

Code No: M0221/R07

Set No. 1

IV B.Tech I Semester Supplementary Examinations, March 2013
POWER SEMICONDUCTOR DRIVES
(Electrical & Electronics Engineering)

Time: 3 hours

Max Marks: 80

Answer any FIVE Questions
 All Questions carry equal marks

1. Draw and explain the power circuit diagram of semi-converter feeding a separately excited D.C motor. Explain with typical voltage and current waveforms, the operation in continuous armature current Mode. [16]
2. The speed of a 25 HP, 380V, 1800 rpm separately excited dc motor is controlled by a three phase fully controlled converter and is fed from a 210V 50 Hz supply and is star connected. The field circuit is also supplied from the same converter and the current is set to maximum possible value. The rated armature current of the motor is 170A. motor parameters are $R_a=0.999\Omega$, $L_a=0.73\text{mh}$, $\Omega=0.33$.
 - (a) Determine the no load speeds at firing angles 0° and 30° . Assume that no load current is 10% of the rated current and is continuous.
 - (b) Find the firing angle to obtain rated power at rated motor speed.
 - (c) Determine the speed regulation. [16]
3. (a) With neat circuit diagram and waveforms, explain dynamic braking of separately excited motor by single phase converter.
- (b) A dc shunt motor has the armature resistance of 0.04Ω and the field winding resistance of 10Ω . Motor is coupled to an over hauling load with a torque of 400N-m. Following magnetization curve was measured at 600 rpm:

Field Current, A	2.5	5	7.5	10	12.5	15	17.5	20	22.5	25
Back emf, V	25	50	73.5	90	102.5	110	116	121	125	129

 Calculate the value of R_B when the motor is required to hold overhauling load at 1200rpm. [8+8]
4. What is a Chopper? Explain the Chopper control of a D.C series motor.
 - (a) Motoring Mode
 - (b) regenerative braking mode and also draw the Speed-Torque Curves in each mode. [8+8]
5. (a) Generally the stator voltage control is suitable for speed control of Induction motor in fan and pump drives. Discuss in detail why the above method is useful.
- (b) Explain why the stator voltage control is not an efficient method of control. [8+8]

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6. A 3 Phase, 1500 rpm Induction motor is developing torque of 3000 Syn. watts at an input frequency of 50Hz. If the motor torque is now reduced to 1500 Syn.watts, determine the new value of stator frequency. The motor is operating in constant HP region. Assume constant rotor frequency and neglect effect of rotor resistance. [16]
7. (a) State the major features of Rotor resistance control of Wound Rotor Induction motor.
(b) In the rotor resistance control, what type of motor speed - torque characteristics will be obtained if one phase has a loose contact? [8+8]
8. Discuss in detail with suitable circuit diagram the principle of operation of Self-controlled Synchronous motor drive employing load commutated thyristor inverter. [16]

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Set No. 2

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1. Derive the Speed, Torque Equations of a fully controlled converter connected to separately excited D.C motor with continuous current operation with necessary waveforms. [16]
2. The speed of a 150 HP 650V 1750 rpm separately excited dc motor is controlled by a three phase fully controlled converter and is fed from a 460V 50 Hz supply. The rated armature current of the motor is 170A. motor parameters are $R_a=0.999\Omega$, $L_a=0.73\text{mh}$. $\Omega=0.33$.
 - (a) Determine the no load speeds at firing angles 0° and 30° . Assume that no load current is 10% of the rated current and is continuous.
 - (b) Find the firing angle to obtain rated speed of 1750rpm at rated motor current.
 - (c) Determine the speed regulation for the firing angle obtained in part b. [16]
3. (a) With neat circuit diagram and waveforms, explain dynamic braking of separately excited motor by single phase converter.
- (b) A dc shunt motor has the armature resistance of 0.04Ω and the field winding resistance of 10Ω . Motor is coupled to an over hauling load with a torque of 400N-m. Following magnetization curve was measured at 600 rpm:

Field Current, A	2.5	5	7.5	10	12.5	15	17.5	20	22.5	25
Back emf, V	25	50	73.5	90	102.5	110	116	121	125	129

 Calculate the value of R_B when the motor is required to hold overhauling load at 1200rpm. [16]
4. A class-A chopper, operating in time-ratio control, is supplying the armature of the separately excited dc motor. Show that the motor speed-torque relationship is ,

$$\omega_m = \frac{\delta V}{K} - \frac{R_a}{K^2} T_a$$
 Where V - chopper input voltage, R_a - Armature resistance, T_a - motor torque, K- torque constant. [16]
5. An inverter supplies a six pole three-phase cage Induction motor rated at 415V, 50Hz. Determine the approximate voltages required of the inverter for motor speeds 600/800/1500/ 1800 rpm. [16]
6. Explain the principle of varying the speed of an Induction motor by variable frequency control of stator voltage. Draw the speed torque curves for variable frequency control for motoring and braking modes. [16]

