

# GUJARAT TECHNOLOGICAL UNIVERSITY

## BE-5 SEMESTER – OLD PAPER – S22 TO W25 – QUESTION BANK

### Subject Name & Code: Electrical Machine-II (3150910)

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#### Unit 1 – Induction Machines

##### Repeated Questions:

1. **Explain the working principle of 3-phase induction motor.**
  - Appeared in: S22 (Q3a, 03 marks), W22 (Q1b, 04 marks), S24 (Q3a, 03 marks), W24 (Q2b, 04 marks)
2. **Explain torque-slip characteristics of 3-phase induction motor.**
  - Appeared in: S23 (Q1b, 04 marks), S24 (Q2c, 07 marks), W24 (Q2c, 07 marks), W23 (Q2b, 04 marks)
3. **Explain no-load and blocked rotor test on 3-phase induction motor.**
  - Appeared in: S23 (Q3c OR, 07 marks), W22 (Q3c, 07 marks), S24 (Q3c OR, 07 marks), W24 (Q3b, 04 marks)
4. **Explain speed control methods of 3-phase induction motor.**
  - Appeared in: S22 (Q2c OR, 07 marks), S24 (Q2c, 07 marks), W25 (Q2c OR, 07 marks)
5. **Explain necessity of starter in 3-phase induction motor & explain any one starter.**
  - Appeared in: S24 (Q1a, 03 marks), S24 (Q1b, 04 marks), W25 (Q2c, 07 marks), W23 (Q2c OR, 07 marks)

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##### Other Important Questions:

1. **Derive the equation of electromagnetic torque for 3-phase induction motor and obtain condition for maximum torque.**
  - Appeared in: W25 (Q1c, 07 marks)
2. **Explain power stages in induction motor with flow diagram.**
  - Appeared in: S22 (Q4b, 04 marks), W25 (Q2a, 03 marks), W23 (Q2a, 03 marks), W22 (Q4a, 03 marks)
3. **Explain production of rotating magnetic field in 3-phase induction motor (analytical method).**
  - Appeared in: S24 (Q1c, 07 marks), W22 (Q1c, 07 marks)
4. **Explain cogging and crawling in induction motor.**
  - Appeared in: S22 (Q3a OR, 03 marks), W25 (Q4b OR, 04 marks), W23 (Q3a, 03 marks)
5. **Explain double cage induction motor.**
  - Appeared in: S22 (Q3b, 04 marks), W22 (Q4b OR, 04 marks)
6. **Explain effect of slip on rotor circuit in 3-phase induction motor.**
  - Appeared in: W22 (Q4a OR, 03 marks)
7. **Explain induction generator operation / working principle.**
  - Appeared in: S22 (Q2a, 03 marks)
8. **Write a short note on universal motor.**
  - Appeared in: S22 (Q5c, 07 marks), W24 (Q3b, 04 marks)
9. **Explain losses in 3-phase induction motor.**
  - Appeared in: W24 (Q3a OR, 03 marks)
10. **Draw per phase complete equivalent circuit of 3-phase induction motor.**
  - Appeared in: W22 (Q2b, 04 marks)
11. **Explain methods to get more starting torque in slip ring induction motor.**
  - Appeared in: W24 (Q3a, 03 marks)

12. **Explain star-delta starter with diagram.**
  - Appeared in: S22 (Q3c, 07 marks), W22 (Q2c OR, 07 marks), W23 (Q3b OR, 04 marks)
13. **Explain auto-transformer starter in detail.**
  - Appeared in: W25 (Q2c, 07 marks)
14. **Explain frequency of rotor current in induction motor. Derive torque equations for starting and running condition.**
  - Appeared in: W23 (Q1c, 07 marks)
15. **Explain circle diagram of induction motor – steps to draw.**
  - Appeared in: W23 (Q2c, 07 marks)
16. **Explain effect of unbalanced voltages on performance of motor.**
  - (From syllabus, not directly asked but implied in unit coverage)

