Total No. of printed pages = 3

EE 181602

30/7/22

Roll No. of candidate | | | | | | | | | | |

2022

B.Tech. 6th Semester End-Term Examination

ELECTRIC DRIVES

(New Regulation and New Syllabus)

Full Marks – 70 Time – Three hours

The figures in the margin indicate full marks for the questions.

Question No. 1 is compulsory. Answer any four from the rest.

1. Fill in the blanks : (10 × 1 = 10)

(i) The ———— motor enclosure is the safest.

(ii) The fill load slip of a 400 V, 50 Hz, three-phase induction motor is 5%. The frequency of emf induced in the rotor if plugging is employed is ————.

(iii) The value of 'x' in Star-Delta method of starting three-phase induction motor is ————.

(iv) Compression of a spring is an example of ———— load.

(v) Regenerative braking in a full wave controlled dc motor drive can be obtained if the firing angle is ————.

(vi) A motor used in drive designed for continuous duty but loaded intermittently. The motor was ON for 55 minutes and OFF for 15 minutes during the operation. The cyclic duration factor is ————.

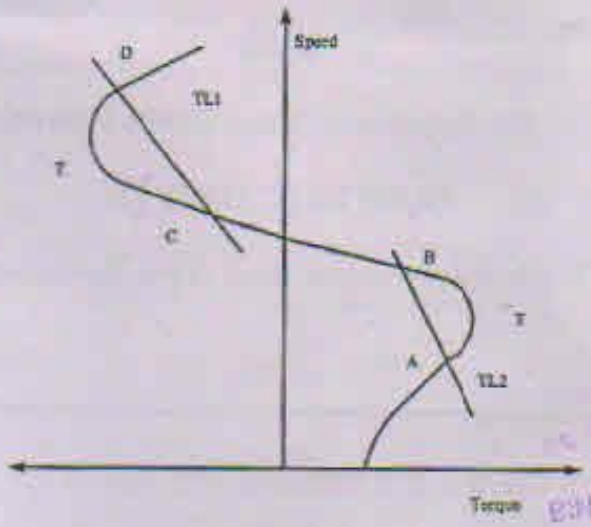
(vii) A certain motor draws a maximum current of 55 A while operating a load. The rated current of the motor is 50 A. The overload capability of the motor is ————.

(viii) The modulation index for PWM is maintained to be ————.

(ix) The reversing of dc motor is achieved by reversing the ————.

(x) The rotor current of an Induction motor in dc rheostatic braking is dc. (True/ False).

2. (a) Derive an expression for steady state stability of an electric drive system. Hence comment on the stability of the operating points A, B, C and D in the characteristics plots of speed vs motor and load torques given by the following figure. (10)



(b) A drive has the following parameters :

$J = 10$ kg-m^2, $T = 100 - 0.1$ N, N-m, passive load torque $T_1 = 0.05$ N, N-m, where 'N' is the speed in rpm. Initially the drive is operating in steady state. Now it's to be reversed. For this motor characteristic is changed to $T = -100 - 0.1$ N, N-m. Calculate the time of reversal. (5)

3. (a) Explain dc rheostatic braking of three-phase induction motor with suitable phasor diagrams. Derive an expression for the braking torque during this braking and also derive condition of obtaining maximum braking torque. Describe any one method of providing dc supply during braking. (8)

(b) A 400 V, 50 kW, 50 Hz, 960 rpm, Y-connected, 3-phase, 6 pole slip-ring induction motor has $R_1 = 0.08\ \Omega$, $= 0.1\ \Omega$, $X_1 = X_2' = 0.3\ \Omega$ referred to stator. Motor is braked by dc dynamic braking. The magnetizing reactance under rated condition is known to be 6 Ω per phase referred to the stator. DC excitation is applied keeping the third stator terminal open. If the dc excitation produces only the rated voltage ($E = 231$ V) in the rotor circuit at synchronous speed, neglecting saturation determine maximum braking current, maximum braking torque and the speed at which it occurs. (7)

4. (a) Cite the reasons of heating of electric motors. Derive an expression for heating and cooling of electric motors. (7)

(b) In a certain machine the temperature rise is 25° C after one hour and 37.5 C after two hours starting from cold conditions. Calculate the final steady state temperature rise and the heating time constant. If the machine temperature falls from the final steady value to 40 C in 1.5 hour when disconnected, calculate it's cooling time constant. The ambient temperature is 30 C. (8)

5. (a) Explain the working principle of four-quadrant chopper controlled dc motor drive with suitable diagrams and waveforms. (8)

(b) A 200-hp, 230 V, 500 rpm separately excited dc motor is controlled by a chopper. The chopper is connected to a diode bridge rectifier supplied from a 230 V, 3-φ, 60 Hz main. The motor has R_a = 0.04 Ω, L_a = 1.5 mH, K_b = 4.172 V/rad/sec, f_c = 2 kHz. The motor is running with 300 rpm with 55% duty cycle in the chopper. Determine the average current from the steady state waveform and the electromagnetic torque produced in the motor. (7)

6. A 40-hp, 230 V, 3500-rpm separately excited dc motor is controlled by a linear converter of gain K_2 = 200. The moment of inertia of the motor load is J = 0.156 N-m/rad/sec, viscous friction constant is negligible, total armature resistance is R_a = 0.045 Ω and total armature inductance is L_m = 730 mH. The back emf constant is K_v = 0.502 V/A. rad/sec and the field current is maintained constant at I_f = 1.25 A. (a) Obtain the open loop transfer function ω(s)/V_r(s) and ω (s)/T_L(s) for the motor (b) compute the motor steady state speed if the reference voltage is V_r = 1 V and the load torque is 60% of the rated value. (15)

7. Write short notes on any *three* : (3 × 5 = 15)

(a) Krammer drive

(b) Vectror controlled Induction motor drive

(c) BLDC motor

(d) Permanent Magnet Synchronous Motor

(e) VSI