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7. A 3 phase, 440 V, 6 pole, 970 rpm, 50 Hz, Star connected Induction motor has the following parameters referred to the stator.
 $R_s = 0.2$ ohm, $R_r' = 0.15$ ohm, $X_s = 1.5$ ohm, $X_r' = 4$. The stator to rotor turns ratio is 3.5. The motor speed is controlled by Static Scherbius drive. The drive is designed for a speed range of 30% below the Synchronous speed. The max. value of the firing angle is 170° . Calculate
- (a) The turns ratio of the transformer
 - (b) Torque for a speed of 750 rpm and $\alpha = 140^\circ$. [16]
8. (a) What is the basic difference between true synchronous mode and self control mode for variable frequency control of Synchronous motor?
- (b) When operating in true synchronous mode, why the frequency must be changed in small steps? [8+8]

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Set No. 3

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1. Draw and explain the power circuit diagram of semi-converter feeding a D.C series motor. Explain with typical voltage and current waveforms, the operation in both continuous armature current Mode. [16]
2. Draw the circuit diagram and explain the operation of three phase, half wave converter drives. [16]
3. Explain various speed control method of D.C motors and also draw speed-torque curves for each method. [16]
4. (a) Derive the expressions for average motor current, current I_{max} and I_{min} and average torque for chopper-fed dc separately excited motor.
 (b) A dc chopper controls the speed of a separately excited motor. The armature resistance is $R_a=0.05\Omega$. The back emf constant is $K_v=1.527v/A\text{-rad/s}$. The rated field current is $I_f=2.5A$. The dc input voltage to the chopper is $V_s=600V$. If it is required to maintain a constant developed torque of $T_d = 547N\text{-m}$, plot the motor speed against the duty cycle k of the chopper. [8+8]
5. A 3 phase Squirrel cage Induction motor having 6 poles operating at 50 Hz has rotor resistance and stand still reactance referred to stator are 0.2 ohm and 1 ohm per phase when it is operated at rated voltage and rated frequency has a slip of 4 percent at full load . At what speed the motor will operate when the stator impressed voltage is reduced to 1/1.414 times the rated voltage. Assume that the load torque remains constant at the rated motor torque. [16]
6. Derive torque speed characteristic of an Induction motor operating on variable frequency supply for
 - (a) $V/f=\text{Constant}$.
 - (b) $E/f =\text{Constant}$. [8+8]
7. The speed of a 3 ϕ SRIM is controlled by variation of smotor resistance. The full load torque of the motor is 50NM. at a slip of 0.3. The drives load having a charecterstic $T\propto N^2$. 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 motor circuit. Determine the average torque developed for a time ratio of 0.4. [16]

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8. (a) What is the basic difference between true synchronous mode and self control mode for variable frequency control of Synchronous motor?
- (b) When operating in true synchronous mode, why the frequency must be changed in small steps? [8+8]

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Set No. 4

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1. Give the general circuit layout of single phase D.C drives? Enumerate the various single phase D.C drives used. [16]
2. A dc motor driven from a 3 phase full converter draws a dc line current of 90 A with negligible ripple.
 - (a) Sketch the line voltage taking it zero crossing and becoming positive at $\omega t=0$. Also sketch line current and thyristor current for a firing angle of 30° .
 - (b) Calculate average and rms values of thyristor current.
 - (c) Compute power factor at ac source.
 - (d) For motor constant of 2.5 and R_a of 0.4Ω . calculate the motor speed. [16]
3. What are the differences between the ideal and practical dual converters applied for the control of dc motors. [16]
4. A 220V, 70A D.C series motor has combined resistance of armature and field is 0.12 ohms running on no-load with the field winding connected to a separate source. It gave following magnetization characteristics at 600 rpm

Field Current (A)	10	20	30	40	50	60	70	80
Terminal Voltage (V)	64	118	150	170	184	194	202	210

 Motor is controlled in regenerative braking by a chopper with a source voltage of 220V.
 - (a) Calculate motor speed for a duty ratio of 0.5 and motor braking torque equal to rated motor torque.
 - (b) Calculate maximum allowable motor speed for a maximum permissible current of 70A and maximum permissible duty ratio of 0.95.
 - (c) What resistance must be inserted in armature circuit for the drive to run at 1000 rpm without exceeding armature current beyond 70 A? the duty ratio of the chopper has a range from 0.05 to 0.95.
 - (d) To What extent the number of turns in field winding should be reduced to run at 1000 rpm without exceeding armature current beyond 70 A? [16]
5. (a) Generally the stator voltage control is suitable for speed control of Induction motor in fan and pump drives. Discuss in detail why the above method is useful.
 - (b) Explain why the stator voltage control is not an efficient method of control. [8+8]

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6. A 3 Ph Star connected Induction motor operating at a frequency of 60 Hz consists of 4 poles. The parameters of the stator and rotor referred to stator side are $R_1 = R_2 = 0.024$ ohm and $X_1 = X_2 = 0.18$ ohm. If the motor is controlled by the variable frequency control with v/f constant ratio determine the following parameters at an operating frequency of 12 Hz. Starting torque and rotor current in terms of their values at rated frequency. [16]
7. Draw the circuit diagram and explain the operation of rotor- resistance control using chopper. Mention the advantages and disadvantages of the above method of control. [16]
8. (a) What is the basic difference between true synchronous mode and self control mode for variable frequency control of Synchronous motor?
(b) When operating in true synchronous mode, why the frequency must be changed in small steps? [8+8]

FirstRanker