B.E. (EE) Part II 4th Semester Final Examination, 2012

Subject : ELECTRICAL MACHINES - II

Subject Code : EE-402

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

Two marks are reserved for neatness in each half

Graph papers will be supplied

FIRST HALF

Answer any THREE questions

1. (a) When operated at rated voltage and frequency, a 3-phase squirrel cage induction motor runs on full load at a slip of 5%.It has maximum torque of 280% of full load torque at a slip of 40%. Neglect core and rotational losses. Determine the torque and rotor current at starting as a fraction of the values at rated condition.

   (b) A 550 V, 3-phase, 50 Hz, 6-pole induction motor develops 30 hp (including 2 hp mechanical losses) at a speed of 950 rpm. The corresponding stator losses are 2kW and p.f. is 0.88. Calculate (i) the slip, (ii) the input power, (iii) the overall efficiency, (iv) the line current and (v) the number of complete cycles the rotor emf makes in a rotation.

   (c) What will happen if appropriate 3-phase supply is fed to the rotor windings of a 3-phase slip ring induction machine keeping the stator terminals shorted? **[4+5+2]**

2. The following test data relate to a 3.2 hp, 400V, 3-phase, 50Hz, 4-pole delta connected squirrel cage induction motor:

   No-load test: 400V, 3.2 A, 385 W

   Blocked rotor test: 105 V, 8 A, 510W

   The (hot) resistance measured between any two stator terminals under hot condition is 0.24 Ω. Draw the circle diagram and evaluate the following: (i) input line current, (ii) p.f., (iii) slip and (iv) efficiency at rated load. Also find (v) the maximum torque and (vi) the slip for maximum torque. Separate marks are reserved for neat drawing of the circle diagram and clarity of working out. **[6+5]**

3. (a) The following test results were obtained from a 3-phase, 20 h.p., 400 V, 50 Hz, 6-pole induction motor. No load: 400 V, 10 A, power factor 0.8; short-circuit: 200 V,50 A, power factor 0.415. The motor drives a load having constant torque of 175 N m. Estimate the possible percentage reduction in the supply voltage before the motor stalls. Assume that the copper losses are equally divided between the stator and the rotor.

(b) If the above machine is to be run as an isolated induction generator, with the stator frequency being 50 Hz, what should be the value of the capacitor connected to the terminals at no load but developing rated terminal voltage?

(c) Why is it told that induction generators operate at leading pf? **[6+3+2]**

4. (a) The winding particulars of the stator of a 15 hp, 415 V, 4-pole, 3-phase, delta-connected squirrel cage induction machine are given below:

(i) Total no. of slots = 36

(ii) winding arrangement : double layer

(iii) no. of turns per coil = 4

(iv) coil pitch: short pitched by one full slot

Calculate the amplitude of the space fundamental component of the resultant armature mmf at full load. The efficiency and operating pf may be taken as 88% and 0.87 respectively. Show the calculation steps with brief clarification for the calculations.

(b) What are pitch factor and breadth factor of the armature winding of an ac machine? Derive expressions. Also find the limits of the value of breadth-factor.

(c) What is meant by a sinusoidal current sheet? Derive an expression for the same. **[5+5+1]**

5. (a) Starting from basic principles of electromechanical energy conversion, show with appropriate derivations that the torque developed in a d.c. machine is given by,

$T = k_t \varphi_P I_a$, where symbols have their usual significance.

(b) Graphically derive the waveform of the air-gap mmf of a 12 slot, 2-pole, double-layer wound dc machine. Indicate the assumptions and basic principles on which it is based.

[6+5]

SECOND HALF

Answer Question no. (6) and any TWO from the rest

6. Justify the validity of the following statements with proper reasoning:
   (i) The relative amount of inductively power transferred and conductively power transferred depend upon the ratio of transformation in an auto transformer.
   (ii)The third harmonic magnetizing current can flow in the closed delta connected side of the transformer but not in the lines.
   (iii) Zigzag-connected transformer requires less copper than a star connected transformer for the same rating.
   (iv) Deep bar cage rotor induction motor develops a high starting torque compared to a normal bar cage rotor motor.
   (v) Swinburne's test cannot be performed on d.c series motor. **[3+2+2+2+2]**

7. (a)Explain the different types of stator slots normally employed in a three-phase induction motor. Why the air gap is made as small as practicable in a three-phase induction motor?
   (b)The standstill impedance of the outer cage of a double cage induction motor is $(2 + j1.2)$ ohm and that for the inner cage is $(0.5 + j3.5)$ ohm. Determine the slip at which the two cages will develop equal torque. **[5+6]**

8.(a)What are the common schemes for conversion from three-phase to six-phase supply? Draw the phasor and connection diagrams for each connection.
   (b)Why tappings should be provided on high voltage side of a transformer?
   (c) Explain the operation of a center-tapped reactor type on-load tap changer with necessary diagram. **[5+3+3]**

9.(a)Explain the various purposes of the tertiary winding in a three-winding transformer.
   (b) A 6600/3000/400 V, star/star/delta transformer has a magnetizing current of 5.0A. The respective primary, secondary and tertiary p.u resistance drops are 0.006, 0.007, 0.008 and p.u reactance drops are 0.03, 0.028, 0.034 on a 1500 kVA base power. Determine the following voltage regulations (in p.u) when a three-phase balanced load of 1500 kVA at 0.8 p.f (lag) and 600 kVA at 0.6 p.f (lead) are applied on secondary and tertiary respectively.
   (i) primary-secondary voltage regulation
   (ii) primary –tertiary voltage regulation
   (iii) secondary-tertiary voltage regulation
   (iv) tertiary-secondary voltage regulation **[5+6]**

10.(a)With the help of a neat circuit diagram, derive the expression of efficiency of a d.c shunt motor and a d.c shunt generator using Hopkinson's test.
   (b) A 480V, 25 h.p d.c shunt motor takes 2.6 A current under no-load condition. Find the full load efficiency of the motor if the motor armature resistance (hot) is 0.5 Ω and field resistance is 600 ohm. Assume a brush voltage drop of 2V. **[5+6]**