**Code: 13A02601** **R13**

B.Tech III Year II Semester (R13) Supplementary Examinations December 2016

**POWER SEMICONDUCTOR DRIVES**

(Electrical and Electronics Engineering)

Time: 3 hours Max. Marks: 70

**PART – A**

(Compulsory Question)

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1 Answer the following: (10 X 02 = 20 Marks)

(a) A 200 V, 875 rpm, 150 A, separately excited dc motor has an armature resistance of 0.05 Ω. It is fed from single phase fully controlled rectifier with an ac source voltage of 220 V, 50 Hz. Assuming continuous conduction, calculate firing angle for rated motor torque and speed of 800 rpm.

(b) Sketch torque – speed characteristics of DC series motor connected to Fully controlled converter for firing angles less than 90 degrees, for both continuous and discontinuous modes of operation.

(c) Write short notes on counter current braking.

(d) A separately excited DC motor has armature resistance of 0.05 Ω. Motor is coupled to an over hauling load with a torque of 400 N-m drawing a current of 200 A. Motor is braked by dynamic braking with a braking resistance of 1 Ω. At what speed will the motor hold the load?

(e) List out some comparative advantages of choppers over controlled rectifiers for drive applications.

(f) Write short notes on Time Ratio Control.

(g) Draw the power circuit diagram of CSI driving a three phase Induction motor.

(h) What are the advantages of Kramer drive compared to Scherbius drive?

(i) A three phase, 4-pole, 50 Hz, star connected synchronous motor has $X_S$ = 6 Ω, $R_a$ = 0, $E_a$ = 6000 V, $E_f$ = 5000 V all per phase values. What is the value of pull out torque?

(j) The power input to a salient pole synchronous motor has two components. What are they? Write their expressions.

**PART – B**

(Answer all five units, 5 X 10 = 50 Marks)

**UNIT – I**

2 Explain the operation of Single Phase Fully Controlled Converter fed separately excited DC motor in both continuous and discontinuous current modes with relevant waveforms. Derive the expressions for Torque – Speed relation, critical value of induced e.m.f and critical speed.

**OR**

3 A separately excited DC motor at 10 kW, 300 V, 1000 rpm is supplied from 3- phase half controlled bridge rectifier. The three phase supply is rated at 220 V, 50 Hz. Armature resistance of motor $R_a$ = 0.2 Ω and sufficient inductance is added to maintain continuous conduction. It delivers rated power at rated speed when $\alpha = 0°$. If the firing angle is retarded to $\alpha = 30°$, calculate the speed, power factor and efficiency of the operation if: (a) The load torque is constant. (b) The load torque is proportional to speed.

**UNIT – II**

4 Discuss the closed loop operation of DC motor fed from Controlled rectifier, for speed control with current limit so that speed can be controlled above and below rated speeds.

**OR**

5 A DC series motor has the following parameters:
P = 25 kW, V = 230 V, $R_{se}$ = 0.08 Ω, $R_{sh}$ = 0.15 Ω, I = 80 A, N = 350 rpm. What resistance must be connected in series with the armature at the instant of plugging to limit the current to 120 A? Calculate the braking torque at the instant of plugging. Also find the braking torque when the speed of the motor has fallen to 75 % of its rated speed. The magnetization curve of the motor is a straight line given by $E_g = (1.07\, I_a + 115)\, V$ between $I_a = 60\, A\, to\, 120\, A$.

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**UNIT – III**

6 Explain the operation of Two-Quadrant, Type-D chopper drive with necessary equivalent circuits and waveforms.

**OR**

7 A 230 V, 1000 rpm, 30 A separately excited DC motor has an armature resistance of 0.7 Ω and inductance of 50mH. Motor is controlled in regenerative braking by a chopper operating at a frequency of 800 Hz from a DC source of 230 V. Assuming continuous conduction, (i) Calculate duty ratio of chopper for rated torque and speed of 800 rpm. (ii) What will be the motor speed for duty ratio of 0.6 and rated motor torque? (iii) What will be the maximum allowable speed of the motor, if the chopper has a maximum duty ratio of 0.9 and maximum allowable motor current is twice the rated current? (iv) Calculate power fed to the source for operating condition in (iii). (v) Motor field is also controlled along with armature voltage. Rated field current is 0.5 A. Calculate the field current for duty ratio of 0.9 and motor speed of 1500 rpm and armature current of 30 A.

**UNIT – IV**

8 Discuss in detail speed control of three phase induction motor through stator frequency for the following conditions:

(a) Below rated frequency.

(b) Above rated frequency.

**OR**

9 A three phase, 420 V, 4 pole, 50 Hz star connected slip ring induction motor has its speed controlled by means of GTO chopper in its rotor circuit. The effective phase turns ratio from rotor to stator is 0.8. The filter inductor makes the inductor current ripple free. Losses in the rectifier, inductor, GTO chopper and no load losses of the motor are neglected. Load torque proportional to speed squared is 450 N-m at 1440 rpm.

(a) For a minimum motor speed of 1000 rpm, calculate the value of chopper resistance R.

(b) For the value of R obtained in part (a), if the speed is raised to 1320 rpm, calculate Inductor current.

(c) Duty cycle of the chopper.

(d) Rectified output voltage.

**UNIT – V**

10 Discuss self control and separate control of Synchronous motor in detail.

**OR**

11 A three phase 230 V, 60 Hz, 40 kW, 8 pole star connected salient pole synchronous motor has $X_d = 2.5\ \Omega\ and\ X_q = 0.4\ \Omega$. The armature resistance is negligible. If the motor operates with an input power of 25 kW at a leading power factor of 0.86. Determine: (i) Torque angle. (ii) Excitation voltage $V_f$. (iii) torque $T_d$.

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