Code No: RR410202 **Set No.1**

IV B.Tech. I Semester Regular Examinations, November -2005
POWER SEMI CONDUCTOR DRIVES
(Electrical & Electronic Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. A dc series motor has $R_a = 3\ \Omega$, $R_f = 3\ \Omega$ and $M_{af} = 0.15$ H. The motor speed is varied by a phase-controlled bridge. The firing angle is $^{\pi}/4$ and the average speed of the motor is 1450 rpm. The applied ac voltage to the bridge is 330 Sin wt. Assuming continuous motor current find the steady state average motor current and torque. Sketch the waveforms for output voltage, current and gating signals.

[16]

2. (a) What is a dual converter? Explain the principle of operation of a dual converter in circulating current mode. How the same is used for speed control of dc drive.

   (b) A 230v separately excited dc motor takes 50A at a speed of 800rpm. It has armature resistance of 0.4Ω. This motor is controlled by a chopper with an input voltage of 230v and frequency of 500Hz. Assuming continuous condition throughout, calculate and plot speed-torque characteristics for:

      i. Motoring operation at duty ratios of 0.3 and 0.6.

      ii. Regenerative braking operation at duty ratios of 0.7 and 0.4.

[8+8]

3. (a) Deduce the mathematical expression for minimum and maximum currents for a class A chopper operated dc motor with back emf.

   (b) A 220v, 24A, 1000rpm separately excited dc motor having an armature resistance of 2Ω is controlled by a chopper. The chopping frequency is 500Hz and the input voltage is 230v. Calculate the duty ratio for a motor torque of 1.2 times rated torque at 500rpm.

[8+8]

4. A pump has a torque-speed curve given by $T_L = (1.4/10^3)N^2$ Nm. It is proposed to use a 240V, 50 Hz, 4 pole, star connected Induction motor with the equivalent circuit parameters (referred to stator turns)
   $R_1 = 0.25\Omega$, $R_2 = 0.6\Omega$, $X_1 = 0.36\Omega$, $X_2 = 0.36\Omega$, $X_m = 17.3\Omega$. The pump speed N is to vary from full speed 1250 RPM to 750 RPM by voltage control using pairs of inverse-parallel connected thyristors in the lines. Calculate the range of firing angles required. [16]

5. With the help of circuit diagram and waveforms explain the induction motor with current source inverter. Draw the circuit diagram of the Auto-sequentially commutated inverter. [16]

6. A 3-phase, 420V, 50Hz, star connected induction motor has the following parameters: $R_1 = 2.95\Omega$, R_2' $= 2.08\Omega$, $X_1 = 6.82\Omega$, X_2' $= 4.11\Omega$ per phase. Neglect core loss. The motor draws a current 6.7A at no load and controlled by rotor resistance controller. A resistance R_e Ω has been controlled by chopper. Determine the value of R_e to get a speed range of 1500 to 500 rpm, assuming a turns ratio of two between stator and rotor. The torque and speed of the load are related by T α N. Determine the characteristics giving the speed Vs time ratio of the chopper. [16]

7. A 6 MW, three phase, 11 kV, 50 Hz, unity power factor, 6-pole, star-connected synchronous motor has the following parameters: armature resistance = 0, synchronous reactance = 9 ohms, rated field current = 60 A. The machine is controlled by variable frequency at constant V/f ratio up to base speed and at constant V above base speed. Calculate the torque and field current for rated armature current, 750 rpm and 0.8 leading power factor. Draw motor characteristics and waveforms under the above method of control. [16]

8. Describe self-controlled and load-commutated inverter controlled synchronous motor drives in detail and compare them [16]

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Code No: RR410202 **Set No.2**

IV B.Tech. I Semester Regular Examinations, November -2005
POWER SEMI CONDUCTOR DRIVES
(Electrical & Electronic Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Explain how the speed of a dc series motor is controlled using converters.
   (b) A series motor is supplied from a full converter whose $\alpha = 65^0$, 1 ϕ supply of 230V rms, 50HZ frequency. The armature and field resistance together equal 2 Ω. The torque constant M_{af} is 0.23H and the load torque is 20Nm. Neglect damping and find the average armature current and speed.

