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MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

VII SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)

END SEMESTER EXAMINATIONS, NOVEMBER 2017

SUBJECT: SOLID STATE DRIVES [ELE 4011]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 28 November 2017** **Max. Marks: 50**

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed. Use of sine graphs permitted.

1A. Mention the various components of load torque. Explain how each of them is modelled. ***(03)***

1B. Derive the condition for the steady state stability of an equilibrium point. ***(03)***

1C. A 200 V, 875 rpm, 150 A separately excited dc motor has an armature resistance of 0.06 Ω. It is fed from a single phase fully-controlled rectifier with an ac source voltage of 220 V, 50 Hz. Assuming continuous conduction, calculate firing angle for rated motor torque at 750 rpm. ***(04)***

2A. A dc chopper is used for regenerative braking of a separately excited dc motor. DC supply voltage is 400 V. Motor has armature resistance of 0.2 Ω and motor constant is 1.2 volts/rad/sec. The average armature current during regenerative braking is kept constant at 300 A with negligible ripple for a duty cycle of 60%. Determine the maximum and minimum permissible braking speed. ***(02)***

2B. A 30 kW, 230 V, 860 rpm, 144 A dc motor has an armature resistance of 0.07 Ω. It is fed by a three phase fully controlled rectifier from an ac source of 170.3 V, 60 Hz. Assuming continuous conduction, calculate the speed for $\alpha = 120°$, T = –400 rpm (obtained by the field current reversal). Also, plot the waveforms for the armature voltage and the armature current along with the complete triggering sequence. ***(04)***

2C. A 220 V, 1500 rpm, 11.6 A separately excited dc motor has armature resistance and inductance of 2 Ω and 28.36 mH respectively. This motor is controlled by a single phase fully controlled rectifier with controlled freewheeling. AC source voltage is230 V, 50 Hz. Identify the mode of operation and calculate the developed torque for $\alpha_n = 0°$, $\alpha = 60°$ and speed = 891 rpm. ***(04)***

3A. A 230 V, 600 rpm, 1 hp, 4 A dc motor has armature resistance of 7.5 Ω and inductance of 50 mH. Determine the minimum value of t_{on} for which the current is continuous at rated speed if the motor is controlled by a Class A chopper fed from a 240 V dc source operating at 500 Hz chopping frequency. ***(03)***

3B. With a neat circuit schematic, plot the waveforms for armature voltage and armature current for a Class B chopper along with the triggering sequence. ***(03)***

3C. A 2.4 kW, 220 V, 480 rpm, 12.8 A dc motor has the armature resistance and inductance of 2.2 Ω and 40 mH respectively. It is fed by a single phase fully controlled rectifier with an ac source voltage of 240 V, 60 Hz. Identify the mode and calculate the torque for $\alpha = 60°$ and speed = 155 rpm. ***(04)***

4A. With the help of a block schematic, explain the closed loop power factor control of a synchronous motor drive. ***(03)***

4B. With the help of torque slip characteristics, explain the speed control of induction motor when operated with adjustable frequency at constant voltage. Mention the advantages and disadvantages of the same. ***(03)***

4C. With the help of a suitable torque slip characteristics, explain why stator voltage control method of speed is best suited for a fan drive. Also, with a suitable schematic explain how direction of rotation can be reversed while employing stator voltage control technique to an induction motor. ***(04)***

5A. With the help of a block schematic, explain the control technique employed for LCI synchronous motor drive. ***(03)***

5B. Mention the advantages of direct torque control technique over field oriented control technique. Draw the block schematic of direct torque control technique for an induction motor control application. ***(03)***

5C. With the help of suitable schematic, explain the working of a three phase half wave brushless dc motor drive. Also, plot the idealized torque/angle characteristics for the individual phases. ***(04)***