M. E. (Electrical) 2nd Semester Examination, 2013

Analysis of Synchronous and Asynchronous Machines-I
(EE-1006)

Time: 3 hours **Full Marks : 70**

Answer all Groups in the same answer script
Four marks are reserved for neatness

Group – A

Answer any two from this Group:

1. Derive the volt-ampere equations of Kron's primitive machine in '+ -' reference frame for analysis of operation under dynamic unbalance. Make reasonable assumptions and state them in the process of derivation. [11]

2. Explain the principle of operation of a commutatorless DC motor fed from a DC current source through a two-level inverter operating under self-control with 120 degree conduction, with MMF space vectors and show its similarity with conventional DC motor. [11]

3. A Commutatorless DC motor is fed from a DC current source through a 120 degree conduction two-level inverter. For a certain operating condition, the equivalent brush shift position is 30 degree lead, the DC link current is 1.2 Amperes, and the operating mechanical speed is 1400 RPM. The machine is a star-connected 4-pole one and its synchronous inductance is 0.09H per phase. The fundamental induced EMF is 350V. Neglecting all losses, find out the average shaft torque, power output and the power factor at the machine terminals in this operating condition. [11]

Group – B

Answer any two from this Group:

4.(a) Develop the block diagram of a synchronous machine in motor mode.
(b) Describe locked line to line test [5+6]

5.(a) Describe Slip test with necessary mathematical support.
(b) What are the assumptions made in the approximate analysis of synchronous machine? Write down the approximate equations.
(c) Define zero sequence impedance of a synchronous machine. [6+3+2]

6.(a) Describe a test to determine the negative sequence impedance of a synchronous machine with necessary mathematical support.

(b) Write a note on Maximum Lagging Current test. [5+6]

Group-C

Answer Question No. 7 and any One from the rest of this Group

7.(a) A 400 V, 50 Hz, 6 pole, Y-connected wound-rotor induction motor has following parameters referred to stator:

$R_s = 0.5\ \Omega,\ R_r' = 0.4\ \Omega,\ X_s = X_r' = 1.1\ \Omega,\ X_m = 45\ \Omega$

(Symbols have their usual meanings.)

An external resistance is inserted into the rotor circuit so that maximum torque is produced at $s_m = 2$. The motor, which was initially operating on no-load is being braked by single-phase ac dynamic braking with three lead connection. Calculate the braking current and torque as a ratio of their full load values for 960 r.p.m.

(b) During plugging operation of a wound rotor induction motor, usually an external resistance is inserted into the rotor circuit, why? [9+2]

8.(a) Discuss the effects of pulsating harmonic torques on a three-phase induction motor.

(b) Compare two-lead ac dynamic braking of a star-connected induction motor with that for three-lead connection.

(c) Derive an equivalent circuit for the dc dynamic braking of an induction motor and explain why it is necessary to account for the saturation in the magnetic circuit. [3+3+5]

9.(a) Explain the significance of the name "Brushless DC Motor". Draw the waveforms of flux-linkage, back-emf, current and torque in a BLDC motor. Mention some applications of BLDC motors.

(b) From the per-phase equivalent circuit at fundamental frequency, derive the nth harmonic equivalent circuit of a three-phase induction motor and its approximate equivalent circuit. [(2+3+2)+4]