Printed Pages – 5 **TEE – 501**

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 2055 **Roll No.** | | | | | | | | | |

B. Tech.

FIFTH SEMESTER EXAMINATION, 2006-07

ELECTRO MECHANICAL ENERGY CONVERSION - II

Time : 3 Hours *Total Marks : 100*

Note : *(i)* *Attempt **ALL** questions.*

(ii) *All questions carry equal marks.*

(iii) *In case of numerical problems assume data wherever not provided.*

(iv) *Be precise in your answer.*

1. Attempt *any two* parts of the following : **(10x2=20)**

(a) Discuss about 'open-circuit' and 'short-circuit' characteristics of a synchronous generator. Draw the phasor diagram of alternator under short circuit condition. What do you understand by the term "short circuit ratio" ? Discuss how the short circuit ratio can be calculated from two characteristic curves.

(b) A 2000 kVA, 11kV, 3-phase star connected alternator has a resistance of 0.3 ohm and reactance of 5 ohms/phase. It delivers full load current at p.f. of 0.8 lagging and normal rated voltage. Compute the terminal voltage for same excitation and load current at 0.8pf. leading. Comment on the results obtained.

(c) The full-load torque angle of a synchronous motor at rated voltage and frequency is 30° elect. The stator resistance is negligible. How would the torque angle be affected by following changes ?

(i) The load torque and terminal voltage remaining constant, the excitation and frequency are raised by 10%.

(ii) The load power and terminal voltage remaining constant, the excitation and frequency are reduced by 10%.

(iii) The load torque and excitation remaining constant, the terminal voltage and frequency are raised by 10%.

(iv) The load power and excitation remaining constant, the terminal voltage and frequency are reduced by 10%.

2. Attempt *any two* parts of the following : **(10x2=20)**

(a) Explain the parallel operation of sychronous generators with drooping characteristics. Also draw the phasor diagram under the oprating conditions for parallel operation and elaborate the same.

(b) A 3 phase synchronous generator has a direct-axis synchronous reactance of 0.8 p.u. and a quadrature-axis synchronous reactance of 0.5 p.u. The generator is supplying full-load at 0.8 p.f. lagging at 1.0 p.u. terminal voltage. Calculate power angle and the no-load voltage if excitation remains unchanged.

(c) A 20MVA, 11kV, 3-phase, delta- connected synchronous motor has a synchronous impedance of 15 ohm/phase. Windage, friction and iron losses amount to 1200kW.

(i) Find the value of unity power factor current drawn by the motor at a shaft load of 15MW. What is the excitation emf under this condition ?

(ii) If the excitation emf is adjusted to 15.5kV (line) and the shaft load is adjusted so that the motor draws unity power factor current. find the net motor output.

3. Attempt *any two* parts of the following : **(10x2=20)**

(a) The following test results were obtained on a 7.5kW, 400V, 4-pole, 50Hz, delta connected induction motor with a stator resistance of 2.1 ohm/phase.

No load	:400V	5.5A	410W
Rotor blocked	:140V	20A	1550W

Obtain the approximate equivalent circuit model. Also estimate the breaking torque developed when the motor running with a slip of 0.05 has two of its terminals suddenly interchanged.

(b) For high starting torque applications, which type of rotor constructions are preferably adopted in induction motor. Explain above rotor constructions with its suitable torque-slip characteristic.

(c) A 3.3 kV, 20pole, 50Hz, 3-phase star-connected induction motor has a slip ring rotor of resistance 0.025 ohm and standstill reactance of 0.28 ohm per phase. The motor has a speed of 294 rpm when full-load torque is applied. Compute slip at maximum torque and the ratio of maximum to full-load torque. Neglect stator impedance.

4. Attempt *any two* parts of the following : **(10x2=20)**

(a) (i) Explain the different methods of starting squirrel cage induction motors. Compare them.

(ii) Explain in brief Cogging and Crawling phenomena.

(b) A 440V, 50Hz, 4-pole, 3-phase delta connected induction motor has a leakage impedance of (0.3 + j5.5 + 0.25/s) ohm/phase (delta phase) referred to the stator. The stator to rotor voltage ratio is 2.5. Determine the external resistance to be inserted in each star-phase of the rotor winding such that the motor develops a gross torque of 150N-m at a speed of 1250 rpm.

(c) A 3-phase induction motor runs at a speed of 1485 rpm at no-load and at 1350 rpm at full-load when supplied from a 50Hz, 3-phase line.

(i) How many poles does the motor have ?

(ii) What is the % slip at no-load and at full-load ?

(iii) What is the frequency of rotor voltages at no-load and at full-load ?

(iv) What is the speed at both no-load and full-load of, the rotor field with respect to rotor conductors, the rotor field with respect to the stator and the rotor field with respect to the stator field.

5. Attempt *any two* parts of the following : **(10x2=20)**

(a) A 220V, 6-pole, 50Hz single winding single phase induction motor has the following equivalent circuit parameters as referred to the stator

$r_{1m} = 3\Omega$ $x_{1m} = 5$

$r_2 = 1.5\Omega$ $x_2 = 2\Omega$

Neglect the magnetizing current, when the motor runs at 97% of the sychronous speed, compute the ratio Emf/ Emb and ratio T_f/T_b.

(b) (i) Explain the principle of operation of capacitor-start and capacitor-run single-phase induction motors. Discuss about the torque-speed characteristic of each.

(ii) Explain the working principle of permanent magnet stepper motor with constructional diagram.

(c) (i) A universal motor (ac-operated) has a 2-pole armature with 960 conductors. At a certain load, the motor speed is 5000 rpm and the armature current is 4.6 Amp, the armature terminal voltage and input are respectively 100V and 300W. Compute effective armature reactance and maximum value of useful flux/pole, assuming an armature resistance of 3.5 ohm.

(ii) Show that if the stator voltages of 2-phase induction motor are V_m and V_a with a fixed phase difference of 90°, the starting torque is same as that for a balanced voltage of $\sqrt{V_m \cdot V_a}$ per phase.

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