Reg. No.									

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

FIRST SEMESTER M.TECH. (POWER ELECTRONICS & DRIVES)

END SEMESTER EXAMINATIONS, JANUARY 2023

POWER SEMICONDUCTOR CONTROLLED DRIVES [ELE 5173]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 05 January 2023** **Max. Marks: 50**

Instructions to Candidates:

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

1A. Illustrate clearly how the drive specifications are governed by the load requirements. ***(02)***

1B. A DC drive is used in a hoist to raise and lower weights up to 405 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 DC motor through a gearbox that has an efficiency of 86.06%. If the speed of the motor is 1300 rpm, estimate (i) Gearbox ratio that will match the speed of the motor to the velocity of the hoist. (ii) The equivalent torque and power provided by the motor. ***(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 of operation with proper justifications. ***(05)***

2A. Explain dynamic braking for DC series motors using speed-torque curves. ***(02)***

2B. With the help of a block diagram explain the closed-loop armature control of DC motor with field weakening method. Justify the usage of these two techniques together. ***(04)***

2C. The DC motor drive has following different types of loads. If the moment of inertia of the motor is 3 kg-m^2 and motor runs at a speed of 1000rpm. Estimate the torque and power rating of the DC motor.

Load I: Speed=200rpm, Inertia= 6 kg-m^2; Torque=6Nm

Load II: Speed=10m/s, mass=20 kg; Force=20N

Load II: Speed=10m/s, mass=20 kg; Force=0N

Load III: Speed=200rpm, Inertia= 7 kg-m^2; Torque=10Nm

Load IV: Speed=10m/s, mass=30 kg; Force=30N

Load V: Speed=200rpm, Inertia= 2 kg-m^2; Torque=0Nm

Load VI: Speed=10m/s, mass=20 kg; Force=20N ***(04)***

3A. A motor load system has following details: In quadrant I and II, T_m = 400 − 0.4N, where N is the speed in rpm and T_m is the motor torque in N_m and the active load torque T_L= ± 200Nm. Find the equilibrium speed for braking operation in the forward direction. Also estimate the equilibrium speed for third quadrant if T_m= − 400 − 0.4N. ***(02)***

3B. A separately excited DC motor is fed by a three phase fully controlled rectifier and is working in motoring mode with continuous conduction. With relevant waveforms and triggering sequence, derive the expression for the average voltage developed across the armature and motor speed. ***(04)***

3C. A 220V, 20kW, separately excited DC motor running at rated speed of 1200 rpm. Evaluate braking torque when the resistance is placed in armature circuit to limit the braking current to twice the rated current and torque when the speed of motor falls to 500 rpm if the motor is braked by plugging. Assume the efficiency of the DC motor as 87.88% and Ra=0.102Ω. ***(04)***

4A. Explain with the help of relevant circuit diagram and waveforms, working of a class C two-quadrant chopper used to control the speed of separately excited DC motor. ***(03)***

4B. A 3-phase, 60 Hz, 6-pole star connected induction motor is used for regenerative braking and the constants of the motor are V_T = 231.01 V, R_{sT} = R_r' = 1 Ω X_{sT} = X_r' = 2 Ω. Estimate the maximum value of active load torque the motor can take and the corresponding speed of the motor. ***(05)***

4C. Justify the following points with respect to the variable frequency control method of induction motor.

(i) For speeds below base speed (V/f) ratio is maintained constant.

(ii) For speeds above base speed, the terminal voltage is maintained constant. ***(02)***

5A. An electric car employs a DC motor fed through a chopper from a 250V battery. The chopper operates at a fixed frequency of 2kHz. The motor resistance is 0.05 ohm and the total inductance in the load circuit is 0.25mH. At a speed of 40km/h, the motor develops an induced emf of 50V. The chopper duty cycle while traveling at this speed is 34%. Estimate a) peak-to-peak ripple current in the motor b) the DC component of the motor current. ***(04)***

5B. Explain the concept of slip power recovery scheme of speed control of induction motor with the help of power flow diagram. What modification is needed to achieve super-synchronous mode of operation. ***(03)***

5C. Explain field oriented control method for variable speed induction motors with the help of block diagram. Why field-oriented control is superior to other types of speed control? ***(03)***