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Question Paper Code : 10410

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2012.

Third Semester

ME 2205 / 131305 / ME 36 / 10122 ME 306 / EE 1205 / 080120013 — ELECTRICAL DRIVES AND CONTROLS

(Common to Mechanical Engineering, Production Engineering and Chemical Engineering)

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define cooling time constant of an electrical machine.

2. Define the thermal overload factor for a motor working on short time duty.

3. It is said that the speed of a DC motor depends on the back e.m.f. and on the flux produced. State what kind of proportionality exists between these quantities.

4. Single phase induction motor is not a self starting motor. Why?

5. State the necessity of starter for a DC motor.

6. Mention the types of starters suitable for three phase squirrel cage induction motor.

7. What are the various methods of speed control in DC motors?

8. A single phase, 230 V, 50 Hz source drives a d.c motor through a fully controlled rectifier. Find the average voltage applied to the motor for a firing angle delay of 30° if continuous current operation is assumed.

9. What is the significance of constant V/f method of speed control in induction motor?

10. Compare voltage source inverter and current source inverter, as applied to their use in speed control of induction motor.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Explain the various factors that influence the choice of electric drives. (8)

(ii) The heating and cooling time constants of an electric motor are 100 and 150 minutes respectively. The rating of the motor is 125 kW. If it is working on duty cycle of 15 minutes on load and 30 minutes on no load, determine the permissible overloading of the motor. Assume the losses are given by the expression $P_c + x^2 P_{cu}$ and $\frac{P_c}{P_{cu}} = \alpha = 0.4$. (8)

Or

(b) Sketch the load-time diagram and temperature-time diagram for the following classes of duties of a motor :

(i) Continuous duty

(ii) Short time duty

(iii) Intermittent periodic duty

(iv) Intermittent periodic duty with starting

(v) Intermittent periodic duty with starting and braking

(vi) Continuous duty with Intermittent periodic loading

(vii) Continuous duty with starting and braking

(viii) Continuous duty with periodic speed changes.

Mention also the expression for 'Duty factor' wherever necessary. (8 × 2 =16)

12. (a) (i) Explain, with a neat circuit diagram, the rheostatic braking of DC shunt motor. Sketch also the braking characteristics. (8)

(ii) A 35 kW, 440 V DC shunt motor is braked by plugging. Armature resistance is 0.1 ohm; full load armature current is 100 A and full load speed is 600 r.p.m. Calculate the value of the resistance to be placed in series with the armature circuit to limit the braking current to 150 A. Also find the corresponding braking torque. (8)

Or

(b) (i) Sketch neat circuit diagrams of the 'Long Shunt DC Compound Motor' and the 'Short Shunt DC Compound Motor'. Write down the relation between the voltage, armature current and the current through shunt winding, in each case. (6)

(ii) State the difference between 'Cumulative Compound Motor' and 'Differential Compound Motor'. Which one is commonly used? Why? (4)

(iii) Sketch the characteristics of compound motors showing the relations of 'Torgue Vs I_a', 'Speed Vs I_a' and 'Speed Vs Torque', where I_a is the armature current. (6)

13. (a) (i) With a neat sketch, explain the working of a four point starter for a DC shunt motor (8)

(ii) A 230 V shunt motor has an armature resistance of 0.2 ohm. The starting armature current must not exceed 50 A. If the number of sections of resistances in the starter is 5, find the value of resistance in each section. (8)

Or

(b) (i) Sketch a schematic circuit diagram of a direct-on-line starter for a three-phase induction motor and explain its working. How the protection against over-load works? (8)

(ii) A delta connected, 400 V, 36 kW, 750 r.p.m squirrel cage motor takes a full load current of 50 A and has a full load slip of 4.5 percent. The impedance per phase is 2.5 ohm. Determine the starting torque and the starting line-current if the motor is started by

(1) D.O.L starter

(2) Star-delta starter;

(3) Auto transformer starter with 70% tapping. (8)

14. (a) (i) Sketch a schematic circuit for the 'Field diverter' method of controlling the speed of a DC series motor. State clearly whether the speed will increase or decrease and prove your statement. (6)

(ii) A DC series motor drives a load, the torque of which varies as the square of the speed. The motor takes a current of 20 A, when the speed is 800 r.p.m. All motor losses may be neglected. Assume that the magnetic circuit is unsaturated. Calculate the speed and current, when a field diverter is used. Take the resistance of the field diverter same as that of the field winding. (10)

Or

(b) (i) Sketch the circuit of a single phase full-wave controlled rectifier for DC drives. Explain its operation with necessary waveform diagrams. (10)

(ii) A DC shunt motor draws a current of 50 A from a supply of 440 V and runs at 900 r.p.m. The field resistance is 100 ohms and field voltage is 440 V. The armature resistance is 0.3 ohm. A chopper is used to control the speed in the range 300 to 600 r.p.m. while the torque remains same. The ON-period of the chopper is 4 ms. Determine the chopper frequencies at 300 r.p.m. and at 600 r.p.m. (6)

15. (a) For a three phase induction motor, under steady state conditions, the ratio of T, the full load torque and T_{max}, the maximum possible torque, is given by

$$\frac{T}{T_{max}} = \frac{2}{\frac{s}{s_m} + \frac{s_m}{s}}$$

where s is the slip at full load and s_m is the slip at maximum torque. If the load torque T is proportional to (speed)^n, derive an expression for the speed (or slip) of the induction motor when the supply voltage falls to a fraction of the original voltage. (16)

Or

(b) With suitable schematic diagrams, explain the following solid state methods of controlling speed of three phase induction motors :

(i) Static Kramer drive (8)

(ii) DC link Scherbius drive. (8)