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**Numerical Questions (No solution needed, only listing):**

1. **S22 (Q2c):** A 750 Hp, 415 V, 3-Phase, 50 Hz, 12-pole induction motor has rotor impedance  $(0.02+j0.15) \Omega$  at standstill. Full load torque at 480 RPM. Find (i) ratio of max to full load torque, (ii) speed at max torque, (iii) rotor resistance to be added for max starting torque. (07 marks)
2. **S22 (Q5c):** A 6-pole, 440 V, 50 Hz, 3-phase induction motor develops 8 HP at 955 rpm. Stator losses = 400 W, friction losses = 0.5 HP. Calculate (i) rotor copper loss, (ii) efficiency. (07 marks)
3. **W22 (Q2c):** Power input to rotor of 440 V, 50 Hz, 6-pole, 3-phase induction motor is 80 kW. Rotor EMF makes 100 complete alternations/min. Find slip, rotor speed, mechanical power developed, rotor copper loss/phase, rotor resistance/phase if rotor current = 65 A. (07 marks)
4. **W24 (Q3c):** 500 V, 50 Hz, 6-pole, 3-phase induction motor at 975 rpm, input 40 kW. Stator losses = 1 kW, friction & windage = 2 kW. Find slip, rotor Cu loss, shaft power, efficiency. (07 marks)
5. **W24 (Q3c OR):** No-load test: 3-phase star-connected motor, 10 A, 450 W at 110 V line. Stator resistance =  $0.05 \Omega/\text{phase}$ , friction & windage = 135 W. Find working component, magnetizing component of no-load current, no-load PF,  $R_o$ ,  $X_o$ . (07 marks)
6. **S23 (Q2c OR):** 415 V, 3-phase, 50 Hz, 4-pole star-connected induction motor, line current = 11 A at 0.85 pf lag. Stator losses = 6% of input, rotor Cu loss = 4% of rotor input, mech loss = 3% of rotor input. Find slip, rotor speed, torque developed, shaft torque. (07 marks)

## Unit 2 – Single-phase Induction Motors

### Repeated Questions:

1. **Explain why single-phase induction motor is not self-starting.**
  - Appeared in: S22 (Q1a, 03 marks), S24 (Q3a OR, 03 marks), W22 (Q4a OR, 03 marks)
2. **Explain double field revolving theory of single-phase induction motor.**
  - Appeared in: S22 (Q2b, 04 marks), S23 (Q2b, 04 marks), W25 (Q2b, 07 marks), W22 (Q4a, 03 marks)
3. **Explain working of shaded pole single-phase motor.**
  - Appeared in: S24 (Q3c OR, 07 marks), W25 (Q3b OR, 04 marks), W22 (Q4c OR, 07 marks), W23 (Q3c, 07 marks)
4. **Explain working of capacitor start / capacitor run / split-phase motor.**
  - Appeared in: S22 (Q5b OR, 04 marks), S24 (Q3b, 04 marks), W23 (Q3b OR, 04 marks), W22 (Q4b OR, 04 marks)

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### Other Important Questions:

1. **Write applications of single-phase induction motors.**
  - Appeared in: S24 (Q3a, 03 marks)
2. **Explain split-phase starting methods.**
  - Appeared in: S24 (Q3b, 04 marks)
3. **Explain construction and working of shaded pole motor with diagram.**
  - Appeared in: S23 (Q3b, 04 marks)
4. **List methods of starting of single-phase induction motor.**
  - Appeared in: S24 (Q3c OR, 07 marks), W22 (Q5c OR, 07 marks)
5. **Explain use of centrifugal switch in single-phase induction motor.**
  - Appeared in: W23 (Q3b OR, 04 marks)
6. **Explain universal motor – construction, working, speed control.**
  - Appeared in: S22 (Q5c, 07 marks), W23 (Q3a OR, 03 marks)
7. **Explain repulsion motor construction and working.**
  - Appeared in: W25 (Q5a OR, 03 marks), W22 (Q5a OR, 03 marks)
8. **Draw equivalent circuit of single-phase induction motor based on double revolving field theory.**
  - Appeared in: W22 (Q3b, 04 marks)
9. **Explain single-phase induction motor used in ceiling fan.**
  - Appeared in: W24 (Q4a, 03 marks)
10. **Write types of single-phase induction motor and explain shaded pole motor.**
  - Appeared in: W23 (Q3c, 07 marks)

