

II B.Tech II Semester Regular Examinations, Apr/May 2008

ELECTRICAL MACHINES-II
(Electrical & Electronic Engineering)

Time: 3 hours

Max Marks: 80

Answer any FIVE Questions
All Questions carry equal marks

1. (a) Derive the EMF equation of transformer? Hence derive the voltage ratio.
(b) A 15kVA 2400-240-V, 60 Hz transformer has a magnetic core of 50-cm^2 cross section and a mean length of 66.7 cm. The application of 2400 V causes magnetic field intensity of 450 AT/m (RMS) and a maximum flux density of 1.5 T . Determine
 - i. The turn's ratio
 - ii. The numbers of turns in each winding
 - iii. The magnetizing current [8+8]
2. A 5 kVA, 25 Hz transformer has 1.3 % for copper losses, 0.7 % hysteresis losses & 0.3 % eddy current losses. What will be the % losses when transformer is used on 10 kV, 50 Hz system? Compare full load efficiency in both the cases. [16]
3. (a) What are the advantages of Sumpner's test? Give the related calculation to find the efficiency of a transformer.
(b) In Sumpner's test on two identical transformer rated 500 kVA, 11/0.4 kV, 50 Hz, the wattmeter reading on HV side is 6 kW on rated voltage and on LV side is 15 kW when circulated full load current. Find the efficiency of each transformer on $3/4^{th}$ load & 0.8 pf lagging. What will be the maximum efficiency of each transformer? [8+8]
4. (a) With neat phasor diagram, explain the voltage regulation of three-phase transformer.
(b) An ideal $3\text{-}\Phi$ step down transformer connected in delta/star delivers power to a balanced $3\text{-}\Phi$ load of 120 kVA at 0.8 pf. The input line voltage is 11 kV and the turn's ratio of transformer (phase to phase) is 10. Determine the line voltage line currents, phase voltages, phase currents on both primary & secondary sides. [8+8]
5. (a) Explain clearly the principle of operation of Induction motor.
(b) The frequency of stator EMF is 50 Hz for an 8-pole induction motor. If the rotor frequency is 2.5 Hz, calculate the slip and the actual speed of rotor. [8+8]
6. (a) Explain term Maximum torque, Full load torque, Starting torque & No-load torque.

- (b) An 8-pole, 50 Hz, 3- Φ slip ring IM has effective resistance of $0.08 \Omega/\text{phase}$. The speed correspond to maximum torque is 650 rpm. What is the value of resistance to be inserted in rotor circuit to obtain maximum torque at starting?
[8+8]
7. (a) Calculate reduction in starting current & starting torque when the supply voltage is reduced by 25 %.
- (b) A 3- Φ , cage IM has a short circuit current equal to 5 times the full load current. Find the starting torque as the % of full load torque, if the motor is started by
- i. DOL starter
 - ii. Star- Δ starter
 - iii. an auto transformer starter with x % tapping
 - iv. Rotor resistance starter.
- Starting current in (iii) & (iv) is to be limited to 2.5 times the full load current. Full load slip is 4 %.
[4+12]
8. (a) With neat diagram explain the operation of 3- Φ IM as induction generator.
- (b) Two motors A & B with 10 poles & 12 poles respectively are cascaded. The motor A is connected to a 50 Hz supply. Find
- i. Speed of the set
 - ii. The electrical power transferred to the motor B when the input to the motor A is 60 kW. Neglect losses.
[8+8]

