Code No. M0221 **R07** **Set No.1**

IV B.Tech I Semester Supplementary Examinations, February/March, 2012
POWER SEMICONDUCTOR DRIVES
(Electrical and Electronics Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks
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1. a) Draw and explain the power circuit of single-phase semiconverter feeding a separately excited d.c.motor. Explain with typical voltage and current waveforms, the operation in both continuous armature current and discontinuous armature current modes.
   b) Discuss the effects of armature current ripple on the performance of a d.c. motor.

2. Draw the circuit diagram and explain the operation of a three-phase full converter fed d.c.motor with the help of associated voltage and current waveforms. Also, sketch the speed-torque characteristic.

3. a) Draw the speed torque characteristic for dynamic braking of d.c. series motor. Why torque becomes zero at finite speed?
   b) Discuss relative merits and demerits of four quadrant d.c. drives employing non-circulating and circulating current dual converters.

4. a) Derive the expressions for average motor current, ripple in motor current and average torque for chopper fed separately excited d.c. motor.
   b) A dc chopper is used for regenerative braking of a separately excited d.c. motor. The dc supply voltage is 400 V. The motor has $R_a = 0.2\ \Omega$, $K_m = 1.2$ V-s/rad. The average armature current during regenerative braking is kept constant at 300 A with negligible ripple. For a duty cycle of 60 % for a chopper, determine
      i) power returned to the supply
      ii) minimum and maximum permissible braking speeds and speed during regenerative braking

5. a) Explain plugging operation of 3-Φ induction motor and also explain how it is implemented using AC voltage controllers.
   b) Explain why stator voltage control is an inefficient method of induction motor speed control.

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6. A 3-Φ, star connected, 50 Hz, 4-pole induction motor has the following parameters in ohms per phase referred to the stator: $R_s = R'_r = 0.034$ and $X_s = X'_r = 0.18$. The motor is controlled by variable frequency control with a constant (V/f). Determine the following for an operating frequency of 15 Hz:
   i) The breakdown torque as a ratio of its value at the rated frequency for motoring and braking.
   ii) The starting torque and rotor current in terms of their values at the rated frequency.

7. a) Draw a suitable diagram and explain the working of slip-power recovery system using commutatorless Kramer drive.
   b) What are the advantages of static rotor resistance control over conventional methods of rotor resistance control?

8. With suitable circuit diagrams explain the principle of operation of Current source inverter fed Synchronous motor drive.

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

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1. a) Draw the circuit diagram of a single phase semi-converter fed d.c series motor and explain its operation with the help of associated voltage and current waveforms assuming discontinuous conduction.
   b) The speed of a 20 HP, 210 V, 1000 rpm series motor is controlled by a single-phase full converter. The combined field and armature circuit resistance is 0.25 Ω. Motor constants are K_{af} = 0.03 N-m/A^2 and K_{res}=0.075 V-s/rad. The supply voltage is 230 V. Assuming continuous and ripple-free motor current, determine motor torque, motor current and supply power factor for a firing angle $\alpha = 30^0$ and speed N = 1000 rpm.

2. Draw the circuit diagram and explain the motoring operation of a three-phase semi-converter fed d.c. motor. Also sketch and explain the following waveforms:
   Output voltage and current at $\alpha = 60^0$
   Output voltage and current at $\alpha = 120^0$.

3. a) Draw speed torque characteristic for regenerative braking operation of a d.c. shunt motor and explain the operation.
   b) Explain the principle of operation of closed-loop control of dc drive using suitable block diagram.

4. a) Draw the circuit diagram and explain the operation of chopper fed d.c. shunt motor with the help of speed-torque characteristics.
   b) A 230 V, 1200 rpm, 15 A separately excited d.c. motor has an armature resistance of 1.2 Ω. Motor is operated under dynamic braking with chopper control. Braking resistance has a value of 20 Ω.
      i) calculate the duty ratio of chopper for motor speed of 1000 rpm 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?

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5. a) During plugging operation of a wound rotor induction motor, usually a external resistance is inserted into the rotor circuit, why?
   b) Why stator voltage control is suitable for speed control of Induction motor in fan and pump drives?

6. a) Explain with a suitable block diagram the closed loop operation of an induction motor drive.
   b) Explain the operation of induction motor by current source inverters.

7. A 3-phase, 420 V, 4-pole, 50 Hz, star-connected induction motor has its speed controlled by means of static Kramer drive. The effective phase turns ratio from rotor to stator is 0.8 and transformer has phase turns ratio from l.v. to h.v. as 0.4. The inductor current is ripple free. Losses in diode rectifier, inductor, inverter and transformer are neglected. The load torque is proportional to speed squared and its value at 1200 rpm is 450 N-m. For a motor operating speed of 1000 rpm, calculate
   i) rotor rectified voltage
   ii) inductor current
   iii) delay angle of the inverter
   iv) efficiency incase inductor resistance is 0.01 Ω and per-phase resistances for stator and rotor are 0.015 Ω and 0. 0.02 Ω respectively

8. a) Explain the operation of a load commutated CSI fed synchronous motor.
   b) Explain briefly about closed loop operation of synchronous motor drive

Code No. M0221 **R07** **Set No.3**

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POWER SEMICONDUCTOR DRIVES
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Time: 3 hours **Max. Marks: 80**

Answer any FIVE Questions
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*****

1. a) Explain the effect of armature inductance on the performance of a d.c.drive.
   b) A separately excited d.c.motor is fed from a 1-Φ semiconverter. The supply is 240 V, the thyristors are triggered at 110^0, and the armature current continues for 50^0 beyond the voltage zero. Determine the motor speed at a torque of 1.8 N-m, given the motor torque constant is 1.0 N-m/A and its armature resistance is 6 Ω. Neglect all converter losses.

