EE 242

(8+12)

INTERNATIONAL CENTRE FOR APPLIED SCIENCES (Manipal University) **IV SEMESTER B.S. DEGREE EXAMINATION – NOV. / DEC.2016** SUBJECT: ANALYSIS AND CONTROL OF ELECTROMAGNETIC DEVICES (EE 242) (BRANCH: E&E, IP & MECH.)

Thursday, 01 December 2016

Max. Marks: 100

✓ Answer ANY FIVE FULL Questions.

1A. A 15 hp, 400 V, 3 phase induction motor with full load efficiency & PF of 0.88 and 0.85 respectively is started using Y/ Δ starter. Short circuit current is 3.75 times the full load current.

Estimate the line current at starting. Also find the ratio of starting torque to full load torque. Full load slip = 0.05.

- **1B.** What are the properties of an ideal transformer?
- **1C.** A factory load of 240 kW is operating at a PF of 0.8 lag. A synchronous motor with a load of 60 kW is connected to make the overall PF 0.9 lag. Determine kVA of synchronous motor and its PF.
- (8+4+8)

2A. A 4 kVA, 200/400 V, 50 Hz transformer has the following data S.C Test 15 V, 10 A, 80 W (HV Side)

Determine the full load regulation at a PF of (i) 0.8 lag (ii) 0.8 lead.

- **2B.** Explain why 3 phase induction motor cannot run at synchronous speed.
- **2C.** A 2000 V, 3 phase, star connected synchronous motor has synchronous impedance of (0.5+j5) Ω per phase. For an excitation voltage of 3000 V, the motor takes an input of 900 kW. Find the line current and PF. (6+2+12)
- **3A.** A 100 kVA transformer has iron loss= 1.02 kW and full load copper loss = 1.02kW. During the day it is loaded as follows:
 - 12 hours - 20 kW at power factor 0.5 6 hours – 45 kW at at power factor 0.9 6 hours – 80 kW at at power factor 0.8 Find the all day efficiency of the transformer.
- 3B. A 3 phase, 6 pole, 50 Hz, 240 V, Y connected induction motor has rotor resistance and rotor reactance of 0.12 Ω and 0.85 Ω respectively. The ratio of stator to rotor turns is 1.8. The full load slip is 4 %. Calculate for this load the torque and horse power output. Also find the maximum torque and speed at maximum torque, starting torque.
- **4A.** A 4 pole 3 phase induction motor delivers 37 hp at a speed of 1425 rpm on 500 V, 50 Hz supply. The mechanical losses total 3 hp. The power factor is 0.9. Stator losses = 1500 W. Calculate

a) slip b) rotor copper loss c) the line current d) efficiency e) rotor frequency

4B. Derive equations for power input & power output of a synchronous motor in terms of E, V, Z_s & δ Also find the condition for maximum input and maximum output.

(8+12)



5B. An 11 kV, 3 Phase, star - connected synchronous motor takes a current of 200 A from supply at unity PF. Find the current and PF when the excitation is i) raised by 20 % ii) lowered by 20 %. Neglect armature resistance, armature reactance is 8 Ω . (8+12) 6A. Distinguish between core type and shell type transformers **6B.** Derive the conditions for zero voltage regulation & maximum voltage regulation for a transformer, draw the regulation curve for a given load. 6C. A 3 phase, 50 Hz, 4 pole induction motor develops a full load torque of 67 Nm at 1425 rpm. Maximum torque developed at 1200 rpm. Find the starting torque. (4+6+10)**7A.** Explain why synchronous motor is not self-starting. Discuss any two starting methods. 7B. The efficiency of a 500 kVA transformer is 98 % when delivering full load at 0.8 PF and 98.5 % at $\frac{1}{2}$ load & 0.9 PF. Calculate the iron loss and full load copper loss. Find the load kVA at maximum efficiency. (6+10+4)**7C.** Derive the condition for maximum efficiency of a transformer. **8A.** Determine the percentage tapping required on an autotransformer to start an induction motor such that line current is limited to 2 times the full load current. If full load slip is 0.05, find the ratio of starting torque to full load torque. **8B.** A 10 pole, 50 Hz, slip ring induction motor runs at 576 RPM on full load. The rotor resistance per phase is 0.25Ω . Calculate the additional resistance in the rotor to reduce the speed to 480 rpm. Assume load torque is constant.

5A. Draw and explain the torque/slip characteristics of a 3 Phase induction motor.

Prove that maximum torque is independent of rotor resistance.

- 8C. A 5 kVA, 220 /440 V, 50 Hz single phase transformer has a core loss of 70 W. The short circuit test conducted from HV side gave the following results 10 V, 6 A, 25 W. Find the
 - a) Efficiency at full load 0.8 PF lag
 - b) Secondary terminal voltage at full load 0.8 PF lead, 0.8 PF lag and unity PF.

(6+6+8)