Printed Pages—4 EEE501

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

PAPER ID : 2111	Roll No.										

B.Tech.

(SEM. V) ODD SEMESTER THEORY EXAMINATION 2013-14

ELECTROMECHANICAL ENERGY CONVERSION–II

Time : 3 Hours *Total Marks : 100*

Note :– Attempt **all** questions. Each question carries equal marks.

1. Answer any **two** parts of the following : **(10×2=20)**

   (a) Explain why 3ϕ synchronous machines are run at constant speed such as synchronous speed $\left(N_s = \frac{120f}{\rho}\right)$, where the symbols having their usual meanings ?

   (b) What are the causes of "HUNTING" in synchronous machines ? How is it minimised ? What are the advantages and disadvantages of "HUNTING" in synchronous machines ?

   (c) From the phasor diagram of the salient pole synchronous machine, show that :

$$\tan\delta = \frac{I_a X_q \cos\phi - I_a R_q \sin\phi}{V_t - I_a X_q \sin\phi - I_a R_q \cos\phi}$$

   where the symbols having their usual meanings.

2. Answer any **two** parts of the following : **(10×2=20)**

(a) A salient-pole synchronous motor has

$X_d = 0.85$ p.u.

and $X_q = 0.55$ p.u.

It is connected to bus-bars of 1.0 p.u. voltage, while its excitation is adjusted to 1.2 p.u. Calculate the maximum power output, the motor can supply without loss of synchronism.

Compute the minimum p.u. excitation that is necessary for the machine to stray in synchronism while supplying the full-load torque (i.e 1.0 p.u. power).

(b) What do you mean by "O.C.C." and "S.C.C." in synchronous machines ? Determine the value of synchronous reactance and short circuit ratio from O.C.C. and S.C.C.

(c) A 3-ϕ, hydro-electric synchronous generator is read to be 110 MW, 0.8 p.f. lagging, 6 kV, Y-connected, 50Hz, 100 rpm. Determine the following :

(i) the number of poles

(ii) the kVA rating

(iii) the prime-mover rating if the full-load generator efficiency is 97.1% (leave out field loss).

3. Answer any **two** parts of the following : **(10×2=20)**

(a) What do you mean by "FORWARD" and "BACKWARD" fields in 1-ϕ IMs ? Explain why in case of 1-ϕ IMs, the flux is pulsating in nature. Explain why, 1-ϕ IMs are not self starting ? Enlist the methods of starting of 1-ϕ IMs. Also mention is domestic applications.

(b) Explain the following tests are performed on 1-ϕ IMs :

(i) Stator resistance DC test

(ii) No-load test

(iii) Blocked-rotor test.

Also mention their utility.

(c) For a 3-ϕ IMs, show that :

$$\frac{T}{T_{max}} = \frac{\sqrt{K^2 + 1}}{1 + \frac{1}{2}\sqrt{K^2 + 1}\left\{\frac{S}{S_{max,T}} + \frac{S_{max,T}}{S}\right\}}$$

Where $K = \frac{X_1 + X_2'}{R_1}$ and other symbols having their usual meaning.

4. Answer any **two** parts of the following : **(10×2=20)**

(a) A squirrel-cage Induction Motor is rated 25 kW, 440 V, 3-ϕ, 50 Hz. On full-load it draws 28.7 kW with line current 50 A and runs at 720 rpm. Calculate :

(i) the slip(s)

(ii) the power factor, and

(iii) the efficiency (η).

(b) Write short notes on the following :

(i) Deep-bar rotor in 3-ϕ IMs

(ii) Double-cage rotor in 3-ϕ IMs.

(c) The two-cages of a 3-ϕ, 50Hz, 4-pole, delta-connected induction motor have respective stand still leakage impedances of (2 + j8) and (9 + 2j)Ω/phase. Estimate the gross-torque developed :

(i) at stand still, the effective rotor voltage being 230 V/phase, and

(ii) at 1450 rpm when the effective rotor voltage is 400 V/phase. What is the gross-starting torque if a Y-Δ starter is used ? Rotor quantities given are all referred to the stator; the stator impedance is negligible.

5. Answer any **two** parts of the following : **(10×2=20)**

(a) Define the following :

(i) COGGING PHENOMENA in 3-ϕ IMs

(ii) CRAWLING PHENOMENA in 3-ϕ IMs.

(b) A 3-ϕ, 400 V, 6-pole, 50 Hz, IM develops mechanical power of 20 kW at 985 rpm. Calculate :

(i) the rotor copper loss,

(ii) the total input power, and

(iii) rotor frequency (f_2).

The stator losses are equal to 1800 W. Neglect mechanical loss.

(c) A 4 pole, 50 Hz, 3-ϕ, IM has a rotor resistance of 4.5 Ω/phase and stand still reactance of 8.5 Ω/phase. With no external resistance in the rotor circuit, the starting torque of the motor is 85 N-m.

(i) What is the rotor voltage at stand still ?

(ii) What would be the starting torque if 3Ω resistance were added in each rotor phase ?

(iii) Neglecting stator voltage drop, what would be the induced rotor voltage and the torque at a slip of 0.03 ?