M.E. (Electrical) 2nd Semester Final Examination, 2014

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

Time : 3 hours | Full Marks : 70

Answer **six** questions taking **four** from Group A and **two** from Group B
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 complex transformation? [10+1]

2. a) Define positive sequence, negative sequence and zero sequence impedance of a synchronous machine.
   b) Describe Maximum Lagging Current test of a synchronous machine with necessary mathematical support. [3+8]

3. a) What is meant by a commutatorless DC motor?
   b) With necessary space vector diagrams explain the principle of operation of a commutatorless DC motor fed from a DC current source through a three phase inverter operating under self-control with 120 degree conduction. [2+9]

4. 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]

5. a) Describe a test to determine negative sequence impedance of a synchronous machine with necessary mathematical support.
   b) Write a note on Locked line to line test of a synchronous machine. [5+6]

6. A three-phase balanced short circuit is applied on an unloaded alternator. Derive the expression of short circuit current. [11]

GROUP - B

7. a) 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.
   (i) The speed at which it will hold a load with a load torque of 160 N-m.

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. [6+5]

8. 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 kW, 50 Hz, 960 r.p.m., star-connected, 3-phase, 6-pole slip-ring induction motor has the following parameters referred to the stator:

$R_s = 0.08\ \Omega$, $R_r^{'} = 0.1\ \Omega$, $X_s = X_r^{'} = 0.3\ \Omega$ (Symbols have their usual meanings.)

The motor is braked by dc dynamic braking. The magnetising reactance under rated condition is known to be 6 Ω per phase referred to the stator. DC excitation is applied keeping the third stator terminal open. If the dc excitation produces only the rated voltage (E=231V) in the rotor circuit at synchronous speed, neglecting saturation, determine (i) maximum braking current, (ii) maximum braking torque and the speed at which it occurs. [5+6]

9. a) Discuss the undesirable effects of harmonics on a three-phase induction motor.

b) What are the advantages 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. Mention some applications of BLDC motor. [5+6]