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

PAPER ID : 2111 **Roll No.** | | | | | | | | | | |

B.Tech.

(SEM. V) THEORY EXAMINATION 2011-12

ELECTROMECHANICAL ENERGY CONVERSION–II

Time : 3 Hours *Total Marks : 100*

Note :—All questions carry equal marks.

1. Answer any **four** parts of the following : **(5×4=20)**

(a) Explain why 3-ϕ synchronous machines are always run at synchronous speed $\left(N_s = \frac{120\,f}{P}\right)$? The symbols having their usual meanings.

(b) Explain why 3-ϕ synchronous machines are not self starting ? What are the methods for starting of the 3ϕ synchronous machines ?

(c) Define the v-curves and inverted v-curves at different loading conditions of synchronous motors.

(d) Discuss the constructional details and working principles of 3ϕ synchronous machines. Also mention its applications.

(e) Explain why in case of 3 ϕ synchronous machines, the armature windings put on stator and field windings put on rotor whereas in case of D.C. machines, the armature windings put on rotor and field windings put on stator poles ? Explain in brief.

(f) Write short notes on any **two** of the following :

(i) Mode of operations of synchronous motors.

(ii) Hunting Phenomena in 3 ϕ Synchronous motors.

(iii) Power Flow Equations of Cylindrical and Salient Pole Machines.

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

(a) For a cylindrical rotor alternator working at lagging power factor, show that

$$\tan\delta = \frac{I_a(X_s\cos\theta - r_a\sin\theta)}{V_t + I_a(X_s\sin\theta + r_a\cos\theta)}$$

The symbols having their usual meanings.

(b) A 5 MVA, 11 kV, 50 Hz, 4-pole, star-connected synchronous generator with synchronous reactance of 0.7 p.u. is connected to an infinite bus. Find synchronizing power and the corresponding torque per unit of mechanical angle displacement —

(i) at no load and

(ii) at full load of 0.8. p.f. lagging.

(c) A 500 KVA, 11KV, 3-ϕ , star-connected alternators has the following data :

Friction and windage loss	=	1500 W
Open-circuit core loss	=	2500 W
Effective armature resistance/phase	=	40 Ω
Field copper loss	=	1000 W

Find the following parts in regarding with above synchronous alternators :

(i) Alternator efficiency of half-full load and at 0.85 power factor lagging.

(ii) Maximum efficiency of the alternator.

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

(a) What are the similarities and dissimilarities between "Three Phase Transformers" and "Three Phase Induction Machines" ? Explain why a 3-ϕ IM can't runs at synchronous speed $\left(N_s = \frac{120\,f}{P}\right)$, symbols having their usual meanings ? Also explain the phenomena such as "Cogging" and "Crawling" associated with a 3 ϕ IM.

(b) A 3 ϕ squirrel cage IM (SCIM) has maximum torque equal to twice the full-load torque. Determine the ratio of motor torque to its full load torque, if it is started by :

(i) D.O.L. Starter

(ii) Auto-transformer starter with 70% tapping.

(iii) Star-delta Starter.

The per phase rotor resistance and per phase standstill reactance referred to stator are 0.2 Ω and 2 Ω respectively. Neglect stator impedance.

(c) A 10 kW, 400 V, 50 Hz, 4-pole, Y-connected squirrel cage. IM gave the following test results :

No-load Test	400 V	8A	250 Watts
Blocked rotor Test	90 V	35A	1350 watts.

The d.c. resistance of the stator winding per phase measured immediately after the blocked rotor test is 0.6 Ω.

Calculate the following :

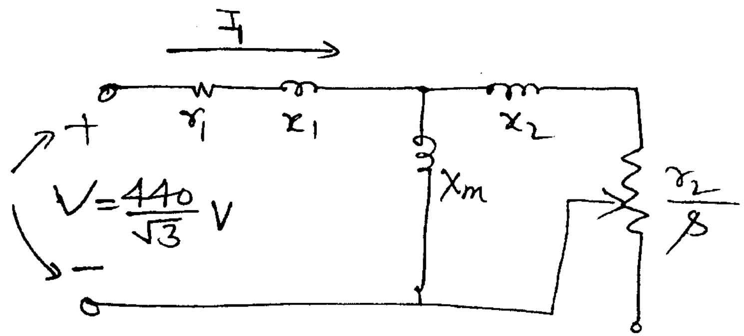
(i) Equivalent circuit parameters of 3 ϕ SCIM.

(ii) Rotational losses.

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

(a) What are the methods for speed control of squirrel cage IM and wound type IM ? Also mention its advantages and disadvantages. Discuss the field of applications of speed control methods of IMs.

(b) Consider the equivalent circuit diagram of 3ϕ, Y-connected, 440 V, 50 Hz, 4-pole, IM shown in Fig.1 :



where r_1= 0.294 Ω; x_1= 0.503 Ω; X_m=13.25 Ω; r_2= 0.209 Ω; x_2= 0.144 Ω.

Fig.1. Equivalent circuit diagram of IM.

(i) Determine the stator current and power factor (motor runs at N_r= 1460 RPM)

(ii) Determine the air gap power and rotor copper losses (motor runs at N_r=1450 RPM).

(iii) What is the value of motor speed at which it takes 30 Ampere current at 0.8 p.f. lagging from supply mains ?

(iv) What is the value of slip when motor runs at N_r= 1480 RPM ?

(c) The impedances at standstill of the inner and outer cages of a double cage rotor are $(0.01 + J\ 0.5)\ \Omega$ and $(0.05 + j\ 0.1)\ \Omega$ respectively. The stator impedance may be assumed to be negligible.

Calculate the ratio of the torques due to the two cages—

(i) at starting, and

(ii) when running with a slip of 5%.

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

(a) Explain why 1-ϕ IMs are not self starting ? What do you understand by "FORWARD FIELD" and "BACKWARD FIELD" in conjunction with 1-ϕ IM ? Draw and explain the equivalent circuit diagram of 1-ϕ IM at no-load and blocked rotor tests. Also explain the double resolving field theory associated with 1-ϕ IM. What are the methods of starting of 1-ϕ IM ? Explain the working principle of 1-ϕ shaded pole type IM and its domestic applications.

(b) Explain the constructional details and working principle of 1-ϕ reluctance motors. Also mention its domestic applications. What are the advantages and disadvantages of this motors ? Compare their performance from 1-ϕ hysteresis motors.

(c) Discuss the constructional details and working principle of any **two** of the following :

(i) Stepper Motors

(ii) Universal Motor

(iii) Single phase AC series compensated motors.

Also mention their industrial applications.