Motilal Nehru National Institute of Technology Allahabad

DEPARTMENT OF ELECTRICAL ENGINEERING

End semester Examination, 2014

B.Tech (EED- Vth Semester)

SUBJECT: AC ELECTRICAL MACHINE (EE-1501)

Duration: 03:00 Hr. **Maximum Marks: 60**

Instructions: Answer all the questions.

Take the necessary assumptions, if required.

1.

a. Why Starters are necessary for starting 3-phase Induction Motors? What are the various type of Starters? Explain the operation of Star-Delta type Starter in detail. (4)

b. A 400 V, 40 hp, 50 Hz, 3-phase star connected squirrel cage Induction Motor gave the following test results:

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 & Windage loss is 300 W. Calculate the circuit elements of the approximate equivalent circuit of the motor. (4)

2.

a. Explain the supply-Frequency control method for speed control of 3-phase Induction Motor. Derive and sketch the Torque-Speed curves of a polyphase Induction Motor if

i. It's supply frequency is varied with constant voltage

ii. Both the supply voltage & frequency are varied in the same ratio.

Which of these Torque-Speed characteristics is more desirable? Explain. (3)

b. Calculate the full load efficiency of a 415 V, 3-phase, 50 Hz, Delta connected Induction Motor from the following test data:

On no load power intake is 1500 W at rated input voltage. On full load line current is 50 A, Power Factor is 0.85 and slip is 0.04. Resistance of stator winding per phase is 0.5 Ω. Assume the ratio of stator core loss to Friction & Windage loss as 3:2. (5)

3.

a. Show that for Alternators running in parallel, the division of load between them is mainly governed by the speed load characteristics of their primemover. (4)

b. An industrial plant has load of 800 kW at a p.f of 0.8 lagging. It is desired to install a synchronous motor to deliver a load of 200 kW and also serve as a synchronous condenser to improve the overall p.f of the plant to 0.92. Determine the kVA rating of the synchronous motor and its power factor. Assume that the synchronous motor has an efficiency of 90 %. (4)

4.

a. For a 3-phase salient pole synchronous machine operating as reluctance machine under maximum power condition, derive the following relation:

$$\tan\theta = \frac{X_d + X_q}{X_d - X_q}$$

where θ = power factor angle of reluctance machine. (4)

b. What are the advantages of distributing the winding in slots? Define distribution factor and show that it's expression for the fundamental frequency component is given by $\frac{\sin m\alpha/2}{m \sin \alpha/2}$. (4)

5.

a. Why are synchronous motors not self-starting? Also explain the various methods employed for the starting of 3-phase synchronous motors. (4)

b. A 3-phase, turbo alternator with a synchronous reactance of 10 Ω per phase and negligible armature resistance is connected to 11 kV constant voltage constant frequency bus bars and supplies 100 A at unity power factor to the system. If the turbine power is kept constant and the excitation of the alternator is increased by 25 %, what would be the new current and power factor? Make appropriate assumptions. (4)

6.

a. Why single phase Induction Motors are not self starting? Explain the double revolving field theory as applied to a single phase Induction motor. (4)

b. A 4-pole, 50 Hz, 1-phase induction motor has an effective rotor resistance referred to stator as 2.4 Ω at slip frequency. At about twice the mains frequency, this resistance should be increased by 50 %. The forward and backward components of current at a slip of 5 % are 2.6 A & 3.8 A respectively. Assuming mechanical loss as 5 % of the internal power developed, compute the output power and torque of the motor. (4)

7. Answer any six of the following: (6x2)

a. In double cage polyphase induction motors, explain how the desirable features of high starting torque and low operating slip are attained.

b. Explain the phenomenon of cogging and crawling in a 3-phase induction motor.

c. Write the causes of harmonics in current and voltage waves of electrical machinery.

d. Explain the method of synchronization by using synchroscope.

e. Write a brief note on Induction Generator.

f. Explain in detail about capacitor start and capacitor run motor.

g. Explain the effect of changing field excitation of two parallel connected alternators when loaded, using phasor diagram.