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# B.M.S. College of Engineering, Bengaluru-560019

**Autonomous Institute Affiliated to VTU**

## June 2025 Semester End Main Examinations

**Programme: B.E.** **Semester: IV**

**Branch: Electrical and Electronics Engineering** **Duration: 3 hrs.**

**Course Code: 23EE4PCISM** **Max Marks: 100**

**Course: Induction Motors and Synchronous Machines**

**Instructions**: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.



| | | UNIT - I | CO | PO | Marks |
|---|---|---|---|---|---|
| 1 | a) | With relevant sketches, explain the concepts of rotating magnetic field in 3-phase induction motor. | CO1 | PO2,3 | **07** |
| | b) | Derive the equation for torque developed by 3Φ Induction Motor. Draw the typical torque-slip characteristics curve. | CO1 | PO2,3 | **07** |
| | c) | A 400 V, 4 pole, 3 phase, 50 Hz star connected IM has a rotor resistance and reactance per phase equal to 0.01 ohm and 0.1 ohm. Determine1.starting Torque 2. Slip at which max torque occurs 3. Max Torque. Assume ratio of stator to rotor turns as 4. | CO1 | PO2,3 | **06** |
| | | **OR** | | | |
| 2 | a) | With suitable sketches, explain the construction of squirrel cage and slip ring induction motor. | CO1 | PO2,3 | **07** |
| | b) | Draw and explain the Torque-Slip characteristics for 3-phase Induction motor covering motoring, generating and breaking regions of operations. | CO1 | PO2,3 | **07** |
| | c) | The power input to a 500V, 50Hz, 6 poles 3Φ IM running at a 975 rpm is 40Kw. The stator losses are 1Kw and frictional & windage losses total are 2Kw. Calculate (i) slip (ii) the rotor cu loss (iii) efficiency (iv) the shaft torque | CO1 | PO2,3 | **06** |
| | | **UNIT - II** | | | |
| 3 | a) | Draw the circle diagram for 5.5kW, 400V, 3-Ph, 50Hz, 4 pole slip ring IM from the test data given (line values)<br>No load Test: 400V, 6A, 0.085 p.f lag<br>Blocked rotor test: 100V, 12A, 700W<br>The ratio of primary to secondary turns is 2.6 stator resistance/ph is 0.67Ω and that of rotor is 0.18 Ω. Calculate (i) FL current (ii) | CO1 | PO2,3 | **10** |

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| | | | FL slip (iii) ratio of max torque to FL torque (Choose a current scale as 1cm=3A) | | | |
| | | b) | With the help of Torque-slip characteristics, describe the performance of an Induction motor as a generator. | CO1 | PO2,3 | **10** |
| | | | **OR** | | | |
| | 4 | a) | Explain 1. Cogging & Crawling in a 3 Phase Induction Motor.<br>2. Double cage Rotor | CO1 | PO2,3 | **10** |
| | | b) | A 440V, 3 phase,8 pole,50Hz, 40kW, star connected three phase induction motor has the following parameters:<br>Stator resistance=0.1 Ω, stator reactance=0.4 Ω<br>Equivalent rotor resistance referred to stator =0.15 Ω<br>Equivalent rotor reactance referred to stator =0.44 Ω<br>The stator core loss is 1250W while mechanical loss is 1000W. It draws a no-load current of 20A at a p.f of 0.09 lagging while running at a speed of 727.5rpm. Using approximate equivalent circuit, calculate i) Input line current and power factor ii) Torque developed iii) Output power iv) Efficiency. | CO1 | PO2,3 | **10** |
| | | | **UNIT - III** | | | |
| | 5 | a) | Explain the following<br>1. V/f method of speed control of 3-phase Induction motor<br>2. Star-delta starter to start 3-phase Induction motor | CO1 | PO2,3 | **10** |
| | | b) | i) Explain the operation of autotransformer starter for a 3-phase Induction motor with a neat circuit diagram.<br>ii) A 3-phase Induction motor has a ratio of maximum torque to full load torque as 2.5:1. Determine the ratio of starting torque to FL torque if star-delta starter is used. The rotor resistance and standstill reactance per phase are 0.4ohms and 4 ohms respectively. | CO1 | PO2,3 | **05**<br>**05** |
| | | | **OR** | | | |
| | 6 | a) | Explain the principle of operation of a 1 - phase Induction motor using double revolving field theory and prove that it cannot produce any starting torque. | CO1 | PO2,3 | **10** |
| | | b) | With neat diagram, explain 1. Capacitors start Induction Motor.<br>2. Split Phase Induction Motor | CO1 | PO2,3 | **10** |
| | | | **UNIT - IV** | | | |
| | 7 | a) | Develop an expression for EMF equation of an alternator having concentrated windings and short pitched coils. | CO2 | PO2,3 | **06** |

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| | | b) | A 3-phase, 16 pole star connected alternator has 144 slots having 10 conductors in each slot. The flux per pole is 30mWb and distributed sinusoidal. The speed is 375rpm. Find the induced EMF for 1. Full pitch winding 2. Coil short pitched by 1 slot | CO2 | PO2,3 | **06** |
| | | c) | Explain Hunting and Damper windings in a synchronous motor. | CO2 | PO2,3 | **08** |
| | | | **OR** | | | |
| | 8 | a) | Deduce the expression for distribution factor with reference to a synchronous machine. | CO2 | PO2,3 | **06** |
| | | b) | A 3-phase star connected alternator is rated at 1600kVA, 13500V. The armature resistance and synchronous reactance are 1.5Ω and 30Ω respectively per phase. Calculate the percentage regulation for a load of 1280kW at a power factor of (1) 0.8 lag. | CO2 | PO1, PO2 | **06** |
| | | c) | Describe the synchronous impedance method to determine regulation of an alternator for lagging and leading power factors. | CO2 | PO1 | **08** |
| | | | **UNIT - V** | | | |
| | 9 | a) | List the conditions for synchronization of alternators and explain the procedure of synchronization of alternators with Infinite bus bar by Two bright one dark lamp method. | CO3 | PO3,4 | **10** |
| | 9 | b) | Two 3-phase synchronous generators operate in parallel on the same load. Determine the kW output and power factor of each machine under the following conditions<br>Synchronous impedance of each generator: 02 + j2 ohm/phase<br>Equivalent impedance of load: 3 + j4 ohm/phase.<br>Induced emf per phase 2000 + j0 volts for machine 1 and 200 +j 100 for machine 2. | CO3 | PO3,4 | **10** |
| | | | **OR** | | | |
| | 10 | a) | Discuss how parallel operation of alternators can be made? List the conditions to be fulfilled to connect two alternators in parallel. | CO3 | PO3,4 | **10** |
| | | b) | With a phasor diagram, explain the concept of Two-reaction theory in a salient pole synchronous Machines. | CO3 | PO3,4 | **10** |



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