   [8+8]

2. (a) Draw the circuit diagram and explain the operation of closed-loop speed control with inner-current loop and field weakening.
   (b) A single phase fully controlled double bridge converter is operated from 120v, 60Hz supply and the load resistance is 10 ohms. The circulating inductance is 40mH. Firing delay angle for converter I and II are 60^0 and 120^0 respectively. Calculate the peak circulating current and the current through converters.

   [8+8]

3. (a) Explain the principle of speed control of a dc motor and show how it can be achieved by a chopper.
   (b) A 230v, 1200rpm, 15A separately excited motor has an armature resistance of 1.2Ω. Motor is operated under dynamic braking with chopper control. Braking resistance has a value of 20Ω.
      i. Calculate duty ratio of chopper for motor speed of 1000rpm and braking torque equal to 1.5 times rated motor torque.
      ii. What will be the motor speed for duty ratio of 0.5 and motor torque equal to its rated torque.

   [8+8]

4. A 3 phase, 4 pole, 50 Hz squirrel cage Induction motor has the following circuit parameter.
   $r_1 = 0.05ohm, r_2 = 0.09ohm, X_1 + X_2 = 0.55ohm.$
   The motor is star connected and rated voltage is 400V. It drives a load whose torque is proportional to the speed and is given as $T_1 = 0.05\ \omega$ Nw-m.
   Determine the speed and torque of the motor for a firing angle of 45^0 of the AC Voltage Controller on a 400V, 50 Hz supply. [16]

5. A 460V, 100-HP (74.6 KW), 1775 RPM, three-phase, squirrel cage Induction motor has the following equivalent circuit parameters.

R_s = 0.060 ohm R'$_r$ = 0.0302 ohm
L_{1s} = 0.638mH, L_{ms} = 23.3 mH, L_{1r}' = 0.957 mH
The motor is to be driven from a current source inverter with the rotor frequency controlled at the rated value. Maximum output power is to be limited to 80% of the rated value. Motor friction, windage, and core losses may be neglected. The load is to consist of a pump presenting a load characteristic described by the equation. $T = \frac{\omega_m^2}{110} N.m$Determine the maximum values of motor speed, inverter frequency, rms motor line current, and fundamental line-to-line motor terminal pd at maximum power output. [16]

6. A 3-phase, 400V, 50Hz, 4 pole, 1400rpm, star connected wound rotor induction motor has the following parameters referred to the stator $R_1 = 2\Omega$, R_2' = 3Ω, $X_1 = X_2$' = 3.5Ω. The stator to rotor turns ratio is 2. The motor speed is controlled by static Scherbius drive. The inverter is directly connected to the source. Determine.

   (a) The speed range of the drive when $\alpha_{max} = 165^0$
   (b) The firing angle for 0.4 times the rated motor torque and speed of 1200 rpm.
   (c) Torque for a speed of 1050rpm and firing angle of 95^0.

   [16]

7. Describe separate controlled mode and self-controlled mode of operation of a synchronous motor drive in detail and compare them. [16]

8. Describe the open-loop and closed loop methods of speed control of a synchronous motor using VSI. [16]

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Code No: RR410202 **Set No.3**

IV B.Tech. I Semester Regular Examinations, November -2005
POWER SEMI CONDUCTOR DRIVES
(Electrical & Electronic Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Two independent single-phase semi-converters are supplying the armature and field circuits of the separately excited dc motor for controlling its speed. The firing angle of the converter, supplying the field, adjusted such that maximum field current flows. The machine parameters are: armature resistance of 0.25 Ω, field circuit resistance of 147 Ω, motor voltage constant Kv=0.7032 V/A-rad/s. The load torque is T=45 N-m at 1000 rpm. The converter are fed from a 208 V, 50 Hz ac supply. The friction and windage losses are neglected. The inductance of the filed and armature circuits are sufficient enough to make the armature and field currents continuous and ripple free. Determine

   (a) the field current,

   (b) the delay angle of the armature converter,

   (c) input power factor of the armature circuit converter.

   [16]

2. Describe the relative merits and demerits of the following types of braking for dc motors: mechanical braking, dynamic braking and regenerative braking with neat diagram. [16]

3. (a) Explain with neat circuit diagram the basic principle of operation of a class A type of chopper. The chopper is connected to R-L-E load. Analyze the same for continuous current mode of operation.

