



**K. K. Wagh Institute of Engineering Education & Research, Nashik**  
(An Autonomous Institute From A.Y. 2022-23)

WINTER - 2025	
Exam Seat No.:	
Academic Year: 2025-2026	Semester: V
Class: TY	Program: B.Tech
Branch Code: ELE	Pattern: 2023
Name of Course: Synchronous and Special Purpose Machines	Course Code: 2306302
Max. Marks: 60	Duration: 2.30 Hrs.

**Instructions:** Candidates should read carefully the instructions printed on the Question Paper and on the cover page of the Answer Book, which is provided for their use.

1. This question paper contains \_\_02\_\_ page(s).
2. Answer to each new question is to be started on a new page.
3. Assume suitable data wherever required, but justify it.
4. Draw the neat labelled diagrams, wherever necessary.
5. The last columns indicates the Course Outcome and level of Blooms Taxonomy of the Question/sub-question.

**Marks CO**

**Question No. 1**

- 1a) Explain the effect of armature reaction on synchronous machines for resistive, inductive and capacitive load. (6) CO1

**Question No. 2**

- 2a) Explain Blondel's two reaction theory for salient pole machines. Draw respective phasor diagram. (6) CO2

**Question No. 3**

- 3a) Explain the operation of Synchronous Motor at constant load and variable excitation (V and inverted V curves). (8) CO2

**OR**

- 3b) Explain any two methods of starting Synchronous Motor (8) CO2

- 3c) A 11000 V, 3-phase star-connected synchronous motor has a resistance of  $1 \Omega$ /phase and synchronous reactance of  $30 \Omega$ /phase. The motor operates at a 0.8 power factor lag with a line current of 60 A. Calculate the value of the induced emf per phase. (8) CO2

**OR**

- 3d) A 4 kV, 3-phase, 6000 kW, 180 rpm, star-connected synchronous motor has synchronous reactance of  $1.2 \Omega$ /phase. At full load, the torque angle is  $20^\circ$  electrical. If the generated back emf/phase is 2.4 kV, calculate the mechanical power developed. What will be maximum mechanical power developed? (8) CO2

**Question No. 4**

- 4a) Explain the construction, working, characteristics, and applications of a Universal Motor. (8) CO3

**OR**

- 4b) Describe the ratings and applications of compensated series motors. Explain how these motors differ from regular series motors. (8) CO3

- 4c) A 300 W, 50 Hz, 250 V single-phase universal motor runs at 2300 rpm and takes 1.4 A when supplied from a 250 V DC supply. If the motor is connected to a 250 V AC supply and takes 1.5 A, (8) CO2

calculate the back emf, torque, and power factor. Assume  $R_a = 35 \Omega$  and  $L_a = 0.4 \text{ H}$ .

**OR**

- 4d) A 500 W, 50 Hz, 230 V single-phase universal motor runs at 2000 rpm and takes 1.6 A when supplied from a 230 V DC supply. If the motor is connected to a 230 V AC supply and takes 1.6 A, calculate the back emf, torque, and power factor. Assume  $R_a = 10 \Omega$  and  $L_a = 0.5 \text{ H}$ . (8) CO2

**Question No. 5**

- 5a) Explain following modes of operation for variable reluctance stepper motor. (8) CO2

1) 1-Phase ON mode

2) 2-Phase ON mode

3) Microstepping

**OR**

- 5b) Explain the construction, working, applications of a Synchronous Reluctance Motors. (8) CO2

- 5c) Describe the construction, working, characteristics, and applications of a Permanent Magnet Synchronous Motor (PMSM). (8) CO2

**OR**

- 5d) Explain AC Servo Motor with respect to its construction, working, characteristics and applications. (8) CO2

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