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(b) A 15kVA 2400-240-V, 60 Hz transformer has a magnetic core of 50-cm^2 cross section and a mean length of 66.7 cm. The application of 2400 V causes magnetic field intensity of 450 AT/m (RMS) and a maximum flux density of 1.5 T . Determine
 - i. The turn's ratio
 - ii. The numbers of turns in each winding
 - iii. The magnetizing current[8+8]
2. (a) What is the efficiency of transformer? How the efficiency of transformer can be calculated?
(b) The turn's ratio of a single phase transformer is 4. The resistance & leakage reactance of HV windings are $1.4\ \Omega$ & $1.6\ \Omega$ respectively and that of LV windings are $0.06\ \Omega$ & $0.08\ \Omega$ respectively. If 200 V is applied to HV winding & LV winding is short circuited, find the current supplied by the source. (Neglect magnetising current)[6+10]
3. (a) Draw the vector diagrams of transformer at load with lagging & leading power factors.
(b) Calculate the voltage regulation for a 200/400 V, 4 kVA transformer at full load & pf. 0.8 lagging with following test data:
OC test: 200 V, 0.8 A, 70 W (LV side)
SC test: 20 V, 10 A, 60 W (HV side)[8+8]
4. (a) What are the disadvantages of current & voltage harmonics in transformers. Explain how these harmonics can be eliminated.
(b) Two single phase furnaces are supplied at 250 V from a 6.6 kV, 3-f system through a pair of Scott connected transformer, if the load on the main transformer is 85 kW at 0.9 pf lagging and that on the teaser transformer is 69 kW at 0.8 pf lagging. Find the values of line currents on the three phase side. Neglect the losses.[8+8]
5. (a) Explain clearly the principle of operation of Induction motor.
(b) The frequency of stator EMF is 50 Hz for an 8-pole induction motor. If the rotor frequency is 2.5 Hz, calculate the slip and the actual speed of rotor.[8+8]

6. (a) With neat diagram explain the equivalent circuit of 3- Φ Double Cage IM.
- (b) A 400 V, 4 pole, 7.5 kW, 50 Hz, 3- Φ , IM develops its full load torque at a slip of 4 %. The per phase circuit parameters of the machine are: $r_1 = 1.08 \Omega$, $x_1 = 1.41 \Omega$, $r'_2 = ?$ $x'_2 = 1.41 \Omega$. Mechanical, core & stray losses may be neglected. Find: rotor resistance/ph referred to secondary, maximum torque and corresponding rotor speed. [8+8]
7. With neat diagram explain the various tests to be conducted on 3- Φ IM to plot the circle diagram. [16]
8. (a) Explain the speed control of IM by rotor resistance control method. How this method of speed control is different from stator side speed control methods.
- (b) A 4 pole, 50 Hz, wound rotor IM has a rotor resistance of $0.56 \Omega/\text{ph}$ and runs at 1430 rpm at full load. Calculate the additional resistance per phase to be inserted in the rotor circuit to lower the speed to 1200 rpm, if the torque remains constant. [8+8]

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1. (a) With neat phasor diagram explain the operation of transformer with capacitive load
(b) The voltage ratio of single phase 50 Hz transformer is 5000/500 V at no-load. Calculate the number of turns in each winding, if the value of the flux in the core is 7.82 mWb. [8+8]
2. (a) Derive the condition for maximum efficiency of a transformer.
(b) A single phase 150 kVA transformer has efficiency of 96 % at full load, 0.8 pf and at half load, 0.8 pf lagging. Find maximum efficiency of transformer and corresponding load. [8+8]
3. With neat diagram, explain the various tests conducted on transformer to obtain its equivalent circuit. Derive all related equations. [16]
4. (a) Explain tests to determine the equivalent circuit parameters of a three-phase transformer.
(b) A 3- Φ . 100 kVA, 5000/400 V Star/Star, 50 Hz transformer has an iron loss of 1400 W. The maximum efficiency of transformer occurs at 80% of load. Calculate:
 - i. The efficiency of transformer at full load and 0.85 pf lagging
 - ii. The maximum efficiency at UPF. [8+8]
5. (a) Explain the construction of Induction Motor.
(b) An 8 pole, 3- Φ alternator is coupled to a prime mover running at 750 rpm. It supplies an induction motor which has a full load speed of 960 rpm. Find the number of poles of IM and slip. [8+8]
6. (a) A 4 pole, 400 V, 3- Φ IM has a standstill rotor EMF of 100 V per phase. The rotor has resistance of 50 m Ω /ph and standstill reactance of 0.5 Ω /ph. Calculate the maximum torque & slip at which it occurs. Neglect stator impedance.
(b) Explain the various losses taking place in IM. Explain the effect of slip on the performance of IM. [8+8]
7. (a) A cage IM when started by means of a star- Δ starter takes 180 % of full load current & develops 35 % of full load torque at starting. Calculate the starting current & torque in terms of full load torque when started by means of an auto transformer with 75 % tapping.

