Motilal Nehru National Institute of Technology Allahabad

DEPARTMENT OF ELECTRICAL ENGINEERING

End semester Examination, 2017-18

B. Tech (5th Semester)

SUBJECT: AC Electrical Machine (EE 1501)

Duration: 3 hrs. Maximum Marks: 60

Instruction: Answer all the questions

Take necessary assumptions, if required

1. An alternator, connected to infinite bus is operating at unity power factor at half-full load. With field current remaining constant, steam input is increased till alternator begins to operate at full load. Under this condition, discuss what happens to power factor and reactive power flow. (3)

   b. Compare the performance of a synchronous generator connected to an infinite bus with that of an isolated alternator operating on its own load. (1)

   c. The speed regulations of two 800 kW alternators A and B running in parallel are 100 % to 104 % and 100 % to 105 % from full-load to no-load respectively. How will the two alternators share a load of 1000 kW? (4)

2.

   a. Discuss Blondel's two reaction theory of salient pole synchronous machines? (2)

   b. An alternator has an efficiency of 90 percent when operating at unity p.f and at rated kVA. Explain what happens to its efficiency at rated kVA but at 0.8 p.f lagging. (2)

   c. Two similar alternators operating in parallel have following data:
   Alternator 1: Capacity 700 kW, frequency drops from 50 Hz at no-load to 48.5 Hz at full load.
   Alternator 2: Capacity 700 kW, frequency drops from 50.5 Hz at no-load to 48 Hz at full load.
   Calculate how a total load of 1200 kW is shared by each alternator? Also find its busbar frequency. (4)

3.

   a. A turbo-alternator having a per phase reactance of 10 Ω, if supplying 220 A at unity pf to 11 kV infinite bus. (4)

      i. What will be the current and pf if the excitation of the machine is increased by 20 % without changing its steam admission? Will there be any change in power output? Explain.

      ii. With the increased excitation, at what power output would the alternator break from synchronism?

   b. Sketch a typical torque-speed curve of a polyphase induction motor working under rated supply voltage V and frequency f and show the stable region of operation. On the same diagram, sketch the torque-speed curve for the following voltages and frequencies but with constant rotor resistance:(4)

   (i) $\frac{V}{2}$ and f (ii) $\frac{V}{2}$ and $\frac{f}{2}$ (iii) V and $\frac{f}{2}$

4.

   a. A 400 V, 40 hp, 50 Hz, 3-phase induction motor gave the following test data:

No-Load test	:	400 V, 20 A, 1200 W
Blocked-rotor test	:	100 V, 45 A, 2750 W

Stator dc resistance per phase is 0.01 Ω. The ratio of ac to dc resistance is 1.5. The friction and windage loss is 300 W. Calculate the circuit elements of the approximate equivalent circuit of the motor. (5)

b. Power factor of a polyphase induction motor is low at no-load, but it improves as the load on the motor is increased. Explain. (3)

5.

a. A 3-phase, 400 V, 50 A, 4-pole, 1440 r.p.m. induction motor takes a blocked rotor current of 6 times its full load current at 0.4 pf lag at rated voltage and develops a torque of 1 8 times its full load torque. If this induction motor is started by an auto-transformer with 60 % tapping, then at the time of starting, calculate (a) motor power factor (b) motor current (c) line current (d) power input to motor and (e) starting torque in terms of full load torque. (5)

b. In an induction motor explain the method of speed control by pole changing technique. (3)

6.

a. Explain how the stationary, pulsating m.m.f. wave of a single phase induction motor can be considered as equivalent to two equal but oppositely rotating m.m.f. waves. Also explain why the forward flux wave is several times greater than the backward flux wave at normal rotor speed.(4)

b. A 230 V, 4-pole, 50 Hz, capacitor start single phase induction motor has the following constants and losses: (4)

$r_1 = 2.10\ \Omega$ $x_1 = 3\ \Omega$

$r_2 = 4\ \Omega$ $x_2 = 3\ \Omega$

$X_m = 70\ \Omega$

Core loss = 48 watts, Friction and windage loss = 20 watts.

For a slip of 0.05, compute the stator current, pf, power output, torque and efficiency when this motor is running at rated voltage and frequency with its auxiliary winding open.

7. Write short notes on the following: (3x4=12)

a. Double cage induction motor

b. Crawling and cogging phenomenon in induction motor

c. Skewed rotor slots in induction motor

d. Capacitor start and run motors