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MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

VII SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)
END SEMESTER EXAMINATIONS, DECEMBER 2020

SOLID STATE DRIVES [ELE 4011]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 28 December 2020** **Max. Marks: 50**

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A. A drive is used in a hoist to raise and lower weights up to 400 kg at velocity of 25 m/s. The weight hangs from a cable that is wound on a drum of radius of 0.4 m. The drum is driven by the drive motor through a gearbox that has an efficiency of 85%. The maximum speed of the motor is 1300 rpm. Determine
(a) Gearbox ratio that will match the speed of the motor to the velocity of the hoist.
(b) The equivalent torque and power provided by the motor

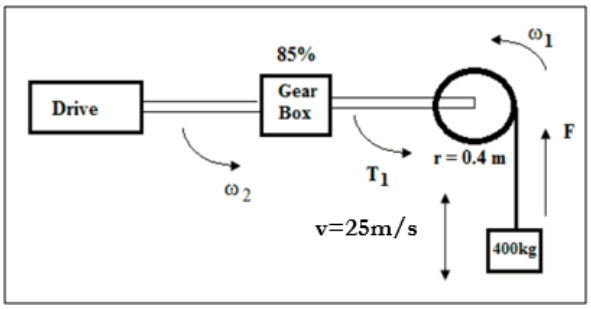

Fig. 1A

(03)

1B. A motor is used to drive a hoist. Motor characteristics are given by

Quadrant I and II: T= 200 – 0.2 **N**, N-m

Quadrant III and IV: T= -200-0.2**N**, N-m

where **N** is the speed in rpm. When the hoist is loaded, the net load torque T_L=100 N-m and when it is unloaded, net load torque T_L=-80N-m.

(a) Obtain the equilibrium speed for operation in all the four quadrants. ***(04)***

(b) Draw a neat sketch showing the operation of a hoist in four quadrants.

1C. A drive has the following motor and load speed-torque equation

Motor: $T_m = -1 - 2\omega_m$ Load: $T_L = -3\sqrt{\omega_m}$

Determine the two steady state equilibrium speeds. Which of these speeds provide stable operating point? ***(03)***

2A. A 220V, 1500rpm, 10A separately excited dc motor is fed from a single phase fully controlled rectifier with an ac source voltage of 230V, 50Hz. Ra is 2 Ω. Assume continuous conduction. Calculate firing angle for half the rated torque and 500rpm. ***(03)***

2B. A 220V, 1500rpm, 10A separately excited dc motor is fed from a single phase fully controlled rectifier with an ac source voltage of 230V, 50Hz. Armature resistance Ra is 2 Ω and armature inductance La is 50mH. For α=60°, Calculate a) No load speed and (b) Critical speed (Also derive the expression) ***(04)***

2C. A 220V, 600rpm,500A separately excited motor has armature resistance of 0.02Ω and is fed from a three phase fully controlled rectifier. A three wire three phase ac source with a line voltage of 440V is available. The rectifier is fed from a three phase transformer with Y-Δ connection.

a) Output voltages of transformers must be such that for zero firing angles rated voltage is maintained across the motor. Calculate transformer turns ratio

b) Assuming continuous conduction, calculate firing angle for rated torque and 400rpm ***(03)***

3A. A 230V, 960rpm and 200A separately excited dc motor has an armature resistance of 0.02Ω. The motor is fed from a Class A chopper which provides motoring operation and fed from Class B for braking operation. The source has a voltage of 230V. Assuming continuous conduction, calculate

(a) Duty ratio of chopper for motoring operation at rated torque and 350rpm

(b) Duty ratio of chopper for braking operation at rated torque and 350rpm ***(03)***

3B. With the help of a circuit diagram, draw the waveforms of the gating signals, motor terminal voltage and motor armature current for a class C chopper in the (i) Forward motoring mode (ii) Forward Braking mode ***(04)***

3C. Stator voltage control is suitable for speed control of induction motors in fan and pump drives. Justify the statement. Also state why stator voltage control is an inefficient method of induction motor speed control ***(03)***

4A. A 440V, 3 phase, 50Hz, 6 pole ,945rpm, delta connected induction motor has the following parameters referred to the stator; Rs = 2 Ω, Rr^1 =2 Ω, Xs= 3Ω, Xr^1=4 Ω.

When driving a fan at rated voltage it runs at rated speed. Fan load torque is given by $T_L = k(1-s)^2$. The motor speed is controlled by stator voltage control. Determine Motor torque and terminal voltage at 800rpm. ***(04)***

4B. For variable frequency control of induction motor explain the following points

(a) For speeds below base speed (V/f) ratio is maintained constant, why?

(b) For speeds above base speed, the terminal voltage is maintained constant, why? ***(02)***

4C. A 3 phase Y connected 4 pole, 50Hz, 400V, 1370rpm, squirrel cage induction motor has the following parameters: Rs = 2 Ω , Rr^1 =3 Ω , Xs= Xr^1=3.5 Ω.

The motor is fed from a voltage source inverter at constant V/f ratio. Calculate the torque for a frequency of 40Hz and speed of 1100rpm ***(04)***

5A. Draw a neat circuit diagram of Static Rotor resistance control of slip ring induction motor. Also derive the expression for the total rotor resistance per phase in terms of duty ratio. ***(04)***

5B. A 3-phase, 400V, 50Hz, 4 pole, 1400 rpm, Y-connected wound rotor induction motor has the stator to rotor turns ratio as 3.5. The motor speed is controlled by Static Kramer Drive. Maximum slip is 0.3 The maximum value of firing angle is 170°. Calculate (a) turns ratio of the transformer (b) speed range of the drive ***(02)***

5C. Explain the principle of Field oriented control with the help of a block diagram. ***(04)***