   (b) A dc supply of 200v supplied power to separately excited dc motor via a class A thyristors chopper. The motor has an armature circuit resistance of 0.33Ω and inductance of 11mH. The chopper is fully on at the rated motor speed 1200rpm when the armature current is 20A. If the speed is to be reduced to 800rpm with the load torque constant, calculate the necessary duty cycle. If the chopper frequency is 500Hz, is the current continuous?

   [8+8]

4. What is an AC Voltage Controller?
   Explain with suitable diagrams the various types of solid state 3 phase AC Voltages Controllers which can be used for speed control of 3 phase Induction motors from stator side. Mention the advantages of the AC Voltages Controllers over the other methods of solid-state speed control techniques of 3 phase Induction motor. [16]

5. Explain the operation of voltage source inverter (180-degree conduction mode), used for induction motor speed control. Draw neat waveforms of line voltages (Vab, Vbc, Vca) and hence show that the phase voltage, Van, is six-step voltage waveform. [16]

6. The speed of a 3-phase slip ring induction motor is controlled by variation of rotor resistance. The full load torque of the motor is 50Nm at a slip of 0.3. The motor drives load having a characteristics T α N^2. The motor has 4 poles and operates on 50Hz, 400V supply. Determine the speed of the motor for 0.8 times the rated torque. The operating condition is obtained with additional resistance in the circuit. The resistance is controlled by chopper in the rotor circuit. Determine the average torque developed for a time ratio of 0.4. [16]

7. Discuss the VSI method of speed control of synchronous motor describe the operation of the converter with waveforms. [16]

8. Describe self-controlled and load-commutated inverter controlled synchronous motor drives in detail and compare them [16]

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Code No: RR410202 **Set No.4**

IV B.Tech. I Semester Regular Examinations, November -2005
POWER SEMI CONDUCTOR DRIVES
(Electrical & Electronic Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Explain how four-quadrant operation is achieved by dual converters each of 3 ϕ full wave configuration for d.c. separately excited motor.
   (b) Distinguish between circulating current and non-circulating current mode of operation.

   [10+6]

2. Describe the relative merits and demerits of the following types of braking for dc motors: mechanical braking, dynamic braking and regenerative braking with neat diagram. [16]

3. (a) Discuss with the suitable diagrams I quadrant and II quadrant choppers.
   (b) A constant frequency TRC system is used for the speed control of dc series traction motor from 220v dc supply. The motor is having armature and series field resistance of 0.025Ω and 0.015Ω respectively. The average current in the circuit is 125A and the chopper frequency is 200Hz. Calculate the pulse width if the average value of back emf is 60 volts.

   [8+8]

4. (a) For stator voltage control scheme of a 3-phase Induction motor discuss about speed range, regeneration, harmonics, torque pulsating, power factor, cost, efficiency and applications.
   (b) Draw a block schematic diagram for automatic speed control of 3 phase cage Induction motor using solid state AC Voltage Controller on stator side.

   [8+8]

5. Discuss in detail the role of Cyclo converters for speed control of Induction motor. Draw neat circuit diagram for speed control of 3 phase Induction motor using Cyclo converters. Mention the merits and limitations of the above scheme. [16]

6. A 3-phase 400V, 4 pole, 50Hz, Star connected induction motor has the following parameters referred to the stator: R_2' = 0.2Ω, X_2' = 0.35Ω. Stator impedance and the magnetizing branch can be ignored. When driving a load with its torque proportional to speed, the motor runs at 1450rpm. Calculate the magnitude and phase of the voltage (referred to the stator) to be impressed on the slip rings in order that the motor may operate at 1200 rpm and unity power factor. [16]

7. A 500 kW, 3-phase, 6.6 kV, 60 Hz, 6-pole, Y-connected wound-field synchronous motor has the following parameters: $X_m = 78$, $X_{sf} = 3$, rated pf = 1, n = 5, R_s = negligible. The motor speed is controlled by variable frequency control with a constant V/f ratio up to base speed and rated terminal voltage above base speed. Calculate and plot T, P_m, V, I_m, and I_F versus speed for the motor operation at rated armature current and unity pf. What is the range of constant power operation? Neglect friction, windage and core loss. Draw motor characteristics and waveforms under the above method of control. [16]

8. Describe self-controlled and load-commutated inverter controlled synchronous motor drives in detail and compare them [16]

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