B.E. ELECTRICAL ENGINEERING EXAMINATION, 2023

(2^{nd} Year, 2^{nd} Semester)

ELECTRICAL MACHINES - II

Time : Three hours | Full Marks : 100

(50 marks for each part)
(Use separate Answer Script for each part)

PART – I

Answer any four from the following: CO1 4x2.5

(a) What is the speed of rotor mmf of a 3-phase induction motor with respect to its stator mmf ? - Justify your answer.

(b) Why stators in a 3-phase induction motor (except large rating ones) are usually provided with semi-closed type slots? Explain.

(c) An 8-pole, 3-phase, 60° spread, double layer winding has 72 coils in 72 slots. The coils are short-pitched by two slots. Calculate the winding factor for the fundamentals and third harmonics.

(d) What is the relationship of developed torque of a 3-phase induction motor with the supply voltage? Justify your answer.

(e) Show that a 3-phase winding carrying sinusoidal currents produces space harmonics of the order of $h = 6k \pm 1$, where k is a positive integer.

(f) Show that, in an three phase induction motor, the 5^{th} harmonic flux produces backward rotating torque at a speed of $1/5^{th}$ synchronous speed whereas 7^{th} harmonic produces forward rotating torque at a speed of $1/7^{th}$ synchronous speed.

(g) What is deep bar rotor induction motor? How it produces high starting torque?

Answer any one from (a) and (b): CO2 10

(a) "A rotating magnetic field of constant amplitude can be produced by supplying a balanced three phase voltage source to a balanced three phase winding" -- Explain. Find out the speed of the rotating magnetic field produced. How can you change the direction of the rotating magnetic field?

(b) Derive an expression for torque developed in an induction motor and draw the torque-speed characteristics. At what slip the torque developed in an induction motor will be maximum?

3. Answer any one from (a) and (b): CO3 10

(a) Develop the equivalent circuit of a three phase induction motor and explain how the mechanical power developed is taken care in the equivalent circuit.

(b) Describe different tests to determine the equivalent circuit parameters of a three phase induction motor. How can you calculate the equivalent circuit parameters from these test results?

4. Answer any one from (a) and (b):

(a) i) If the stator impedance of an induction motor is neglected show that : CO4 10

$$T_e / T_{em} = 2/ (s_{mT}/s + s/ s_{mT})$$

ii) From the equivalent circuit of a poly phase induction motor, obtain the following relations:

1) $I_{2st} / I_2 = \sqrt{[(s^2+s_{mT}^2)/(s^2(1 + s_{mT}^2))]}$

2) $I_{2mT} / I_2 = \sqrt{[0.5 (1 + (s_{mT}/ s)^2)]}$

(b) Why starters are necessary for starting an induction motor? What are the various types of starters used for starting of squirrel cage induction motor? Describe with circuit diagram the working of any one type of starter for starting squirrel cage induction motor and hence derive an expression for starting torque in terms of full-load torque.

5. Answer any one from (a) and (b): CO5 10

(a) The power input to a 6-pole, 50 Hz, 3-phase induction motor is 700 W at no-load and 10 kW at full-load. The no-load copper losses may be assumed negligible while the full-load stator and rotor copper losses are 295 W and 310 W respectively. Find the full-load speed, shaft torque and efficiency of the motor assuming the rotational and core losses to be equal.

(b) The resistance and reactance (equivalent) values of a double-cage induction motor for stator, outer and inner cage are 0.25, 1.0 and 0.15 Ω resistance and 3.5, zero and 3.0 Ω reactance respectively. Find the starting torque if the phase voltage is 250 V and the synchronous speed is 1000 rpm.

Ref No. : **Ex/EE/PC/B/T/222/2023**

Bachelor of Electrical Engineering, 2nd Year 2nd Semester Examination, 2023

SUBJECT: ELECTRICAL MACHINES-II

Time: Three Hours Full Marks: 100 (50 each part)

Use a separate Answer-Script for each part

PART - II

Answer any three questions. Question no. 3 carries 18 marks.

1. (i) With the help of B-H characteristics of magnetic core explain how harmonics are introduced in a transformer **4+6+6=16**

(ii) Show that Delta winding is better in harmonics related issues in a three phase transformer?

(iii) What is oscillating neutral problem? – Explain with proper diagram.

2. (i) Explain the importance of vector groups for three phase transformers. **4+6+6=16**

(ii) Draw the connection diagram and phasor diagram of the following connections.

a) Dd6, b) Dz0 and c) Dy11

(iii) What will happen if a Dy1 connected transformer is paralleled with a Dy11 connected transformer? Show how they can be connected properly with connection modification.

3. (i) Is it possible to connect two single phase transformers, with one having a center tap and the other with no tap, in a Scott-connected transformer? – Discuss with proper diagrams. **7+11=18**

PART - II

(ii) In Scott-connected transformers, teaser transformer supplies 0.75 lagging power factor load of 20 kW at 220 V and main transformer supplies 0.85 power factor leading load of 40 kW at 220 V, from a three phase input line voltage of 3300V. Determine the input 3-phase line currents. Neglect magnetizing currents and the leakage impedance drops. Draw input current phasors computed for above along with a Scott-connection diagram.

4. i) Discuss the placement of taps in a three phase transformer. **6+5+5=16**

ii) Component wise what is the basic difference of an Off-load and an ON-load tap changer?

iii) Describe the operation of a reactor type tap changers.

5. Write Short notes **8 x 2 =16**

(i) Full wave and chopped wave impulse voltage tests on a transformer for detection of faults in the winding.

(ii) Development of voltage stress along the winding of a three phase transformer for input impulse and RMS voltage. And also write the measure to be taken to withstand it.