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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, NOVEMBER 2019

SOLID STATE DRIVES [ELE 4011]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date:28 November 2019** **Max. Marks: 50**

Instructions to Candidates:

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

1A. Consider a hoist drive shown in the Fig.1A. The motor is coupled to the rope drum through a gear mechanism, whose gear ratio is g_1= 0.1. The load mass is M = 500kg, the motor inertia is Jm = 0.5 kgm^2, and the rope drum inertia is J_L = 48.5 kgm^2. The radius of the rope drum is r = 0.25 m. The rope mass, gear inertias, and the mechanical losses are omitted. Calculate the equivalent total inertia at the motor side and the equivalent load torque at the motor side.

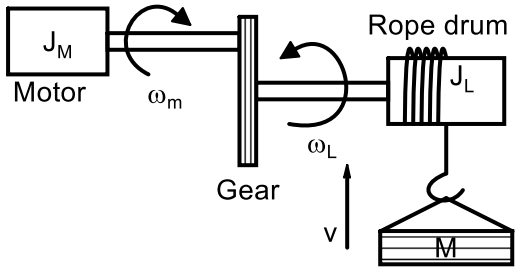

Fig. 1A

(03)

1B. With the help of a block diagram explain the Closed Loop Speed control scheme employing an inner current control loop. ***(03)***

1C. Derive the expression for critical speed which separates the continuous conduction mode from discontinuous conduction mode of operation of single phase fully controlled rectifier fed separately excited DC motor. Sketch the speed torque characteristics showing both the modes. ***(04)***

2A. A 220 volts, 1500 rpm, 10 Amps separately excited dc motor has an armature resistance and inductance of 1 Ω and 28mH respectively. It is fed from a single phase fully controlled bridge rectifier with an ac source voltage of 230 volts, at 50 Hz. Identify the mode of operation and compute developed torque at the firing angle of 45^o and speed of 1000 rpm. ***(04)***

2B. A separately excited DC motor is fed by a single phase bridge rectifier with controlled freewheeling. With the waveforms of armature voltage, derive the speed torque relation for Motoring operation in discontinuous conduction for:

i) $\beta > \pi$

ii) $\beta < \pi$

(04)

2C. A 250V, 18A, 1500 rpm separately excited DC motor with armature resistance of 0.5Ω is fed from a 3 phase fully controlled rectifier. The motor runs at its rated condition for firing angle α =0°. Assume continuous conduction.

(i) Determine the supply line voltage.

(ii) Compute the range of firing angles for a speed control of 1500rpm to 500rpm. The torque is maintained constant at rated value. ***(02)***

3A. A 250V separately excited DC motor has an armature resistance of 2.5Ω. When driving a load at 600 rpm with constant torque, the armature takes 20A. This motor is controlled by a class A chopper with a frequency of 100Hz and an input voltage of 250V. Determine the duty ratio if the speed is reduced to 400 rpm with the load torque maintained constant. ***(02)***

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 D chopper in the

(i) First quadrant operation with D > 0.5

(ii) Fourth quadrant operation with D<0.5. ***(04)***

3C. State the advantages of Squirrel cage induction motor over Dc motors. Also, show the stages involved in DC drives and Induction motor drives with help of block diagrams. ***(04)***

4A. A 440V, 3 phase, 50Hz, 6 pole, 945 rpm, delta connected induction motor has the rotor resistance referred to the stator $Rr'=2\Omega$. Neglect the stator impedance and rotor leakage reactance.
The motor speed is controlled by stator voltage control. The motor drives a load whose torque varies linearly with speed i.e $T_L=k(1-s)$.
Determine the motor speed and torque when the terminal voltage is 280V. ***(04)***

4B. A 4 pole, 50 Hz star connected induction motor is supplied with square wave voltage from an inverter. The motor rotates at a speed of 1425 rpm. Determine the slip of the motor with respect to

(i) 5^{th} harmonic field

(ii) 7^{th} harmonic field ***(03)***

4C. A 3 phase delta connected 6 pole, 50Hz, 400V, 925rpm, squirrel cage induction motor has the following parameters: Rs = 0.2 Ω, Rr^1 =0.3 Ω, Xs= 0.5 Ω, Xr^1=1 Ω.
The motor is fed from a voltage source inverter at constant V/f ratio. Calculate:

(i) Speed for the frequency of 35Hz at full load torque.

(ii) Frequency for a speed of 600rpm at full load torque. ***(03)***

5A. A three phase slip ring induction motor uses static rotor resistance control. The external resistance is 10 times the rotor resistance during the OFF period. If the motor develops torque of 10Nm at a slip of 1% for normal operation, calculate the torque developed at the same slip for 50% duty cycle. The stator to rotor turns ratio is 1. Neglect stator impedance and the rotor leakage reactance. ***(03)***

5B. A 460V, 60Hz, 4 pole, 1760 rpm, Y connected slip ring induction motor is controlled by a static Kramer drive. The drive is designed for a maximum speed range of 30% below the synchronous speed. The maximum value of firing angle is 165°. The stator to rotor turns ratio is 2

(i) Calculate the Transformer turns ratio

(ii) Calculate the torque for α= 105° and 960rpm. The dc link current is 100A. ***(03)***

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