2. The speed of a 150 HP, 650 V, 1750 rpm, separately excited d.c. motor is controlled by a 3-Φ, full converter. The converter is operating from a 3-Φ, 460 V, 50 Hz supply. The rated armature current of the motor is 170 A. The motor parameters are R_a = 0.099Ω, L_a = 0.73 mH, and $K_a\Phi$ = 0.33 V/rpm. Neglecting losses in converter system, determine:
   i) No-load speeds at firing angles $\alpha = 0^0$ and $\alpha = 30^0$. Assume that at no-load, the armature current is 10% of the rated current and is continuous.
   ii) The firing angle to obtain rated speed of 1750 rpm at rated motor current. Also, compute the supply power factor.
   iii) The speed regulation for the firing angle obtain in (ii)

3. a) Draw the block diagram and explain closed-loop speed control operation with inner-current loop and field weakening.
   b) What are the advantages of regenerative braking over other methods of braking?

4. a) What is the principle of rheostatic braking of dc-dc converter fed d.c. motor drives?
   b) Explain how forward motoring and regenerative braking operation of a separately excited DC motor can be obtained using a two quadrant chopper circuit.

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5. a) Discuss briefly the stator voltage control scheme of induction motor. Also draw and explain the speed torque curves.
   b) Draw the schematics of different types of AC voltage controllers which are used for stator voltage control of 3-Φ induction motors.

6. a) Draw and explain the speed-torque curves with variable frequency control for two different modes:
      i) Operation at constant flux
      ii) Operation at constant (V/f) ratio.
   b) Explain briefly the operation of induction motor control by voltage source inverters.

7. a) Discuss about the different speed control methods of induction motor from rotor side.
   b) Draw a suitable diagram and explain the working of slip-power recovery system using Static Scherbius drive.

8. a) Describe VSI fed synchronous motor drive in detail with a suitable block diagram
   b) With suitable block diagram explain the closed loop operation of a synchronous motor drive.

Code No. M0221 **R07** **Set No.4**

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POWER SEMICONDUCTOR DRIVES
(Electrical and Electronics Engineering)

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

Answer any FIVE Questions
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1. a) Derive the expression for critical speed which separates continuous conduction from discontinuous conduction for a single-phase full-converter fed separately excited dc motor.
   b) A 210 V, 1200 rpm, 10 A separately excited d.c.motor is controlled by a single phase full converter with an a.c. source voltage of 230 V, 50 Hz. Armature resistance is 1.5 Ω . Assuming continuous and ripple free armature current
      i) What should be the value of the firing angle to get the rated torque at 800 rpm?
      ii) Compute the firing angle for the rated braking torque at -1200 rpm.
      iii) Calculate the motor speed at rated torque and $\alpha = 165^0$ for regenerative braking in the second quadrant?

2. The speed of a 20-hp, 300 V, 1800 rpm separately excited dc motor is controlled by a 3-Φ full-converter drive. The field current is also controlled by a 3-Φ full converter and is set to the maximum possible value. The ac input is a 3-Φ, star connected, 208 V, 60 Hz supply. The armature resistance R_a is 0.25 Ω, the field resistance R_f is 245 Ω, and the motor voltage constant is 1.2 V/A rad/s. The armature and field currents can be assumed to be continuous and ripple free. The viscous friction is negligible. Determine
   i) The delay angle of the armature converter if the motor supplies the rated power at the rated speed
   ii) The no-load speed if the delay angles are the same as in (i) and the armature current at no load is 10 % of the rated value; and
   iii) Speed regulation

3. a) Explain in detail the four quadrant operation of a d.c. motor using dual converters.
   b) Discuss in detail the drawbacks of rectifier fed dc drives.

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4. a) Describe regenerative braking of a chopper fed separately excited dc motor. Illustrate your answer with circuit diagram and relevant waveforms.
   b) Draw the block diagram of a closed loop chopper fed dc drive and explain its operation.

5. a) Describe stator voltage control technique using AC voltage controller for the speed control of a 3-Φ induction motor.
   b) Why stator voltage control is suitable for speed control of Induction motor in fan and pump drives?

6. Explain the operation of induction motor for two different cases when fed by current source inverters,
   i) Operation at and below rated frequency
   ii) Operation above rated frequency

7. a) Describe static rotor resistance control method for the speed control of a 3-phase induction motor.
   b) A static Kramer drive is used for the speed control of a 4-pole SRIM fed from 415 V, 50 Hz supply. The inverter is connected directly to the supply. If the motor is required to operate at 1200 rpm, find the firing advance angle of the inverter. Voltage across the open-circuited slip rings at stand-still is 700 V. Allow a voltage drop of 0.7 V and 1.5 V across each of the diodes and thyristors respectively. Inductor drop is neglected.

8. a) Explain the operation of a Cyclo-converter fed synchronous motor.
   b) Explain the operation of a load commutated CSI fed synchronous motor.