## Unit 3 – Synchronous Machines

### Repeated Questions:

1. **Derive EMF equation of alternator.**
  - Appeared in: S22 (Q1b, 04 marks), W22 (Q2e OR, 07 marks), W25 (Q3a OR, 03 marks), W23 (Q3a, 03 marks)
2. **Explain armature reaction in synchronous machine / alternator.**
  - Appeared in: S22 (Q4b, 04 marks), S23 (Q1c, 07 marks), W22 (Q3b OR, 04 marks)
3. **Define pitch factor and distribution factor.**
  - Appeared in: S22 (Q4b OR, 04 marks), S23 (Q3a OR, 03 marks), W25 (Q3a, 03 marks), W22 (Q3b, 04 marks)
4. **Explain voltage regulation of alternator & explain ZPF method.**
  - Appeared in: S22 (Q4c, 07 marks), S23 (Q3c OR, 07 marks), W25 (Q3c OR, 07 marks), W24 (Q5a, 03 marks)
5. **Give comparison between salient pole and cylindrical type alternator.**
  - Appeared in: S22 (Q4a, 03 marks), S23 (Q3a, 03 marks), W25 (Q3b, 07 marks), W22 (Q2a, 03 marks)

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### Other Important Questions:

1. **Explain generated EMF equation in AC generator (alternator).**
  - Appeared in: W24 (Q1a, 03 marks)
2. **Explain effect of distributed and short-pitched winding on generated EMF.**
  - Appeared in: W24 (Q1b, 04 marks)
3. **Explain synchronous impedance method for voltage regulation.**
  - Appeared in: W22 (Q2c OR, 07 marks)
4. **Explain MMF method for voltage regulation.**
  - (From syllabus, not directly asked in these papers but part of unit)
5. **Explain two-reaction theory for salient pole machines.**
  - (From syllabus)
6. **Explain power angle characteristics of synchronous machines.**
  - (From syllabus)
7. **Explain parallel operation of alternators – synchronization & load division.**
  - Appeared in: W22 (Q4b OR, 04 marks), W23 (Q5b, 04 marks), W25 (Q4a OR, 03 marks)
8. **Explain conditions for parallel operation of alternators with bus bar.**
  - Appeared in: S22 (Q4a OR, 03 marks), S23 (Q4a, 03 marks), W22 (Q3a OR, 03 marks)
9. **Explain direct load test method for 3-phase alternator with circuit diagram.**
  - Appeared in: S23 (Q4b OR, 04 marks)
10. **Explain how to measure direct axis and quadrature axis reactance for salient pole machine.**
  - Appeared in: S23 (Q4a OR, 03 marks), W25 (Q5b OR, 04 marks)
11. **Explain V-curves of synchronous motor.**
  - Appeared in: S22 (Q4c OR, 07 marks), S24 (Q4b, 04 marks), W25 (Q4b, 04 marks), W22 (Q3c OR, 07 marks)
12. **Explain O.C.C. and S.C.C. of alternator and how to determine synchronous impedance.**
  - Appeared in: W24 (Q5b, 04 marks)
13. **Explain vector diagrams of alternator in loaded condition.**
  - Appeared in: W23 (Q4b OR, 04 marks)
14. **Explain effect of change in steam input and excitation on output power of alternator connected to grid.**
  - Appeared in: W24 (Q5b OR, 04 marks)
15. **Explain synchronization methods (two bright one dark / all dark lamp method).**
  - Appeared in: S22 (Q5c OR, 07 marks), W25 (Q4c OR, 07 marks), W23 (Q5c, 07 marks), W22 (Q4c OR, 07 marks)

