Ref No. : Ex//EE/T/222/2019

Bachelor of Electrical Engineering, 2nd Year 2nd Semester Examination, 2019

SUBJECT: ELECTRICAL MACHINES-II

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

Use a separate Answer-Script for each part

PART - I

Answer Question no.1 and any two from the rest.

1. (i) Draw and explain the connection diagrams and phasor diagrams of the following vector groups of three phase transformers. **9+9=18**

a) Yz_{11} , b) Dz_0 and c) Yd_{11}

(ii) What will happen if transformers vector groups Yd_1 & Dy_{11} are paralleled as it is? Explain how a three phase Yd_1 transformer can be successfully paralleled with a Dy_{11} transformer.

2. (i) Explain how the exciting current of a single phase transformer contains harmonics even when the supply voltage is sinusoidal. **6+5+5=16**

(ii) What type of harmonics related problems may arise for Y-y without neutral wire connected core-type three phase transformer? How this problem can be mitigated?

(iii) How Delta winding is used to overcome the problems of harmonics in a three phase transformers?

3. (i) Explain with the help of connection and phasor diagrams, how Scott-connection is used to obtain two phase supply from a three phase input. **8+8=16**

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(ii) In Scott-connected transformers, the teaser transformer supplies a load of 50 kW with 0.75 p.f. (leading) at 220 V and the main transformer supplies a load of 40 kW with 0.85 p.f. (lagging) at 220 V in the secondary and the three phase input(primary) line voltage of the Scott is 6600V. Determine the input three phase line currents. Neglect magnetizing currents and the leakage impedance drops. Draw the input voltage and current phasors computed.

4. i) Discuss about the tapping strategy in a winding of a transformer considering force, insulation and current handling capability of the tap changer. **8+8=16**

ii) Describe the operation of a tap-changer having center-tapped reactor. What are the advantage and disadvantages of a resistor type tap-changer?

5. Write Short notes (any two) **8 x 2 =16**

(i) Full wave and Chopped wave Impulse voltage tests on a transformer and detection of faults.

(ii) Comparison of a three phase transformer **bank** and a three phase core-type transformer **unit**.

(iii) Various types of over-voltages in the line and their impact in a transformer.

PART-II

6. Answer any four from the following. 4x2.5

   (a) Discuss the similarities between a transformer and an induction machine. Hence, explain why an induction machine is called a generalized transformer.

   (b) What will be the direction of rotation of the rotor, if the primary winding is placed on the rotor of a poly-phase induction motor?

   (c) Explain why the rotor of an induction motor can never attain synchronous speed while the rotor field with respect to the stator rotates with the synchronous speed.

   (d) What do you mean by distributed winding? Find an expression for distribution factor.

   (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. Also 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.

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

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

   (a) Explain how a poly-phase winding fed from a balanced poly-phase supply produces a rotating magnetic field with constant amplitude.

   (a) Derive an expression for torque developed in an induction motor. Also derive the condition for maximum developed torque and draw the torque-speed characteristics.

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

   (a) Draw and explain the phasor diagram of a three phase induction motor and develop 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?

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

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

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

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

(a) Describe the construction of a double cage induction motor and explain how high starting torque is developed in double cage induction motor. Draw the equivalent circuit of double cage rotor induction motor.

10 Answer any one from (a), (b) and (c): 10

(a) A 10 kW, 3-phase, 4 pole, 50 Hz, induction motor has a full load slip of 0.03. Mechanical and stray load losses at full load are 3.5% of output power. Compute

i) Power delivered by stator to rotor

ii) Electromagnetic torque at full load

iii) Rotor ohmic loss at full load.

(b) A three phase 400 Volt, 50 Hz, induction motor takes a power input of 35 kW at full load speed of 980 rpm. The total losses are 1 kW and the friction and windage losses are 1.5 kW. Calculate Slip, rotor ohmic loss, shaft power, shaft torque and efficiency.

(c) A 50 kW, 400 volt, 3-phase, 4-pole, 50 Hz wound rotor induction motor develops a maximum internal torque of 240% at a slip of 20% when working under rated voltage and frequency conditions and with slip ring short-circuited. Determine (a) full load slip, (b) rotor copper loss at full load and (c) starting torque in N-m. Neglect stator resistance and rotational losses.