Reg. No.									

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

VII SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)
ONLINE EXAMINATIONS, JANUARY- FEBRUARY 2021
SOLID STATE DRIVES [ELE 4011]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 29-01-2021** **Max. Marks: 50**

Instructions to Candidates:

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

1A. A drive has the following parameters
Motor torque: T=150 –0.1***N***, N-m where ***N*** is the speed in rpm.
Load torque: T_L=100, N-m.
Initially the drive is operating in steady state. The characteristics of the load torque are changed to TL =-100 Nm.
(i) Calculate the initial and final equilibrium speeds.
(ii) Can a motor load system with a passive load torque have an equilibrium speed in quadrant II ? What will be your answer if the load is active? ***(03)***

1B. Speed torque curve of a motor is shown in Figure 1B. Draw load curves which will give stable operation with the portion of characteristics marked as **AB** and **BC**. Justify your answer.

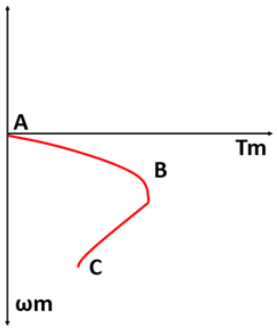

Figure 1B. ***(03)***

1C. The load inertia referred to the motor shaft of a conveyor belt system is 0.0547kgm^2. The materials are transported at the rate of 10.8 tonnes/hr. The belt is of 100 meter long and moves at a uniform speed of 2 m/s. Determine the speed at which the motor is driven?. ***(04)***

2A. A 220V, 1500 rpm, 12 A separately excited DC motor has armature resistance and inductance of 2Ω and 30mH respectively. This motor is controlled by a 1 phase fully controlled rectifier with an AC source of 230V, 50Hz and operates in continuous conduction mode. The motor runs at a speed of 1004 rpm and develops a torque of 30Nm.
(i) Calculate the firing angle α
(ii) Find the torque developed at critical speed for the above α.
(iii) Draw the speed torque characteristics for different values of firing angle clearly showing the boundary between continuous and discontinuous mode. ***(05)***

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) $\beta < \pi$ ***(05)***

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 a rated current of 20A. This motor is controlled by a Class A chopper circuit with a frequency of 400Hz and an input voltage of 250V.

(i) Determine the value of the duty ratio if one desires to reduce the speed from 600 to 400 rpm, with the load maintained constant?

(ii) The value of the armature inductance is La=39mH. For a duty cycle of 0.5, calculate the armature current ripple expressed as a percentage of the rated current. ***(05)***

3B. A three phase AC voltage controller is used to control the speed of a pump drive. Closed loop speed control with inner current control loop is employed.

i. Draw the circuit schematics of the 3 phase ac voltage controller for 3 phase induction machine with
   a. star connected stator and
   b. delta connected stator

ii. Draw the block diagram of the closed loop speed control of the 3 phase ac voltage controller. Also explain the functioning of each block.

iii. State the advantages and disadvantages of stator voltage control ***(05)***

4A. A 460V, 60Hz, 6 pole, 1180rpm, Y connected squirrel cage induction motor has the following parameters per phase referred to the stator:

R_s=0.19Ω, $R_r^{|}$=0.07 Ω, X_s= 0.75 Ω, $X_r^{|}$ =0.67 Ω and Xm=20Ω

The drive is operated at a constant (V/f) ratio.

(i) Determine the rated torque.

(ii) At half the rated torque and 500 rpm, the slip is 0.0181, calculate the inverter frequency and the stator current. ***(05)***

4B. A three phase 400V, 6 pole, 60Hz, 1164 rpm star connected wound rotor motor has the following parameters: Rs=0.5Ω, Rr'= 0.4 Ω, Xs=Xr'=1.2Ω. Stator to rotor turns ratio is 3.5. Motor is controlled by static rotor resistance control. External resistance of 0.96Ω, is chosen for a duty ratio of zero.

(i) Draw the circuit schematic of static rotor resistance control of wound rotor induction motor with closed loop current control.

(ii) Calculate the duty cycle for a speed of 960 rpm at 1.5 times the rated torque. (Neglect stator impedance) ***(05)***

5A. A three phase 400V, 60Hz, 6 pole, 1164rpm star connected wound rotor motor has the following parameters: Rs= 0.4Ω, Rr'= 0.6 Ω, Xs=Xr'=1.8Ω, Xm=40 Ω. Stator to rotor turns ratio is 2.5. Motor is controlled by static Kramer drive. The drive has been decided to provide speed control upto 50% of synchronous speed. The maximum value of the firing angle is 170°.

(i) Draw the circuit schematic of the static Kramer drive with closed loop speed control.

(ii) Determine the torque developed for a firing angle of 120° and 720 rpm. The dc link current is measured to be 100A ***(05)***

5B. Explain the principle of Direct Torque Control (DTC) with the help of a block diagram. Draw a comparison between DTC and Field oriented control scheme. ***(05)***