M.E. (Electrical) 2nd Semester Final Examination, 2012 9-5-12

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

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

Answer SIX questions, taking THREE from each group.
Four marks are reserved for neatness.

GROUP-A

1. a) Assuming the volt-ampere equations for the Kron's primitive machine in 'f-g-α-β' reference frame, develop the volt-ampere equation of the same machine in '+ -' complex reference frame.
   b) What is the usefulness of this complex transformation? [10+1]

2. a) Develop the block diagram of a synchronous machine in motor mode.
   b) Write down the procedure for slip test. Justify the measurement of different parameters from this test. [6+5]

3. a) Describe maximum lagging current test with necessary mathematical support.
   b) Define positive sequence, negative sequence and zero sequence impedance of a synchronous machine. [8+3]

4. a) What are the disadvantages of '+ -' reference frame and how are these problems partially solved?
   b) Describe the procedure for locked line to line test. [6+5]

5. Write a brief note on small forced oscillation of a synchronous machine. [11]

GROUP-B

6. a) 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.
   b) A 400 V, 50 Hz, 6-pole, Y-connected wound-rotor induction motor has following parameters referred to the stator:
   $R_s = 0.08\ \Omega$, $R_r' = 0.12\ \Omega$, $X_s = 0.25\ \Omega$, $X_r' = 0.35\ \Omega$ and $X_m = 10\ \Omega$
   (Symbols have their usual meanings.)
   An external resistance is inserted into the rotor circuit so that the maximum torque is produced at S_m=2.0. The motor connections are now changed from motoring to single-phase ac dynamic braking with three lead connection (one phase in series with other two phases in parallel). Calculate the braking current (line) and torque for a speed of 900 r.p.m. [5+6]

7. a) What are the advantages and disadvantages of a brushless dc motor over a conventional dc motor? Draw the waveforms of flux-linkage, back-emf, current and torque in a BLDC motor. Explain the advantage of having trapezoidal back emf distribution.
   b) Mention some applications of BLDC motors. [(3+3+3)+2]

8. a) 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.
   b) Compare two-lead ac dynamic braking of a star-connected induction motor with that for three-lead connection. [6+5]

9. a) What are the similarities between brushless dc motor and a self-controlled synchronous motor drive?
   b) What are the sensors used with BLDC motor? Suggest a suitable scheme for controlling the speed of a BLDC motor. [4+(2+5)]

10. a) Discuss the undesirable effects of harmonics on a three-phase induction motor.
    b) A 3-phase, 440 V, 50 Hz, 6-pole, star-connected induction motor has following parameters referred to the stator:
    $R_s = 0.5\ \Omega,\ R_r' = 0.6\ \Omega,\ X_s = X_r' = 1\ \Omega$
    (Symbols have their usual meanings.)
    Stator to rotor turns ratio is 2. If the motor is used for the regenerative braking, determine:
    i) Maximum overhauling torque it can hold and the range of speed in which it can safely operate.
    ii) The speed at which it will hold a load with a load torque of 150 N-m. [5+6]