**Numerical Questions:**

1. **S22 (Q4c OR):** 3-phase, 50 Hz alternator, 600 rpm, 2-layer winding, 12 turns/coil, 4 slots/pole/phase, coil pitch = 10 slots, flux/pole = 0.035 Wb. Find induced EMF per phase. (07 marks)
2. **S22 (Q4c OR):** 3-phase star-connected alternator: 1600 kVA, 13500 V,  $R_a=1.5 \Omega/\text{ph}$ ,  $X_s=30 \Omega/\text{ph}$ . Find % regulation at full load, 0.8 lagging pf. (07 marks)
3. **W22 (Q5c):** Same as above but for 1280 kW load at pf 0.8 lag, unity, 0.8 lead. (07 marks)
4. **S23 (Q4c):** 100 kVA, 440 V single-phase alternator,  $R_a=0.1 \Omega$ ,  $X_s=0.3 \Omega$ . Find full load regulation at unity, 0.8 lag, 0.8 lead pf. (07 marks)
5. **S23 (Q4c OR):** 3-phase star-connected 500 kVA, 1100 V alternator,  $R_a=0.1 \Omega/\text{ph}$ . Field current 30 A gives OCV=400 V(line) and SCC=200 A. Find full load regulation at 0.8 lag pf. (07 marks)
6. **W24 (Q4c):** 1 MVA, 11 kV, star-connected synchronous motor,  $R_a=3.5 \Omega/\text{ph}$ ,  $X_s=40 \Omega/\text{ph}$ . Find induced EMF and retardation angle at full load, unity pf. (07 marks)
7. **W24 (Q5c):** 3-phase, 12-pole, star-connected alternator, 180 slots, 10 conductors/slot, coil span=144° electrical, 600 rpm, flux/pole=0.06 Wb sinusoidal. Find phase EMF. (07 marks)
8. **W25 (Q3c):** 6000 kVA, 6600 V, 2-pole, star-connected turbo alternator. Field current=125 A gives OCV=8000 V, SCC=800 A. Resistance drop=3% at full load. Find regulation at 0.8 lag pf. (07 marks)

## Unit 4 – Synchronous Motors

### Repeated Questions:

1. **Explain methods of starting synchronous motor.**
  - Appeared in: S22 (Q2c, 07 marks), S24 (Q5a, 03 marks), W22 (Q5c OR, 07 marks), W24 (Q4b, 04 marks)
2. **Explain synchronous condenser and synchronous phase modifiers.**
  - Appeared in: S22 (Q5a, 03 marks), S24 (Q5a OR, 03 marks), W25 (Q5b, 04 marks), W23 (Q5a OR, 03 marks)
3. **Explain V-curves of synchronous motor.**
  - Appeared in: S22 (Q4c OR, 07 marks), W25 (Q4b, 04 marks), W23 (Q5b OR, 04 marks), W22 (Q3c OR, 07 marks)
4. **Explain hunting in synchronous motor / machine.**
  - Appeared in: S23 (Q5b, 04 marks), W25 (Q1a, 03 marks), W23 (Q1a, 03 marks), W24 (Q4a OR, 03 marks)
5. **Explain auto synchronous motor – construction, principle, operation.**
  - Appeared in: S22 (Q5b, 04 marks), W25 (Q5a, 03 marks), W22 (Q4c OR, 07 marks), W22 (Q5b OR, 04 marks)

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### Other Important Questions:

