and performance of electrical machines* (14th ed.). S. K. Kataria & Sons.
5. Langsdorf, A. S. (2001). *Theory of alternating current machinery* (2nd rev. ed.). Tata McGraw-Hill.

END SEMESTER EXAMINATION – MODEL QUESTION PAPER (STC 2025 SCHEME)

Course Code	25UEET401
Course Name	ELECTRICAL MACHINESII
Max. Marks: 60	Duration: 2.5 Hours

Part A (Answer all questions. Each question carries 3 marks)				
Qn No.	Question	Marks	CO	BL
1.	Explain the torque-slip characteristics of a three-phase induction motor with a neat sketch.	3	1	L2
2.	Describe the purpose of no-load and blocked-rotor tests on a three-phase induction motor.	3	1	L2
3.	Explain the principle of operation of self-excited and line-excited induction generators.	3	2	L2
4.	Describe the applications of split-phase and capacitor-start induction motors.	3	2	L2
5.	Illustrate the significance of coil-span factor and distribution	3	3	L3

	factor in an alternator.			
6.	Use the Open-Circuit (OC) and Short-Circuit (SC) tests to determine the voltage regulation of an alternator.	3	3	L3
7.	Explain the V-curves and inverted V-curves of a synchronous motor	3	4	L2
8.	A salient-pole synchronous generator has direct-axis reactance of 1.5 p.u. and quadrature-axis reactance of 0.9 p.u. Determine the ratio of direct-axis reactance to quadrature-axis reactance.	3	4	L3
Part B				
<i>(Answer any one full question from each Module. Each carry 9 marks)</i>				
Module I				
Qn No.	Question	Marks	CO	BL
9.a.	Illustrate the constructional features and principle of operation of a three-phase induction motor and its torque equation.	5	1	L3
9.b.	Describe the methods of starting of induction motors.	4	1	L2
OR				
10.a.	Develop the equivalent circuit and power flow diagram of a three-phase induction motor and explain the various losses occurring in it.	5	1	L3
10.b.	Explain the methods of speed control of induction motors.	4	1	L2
Module II				
Qn No.	Question	Marks	CO	BL
11.a.	Describe the principle of operation and torque-slip characteristics of induction generators in motoring, braking and regenerative regions.	5	2	L2
11.b.	Explain why a single-phase induction motor is not self-starting using the double revolving field theory.	4	2	L2
OR				
12.a.	Explain the role of the auxiliary winding in a split-phase induction motor.	4	2	L2
12.b.	Describe the principle of operation of a self-excited induction generator.	5	2	L2
Module III				
Qn No.	Question	Marks	CO	BL
13. a.	Demonstrate the constructional features of a three-phase alternator and its EMF equation considering coil-span and distribution factors.	4	3	L3
13. b.	A 3-phase, 50 Hz alternator has 4 poles and 36 slots with 10 conductors per slot. The winding is short-pitched by one slot	5	3	L3

	and flux per pole is 0.05 Wb. Determine the induced EMF per phase.			
OR				
14. a.	Develop the phasor diagram of an alternator under lagging power factor load and explain the effects of armature reaction and synchronous impedance.	4	3	L3
14. b.	Determine the voltage regulation of an alternator using EMF method and MMF method.	5	3	L3
Module IV				
Qn No.	Question	Marks	CO	BL
15.a.	Explain the conditions and methods of synchronization of a synchronous generator with an infinite bus-bar.	5	4	L2
15. b.	Develop the power-angle characteristics of cylindrical rotor and salient-pole synchronous machines and compare their performance.	4	4	L3
OR				
16. a.	Explain the principle of operation and starting methods of synchronous motors.	5	4	L2
16. b.	Apply the slip test to determine the direct-axis reactance and quadrature-axis reactance of a salient-pole synchronous machine.	4	4	L3
