Ref:EX/PE/T/214/2017(s)

Bachelor of Power Engineering 2nd Year Supplementary Semester Examination, 2017

Subject: Electrical Machines I

Four Marks for Neatness

Time Three Hours

Full Marks 100

PART A

Attempt Any Two

1. What is the condition of zero voltage regulation for a single phase Transformer. A 11000/440 V, single phase transformers has an equivalent resistance of 0.04 p.u. and an equivalent reactance of 0.08 p.u. Find the full-load voltage regulation at 0.85 p.f. lag, if the primary voltage is 11000 V. Find also the secondary terminal voltage at full load. (06+10)

2. What are the major advantages of using Auto Transformers. A 11 KV / 2.3 KV single phase autotransformer when used as a two-winding transformer has the rated output of 125 KVA. If the two winding of the transformer are connected in series to form as autotransformer, find the possible voltage ratios and output considering two possible connections as given by (a) and (b). Assume A and B are the fixed terminal of the winding and C is the variable terminal of the auto transformer.

(a) BC=11000 V winding; AC=2300 V winding

(b) BC=2300 V winding; AC=11000 V winding (06+10)

3. What are the different losses of a Transformer. What are their sources. A 220V, 60 Hz, single phase transformer has hysteresis loss of 350 watts and eddy current loss of 150 watts. If the transformer is operated from 250V, 50 Hz supply mains, then compute its total core loss. Assume Steinmetz's constant equal to 1.6. (06+10)

4. What is Askarel. What is its permittivity value. A 10 kVA, single phase transformer has a core loss of 40 watts and full load ohmic loss of 100 watts. The daily variation of load on the transformer is as follows:

7 A.M. to 1 P.M. : 4 kW at pf 0.65
1 P.M. to 6 P.M. : 3 kW at pf 0.85
6 P.M. to 1 A.M. : 8 kW at pf 0.9
1 A.M. to 7 A.M. : No load

Determine the all-day efficiency of the transformer. (06+10)

PART B

Answer any Two

5. How rotating magnetic field is created in a 3 Phase Induction Motor. A 440 V, three-phase, 6 pole, 50 Hz delta connected induction motor has the following circuit constants (all per phas values):

   Stator resistance = 0.25 Ω, stator reactance = 1.4Ω, equivalent resistance of the rotor referre to stator = 0.4Ω, equivalent reactance of rotor at standstill referred to stato r= 1.6Ω. Fo magnetising circuit equivalent resistance and reactance are 200Ω and 20 Ω respectively.

   Find, (a) rotor input (b) rotor copper losses (c) torque (d) mechanical power output from th rotor (assume friction and windage losses as 600 W) (e) stator input (f) efficiency when th motor is running at a slip of 4%. Show the equivalent circuit. (06+10)

6. What is synchronous Watt; explain. A 3-phase, 4 pole, 1400 rpm, 50 Hz induction motor ha star connected rotor winding, having a resistance of 0.2 Ω per phase and a standstill leakag reactance of 1.5 Ω per phase. When the stator is energized at rated voltage and frequency, th rotor induced e.m.f. at standstill is 120 V per phase.

   (i) Calculate the rotor current, rotor power factor and torque both at starting and at full load and compare the results.

   (ii) If an external resistance of 1.5 Ω per phase is inserted in rotor circuit, calculate the rotor current, rotor power factor and torque at the time of starting. (06+10)

7. Find the ratio of $T_{\perp}$ *to* $T_{//}$ in terms of their respective slips. The rotor of a 3-phase inductio motor has a 0.04 Ω resistances per phase and a 0.25 Ω standstill reactance per phase. Wha external resistance is required in the rotor circuit in order to get $3/4^{th}$ of the maximum torqu at stating? Neglect stator impedance. (06+10)

8. Derive the expression of Torque in terms of applied voltage for a 3 Phase Induction Motor. A 3-phase, star connected, 400 Volts, 4 pole, 50 Hz induction motor has the following per phas constants in Ω referred to stator :

r_1 =0.10, x_1=0.40, r_2 =0.15, x_2=0.40 and X_m = 30.5

fixed losses (core, friction and windage losses) = 450 watts.

Compute the stator current, rotor speed, output torque and efficiency when the motor is operate at rated voltage and frequency at a slip of 4 percent. (06+10)

PART C

Answer Any One

9. Draw the torque speed and speed current characteristics of DC shunt motor. A 250V shunt r armature resistance of 0.8ohm and a field resistance of 350ohm. When driving at 750 r.p.m torque load, the armature takes 25A. If it is required to raise the speed from 750 r.p.m to 850 resistance must be inserted in the shunt field circuit assuming linear magnetization ch (3+3+10)
10. What is the relation of Torque and Current for the DC series motors. Explain with example. A series motor having a resistance of 0.75 ohm between terminals drives a fan for which the torque varies as the square of the speed. At 220V the set runs at 500 r.p.m and takes 40A. The speed is to be raised to 800 r.p.m by increasing the voltage. Find the voltage and current for the limiting cases when the magnetic circuit is saturated. (3+3+10)
11. What is interpole and compensating winding. A 4-pole wave-wound short-shunt compound generator supplies a current of 40A at 220V. The armature resistance is 0.25 ohm, series field resistance is 0.06 ohm, and shunt field resistance is 100 ohm. The brush drop is 0.75V per brush. Calculate: a) emf generated, and b) the current per conductor. (3+3+10)

PART D

Answer Any One

12. Draw the equivalent circuit of a single phase induction motor and explain. A 220V, 4-pole, 50Hz split phase induction motor has the following impedance at standstill:

Main winding: r = 1.2 ohm, x = 3.5 ohm

Starting Winding: r = 2.0 ohm, x = 3.5 ohm

Determine the value of capacitance to be inserted in series with the starting winding to get (a) maximum starting torque; (b) maximum torque per ampere at starting. (6+10)

13. Why auxiliary windings are necessary foe single phase induction motor. Explain this requirement. The following test results were obtained on a 200W, 200V, 50Hz, 6-pole single phase induction motor:

Stator winding resistance = 10 ohm

Blocked rotor test: V = 100V, I = 3.5A, P = 240W.

No-load test: V = 200V, I = 1.35A, P = 60W.

Determine the various parameters of the motor. Hence determine the current, power factor, output and efficiency at slip = 0.06. (6+10)