1. **Why is synchronous motor not self-starting?**
  - Appeared in: S23 (Q1a, 03 marks)
2. **Explain how to make synchronous motor self-starting.**
  - Appeared in: W22 (Q5b OR, 04 marks)
3. **Explain effect of over-excitation and under-excitation on synchronous motor with vector diagram.**
  - Appeared in: W23 (Q5a OR, 03 marks)
4. **Explain inverted V-curves of synchronous motor.**
  - Appeared in: W23 (Q5b OR, 04 marks), W22 (Q3c OR, 07 marks)
5. **Explain different torques in synchronous motor (starting, pull-in, pull-out).**
  - (From syllabus)
6. **Explain stability of synchronous motor.**
  - (From syllabus)
7. **Explain effect of change in excitation and steam supply for alternators connected to bus bar.**
  - Appeared in: W23 (Q5c OR, 07 marks)
8. **Explain circle diagram of auto synchronous motor.**
  - (From syllabus)
9. **Explain synchronous motor on load with vector diagrams.**
  - Appeared in: S24 (Q5c OR, 07 marks)
10. **Explain how power factor and armature current vary with field current for synchronous motor at constant load.**
  - Appeared in: W24 (Q4c, 07 marks)

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### Numerical Questions:

1. **W25 (Q4c OR):** Synchronous motor absorbing 60 kW connected in parallel with factory load of 240 kW at 0.8 lag pf. Combined load pf = 0.9 lag. Find leading kVAR supplied by motor and its pf. (07 marks)

## Unit 5 – Special Machines

### Repeated Questions:

1. **Explain permanent magnet brushless DC motor – construction, working, applications.**
  - Appeared in: S23 (Q5c OR, 07 marks), W25 (Q5c, 07 marks), W23 (Q4b, 04 marks), W22 (Q4c OR, 07 marks)
2. **Explain advantages and applications of linear induction motor.**
  - Appeared in: S22 (Q5a OR, 03 marks), W25 (Q4a, 03 marks), W23 (Q4a OR, 03 marks), W22 (Q5b OR, 04 marks)
3. **Explain principle of magnetic levitation.**
  - Appeared in: S24 (Q5b OR, 04 marks), W22 (Q5a OR, 03 marks)
4. **Explain stepper motor – working, applications, advantages/disadvantages.**
  - Appeared in: S24 (Q5b, 04 marks), W23 (Q5a, 03 marks)
5. **Explain switched reluctance motor – construction, working, advantages/disadvantages.**
  - Appeared in: W25 (Q5c OR, 07 marks), W23 (Q4a, 03 marks)

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### Other Important Questions:

1. **Explain repulsion motor construction and working.**
  - Appeared in: W25 (Q5a OR, 03 marks), W22 (Q5a OR, 03 marks)
2. **Explain axial flux machines (Introduction).**
  - (From syllabus, not directly asked in these papers)
3. **Explain synchronous condenser and synchronous phase modifiers (also listed in Unit 4).**
  - Appeared in: S22 (Q5a, 03 marks), W25 (Q5b, 04 marks)
4. **Explain auto synchronous motor (also listed in Unit 4).**
  - Appeared in: S22 (Q5b, 04 marks), W25 (Q5a, 03 marks)
5. **Explain construction and working of shaded pole motor (also listed in Unit 2).**
  - Appeared in: S24 (Q3c OR, 07 marks), W25 (Q3b OR, 04 marks)
6. **Explain universal motor (also listed in Unit 2).**
  - Appeared in: S22 (Q5c, 07 marks), W24 (Q3b, 04 marks)
7. **Explain construction and working of stepper motor.**
  - Appeared in: S24 (Q5b, 04 marks)
8. **Explain principle of operation of stepper motor.**
  - Appeared in: S24 (Q5b, 04 marks)
9. **Explain slip test for measurement of direct and quadrature axis reactance for salient pole machine.**
  - Appeared in: W25 (Q5b OR, 04 marks)
10. **Explain working of switched reluctance motor.**
  - Appeared in: W23 (Q4a, 03 marks)

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