(b) Compare DOL starter, Star Δ starter, Auto transformer starter & Rotor resistance starter with relate to the following:

i. Starting current

ii. Starting torque

iii. Flexibility

iv. Cost & efficiency

[8+8]

8. Explain all the modes of operation of Induction machine. Plot the neat characteristics. [16]

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1. (a) With neat phasor diagram explain the operation of transformer with inductive load
(b) The exciting current for a 50 kVA, 480/240V 50 Hz transformer is 2.5% of rated current at a phase angle of 79.8° . Find the components of magnetising current & loss component. Also find the magnetising reactance & core loss resistance. [8+8]
2. (a) Derive the condition for maximum efficiency of a transformer.
(b) A single phase 150 kVA transformer has efficiency of 96 % at full load, 0.8 pf and at half load, 0.8 pf lagging. Find maximum efficiency of transformer and corresponding load. [8+8]
3. (a) Explain the various simple tests conducted on a single transformer to find the approximate equivalent circuit of transformer.
(b) OC test is preferred to conduct on LV side & SC test is preferred to conduct on HV side. Explain the reasons. [10+6]
4. (a) With neat phasor diagram, explain the voltage regulation of three-phase transformer.
(b) An ideal 3- Φ step down transformer connected in delta/star delivers power to a balanced 3- Φ load of 120 kVA at 0.8 pf. The input line voltage is 11 kV and the turn's ratio of transformer (phase to phase) is 10. Determine the line voltage line currents, phase voltages, phase currents on both primary & secondary sides. [8+8]
5. (a) Explain clearly the principle of operation of Induction motor.
(b) The frequency of stator EMF is 50 Hz for an 8-pole induction motor. If the rotor frequency is 2.5 Hz, calculate the slip and the actual speed of rotor. [8+8]
6. (a) In approximate equivalent circuit of 3- Φ IM, explain step by step the development of equivalent load resistance.
(b) A 440 V, 19 kW, 50 Hz, 8 pole, IM has its stator & rotor connected in star. The effective stator to rotor turn is 2.5:1. The parameters of its circuit model are: $r_1 = 0.4 \Omega$, $x_1 = 1.03 \Omega$, $r_2 = 0.07 \Omega$, $x_2 = 0.18 \Omega$, $r_m = 25.9 \Omega$, $r_i = 127.4 \Omega$ (including rotational losses) Neglect any change in mechanical losses due to change in speed, calculate the maximum added rotor resistance required for the motor to run up to the speed for a constant load torque of 300 Nm. [6+10]

7. A 3- Φ , star connected, 440 V, 4-pole, 50 Hz slip ring IM gave the following test results:

No load Test: 440 V, 9 A, PF = 0.2

Blocked rotor test: 100 V, 22 A, PF = 0.3

All above are the line values. The ratio of primary to secondary turns = 3.5, stator & rotor copper losses are equally divided in blocked rotor test. The full load current is 20 A. Plot the circle diagram and for full load find:

- (a) The line current, The power factor, Slip
 - (b) Starting torque
 - (c) Resistance to be inserted in series with rotor circuit for giving starting torque 200 % of full load torque. Also find current & power factor under this condition. [16]
8. (a) Compare the speed control of 3- Φ IM by rotor resistance control & variable frequency control.
- (b) Two slip ring IMs having 10 & 6 poles respectively are mechanically coupled.
- i. Calculate the possible speed when first motor is supplied from a 50 Hz supply line.
 - ii. Calculate the ratio of power shared by the two motors.
 - iii. If the smallest possible speed is to be attained independently by each machine, calculate the frequency of the voltage to be injected in the rotor circuit. [8+8]
