Total No. of printed pages = 3

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Roll No. of candidate | | | | | | | | | | |

2023

B.Tech. 4th Semester End-Term Examination

ELECTRICAL MACHINE – II

New Regulation (w.e.f. 2017-18) & New Syllabus (w.e.f. 2018-19)

Full Marks – 70 Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer Question No. 1 and any *four* from the rest.

1. Answer the following (MCQ/ Fill in the blanks questions) : $(10 \times 1 = 10)$

(a) The stator of a 3-phase induction motor produces ———— magnetic field

(i) steady (ii) rotating

(iii) alternating (iv) none of the above

(b) A $3-\phi$, $5\,Hz$, 4 pole induction motor has slip of 4%. The speed of the motor is

(i) 1500 rpm (ii) 1450 rpm

(iii) 1440 rpm (iv) 1400 rpm

(c) The condition of induction motor at standstill resemble those of a transformer whose secondary is

(i) short circuited (ii) open circuited

(iii) remains unchanged (iv) none of the above

(d) The purpose of starting winding in a single phase induction motor is to

(i) reduce losses

(ii) limit temperature rise of the machine

(iii) produce rotating flux in conjunction with main winding

(iv) none of the above

[Turn over

(e) The field winding of an alternator is ———— excited

(i) d.c. (ii) a.c.

(iii) both a.c and d.c (iv) none of the above

(f) The disadvantage of a short-pitched coil is that

(i) harmonics are introduced

(ii) waveform becomes non-sinusoidal

(iii) voltage round the coil is reduced

(iv) none of the above

(g) The slip test on an alternator is performed to determine ————

(h) The least expensive fractional horse power motor is

(i) shaded-pole motor (ii) capacitor start motor

(iii) split-phase motor (iv) a.c. series motor

(i) The speed of a synchronous motor can be changed by varying

(i) mechanical load (ii) field excitation

(iii) supply frequency (iv) none of the above

(j) An under-excited synchronous motor behaves as

(i) an inductor (ii) a capacitor

(iii) a resistor (iv) none of the above

2. (a) What do you mean by synchronous speed of a 3-phase induction motor? Derive an expression for it. Why is the rotor speed of a 3-phase induction motor is always less than synchronous speed for all practical application? (2+3+3=8)

(b) A 3-phase induction motor having a 6 pole, star- connected stator winding runs on 240 V, 50 Hz supply. The rotor resistance and standstill rotor reactance are 0.12Ω and 0.85 Ω per phase respectively. The ratio of stator to rotor turns is 1.8 and full-load slip is 4%. Calculate the developed torque at full-load, maximum torque and speed at maximum torque. (7)

3. (a) For a 3-phase induction motor develop an expression to show that $\frac{\textit{Rotar Cu los}}{\textit{Gross rotor output}} = \frac{s}{1-s}$. (5)

(b) A 6-pole, 50 Hz, 3-phase induction motor runs at 960 r.p.m. when the torque on the shaft is 200 N-m. If the stator losses are 1500 W and friction and windage losses are 500 W, find (i) rotor Cu loss and (ii) efficiency of the motor. (6)

(c) Draw the equivalent circuit of a 3-phase induction motor referred to stator and write expressions for rotor input power and total mechanical power developed. (4)

4. (a) What happens when the centrifugal starting switch in a 1-phase Induction motor falls to open? (3)

(b) Explain the principle of operation of a shaded-pole motor. (4)

(c) At starting the windings of a 230V, 50 Hz, split-phase induction motor have the following

Parameters:

Main winding: $R = 4\Omega$; $X_L = 7.5\,\Omega$ and starting winding: $R = 7.5\Omega$; $X_L = 4\Omega$.

Find (i) current I_m in the main winding (ii) current I_s in the starting winding (iii) phase angle between I_s and I_m (iv) line current and (v) power factor of the motor. (8)

5. (a) Why do we use hydrogen for cooling large turbo alternators instead of air? (3)

(b) What are the advantages of distributed winding in an alternator? (2)

(c) What are the effects load power factor on armature reaction in an alternator? (3)

(d) A 3-phase, 50 Hz, star connected, 1000 kVA, 2300 V alternator gives a short circuit current of 400 A for a certain field excitation. With the same excitation, the open-circuit voltage was 1328 V (phase value). The d.c, resistance between two lines is 0.412Ω. Find (i) effective armature resistance (ii) synchronous reactance (iii) the full-load voltage regulation at 0.8 p.f. lagging. (7)

6. (a) Draw the power angle characteristic of a salient pole alternator and indicate different powers in the characteristic. (3)

(b) Derive an expression for synchronising power when two alternators are running in parallel. (5)

(c) A 3000 kVA, 6-pole alternator runs at 1000 r.p.m. in parallel with other machines on 3300 V busbars. The synchronous reactance is 25%. Calculate the synchronising power for one mechanical degree of displacement and the corresponding synchronising torque. (7)

7. (a) Discuss briefly the operating principle of a synchronous motor. (4)

(b) Draw the phasor diagrams for different excitation at constant load in a synchronous motor. (4)

(c) A 3980 V, 50 Hz, 4-pole, star-connected synchronous motor generates back e.m.f. of 1790 V per phase. The resistance and synchronous reactance per phase are 2.2 Ω and 22 Ω respectively. The torque angle is 30° electrical Calculate (i) the resultant armature voltage/phase (ii) armature current per phase and (iii) power factor of the motor. (7)

8. Write a brief note on any three of the following: (3×5=15)

(a) V-curve and O-curve of synchronous motor

(b) Principle of operation and characteristics of reluctance motor

(c) BLDC motor and its applications

(d) Concentrated and distributed windings of AC machines

(e) m.m.f. method of voltage regulation in an alternator

(f) Star-delta starting method of 3-phase squirrel cage induction motor

(g) Speed control of 3-phase induction motor by (V/f) control method

(h) Synchronous condenser.