Code No: RT32026 **R13** SET - 1

III B. Tech II Semester Regular/Supplementary Examinations, April-2018

POWER SEMICONDUCTOR DRIVES

(Electrical and Electronics Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answering the question in **Part-A** is compulsory
3. Answer any **THREE** Questions from **Part-B**

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PART –A

1	a)	Write the torque equation of the motor-load system? What is meant by acceleration mode of the electric drive?	[4M]
	b)	Describe the various drawbacks of rectifier controlled dc series motor drive?	[4M]
	c)	How do you control separately excited DC motor in the fourth-quadrant?	[4M]
	d)	Draw the speed-torque characteristics of induction motor with variable supply voltage and constant frequency?	[4M]
	e)	What are the advantages of Kramer drive compared to the Scherbius drive?	[3M]
	f)	When can be a synchronous motor is load commutated?	[3M]

PART -B

2	a)	The electric motor drive develops a torque expressed by $T_m = a\omega + b$ where a and b are positive constants, the motor is supposed to drive the load torque which is given by $T_L = c\omega^2 + d$ where c and d are other positive constants, The total inertia of the rotating masses is J, Determine the relation among the a, b, c and d in order to start the motor and load together and have an equilibrium operating speed and also calculate this equilibrium operating speed?	[8M]
	b)	Develop a criterion for finding the steady state stability of an electric drive?	[8M]
3	a)	Obtain the speed-torque characteristics of separately excited DC motor operated with 3-phase full converter and describe the effect of firing angle?	[8M]
	b)	A separately excited DC motor is operating from a three phase semi converter at a speed of 1400 rpm, with phase input voltage of 330 V (peak-to-peak), and back emf of 120 V. The converter is fired symmetrically with $\alpha = 30^0$. The armature resistance of 0.5 Ω. Calculate average current and the motor developed torque?	[8M]
4	a)	Explain the operation of two-quadrant, type-D chopper drive with necessary equivalent circuits and waveforms?	[8M]
	b)	A DC chopper is used for regenerative braking of a separately excited DC motor. The supply input voltage is 400 V, armature resistance is 0.25 Ω, $K_m = 1.2\ V - \text{sec}/rad$. The average armature current during regenerative braking is kept constant at 200 A. For a duty cycle of 60% of chopper, determine the following: (i) power fed back to the supply. (ii) Minimum and maximum braking speeds. (iii) Speed during regenerative braking.	[8M]

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5	a)	Draw the speed-torque characteristics of with constant supply voltage and variable frequency based Induction motor drive? Describe the disadvantages of this drive?	[8M]
	b)	For a 3-phase delta connected 6-pole 50 Hz 400 V, 925 rpm squirrel cage induction motor is having $R_s = 0.2\Omega$, $R_r = 0.3\Omega$, $X_s = 0.5\Omega$, and $X_r = 1.1\Omega$. The motor is operated from voltage source inverter with constant V/f ratio form 0 to 50 Hz and having the constant voltage of 400 V above 50 Hz frequency, calculate (i) speed for a frequency of 35 Hz with half full load torque (ii) torque for a frequency of 35 Hz for a speed of 650 rpm.	[8M]
6	a)	Explain with neat diagram and equations about the static Scherbius system of slip power recovery scheme?	[8M]
	b)	A static Kramer drive is used for the speed control of a 6-pole slip ring induction motor fed from 415 V, 50 Hz supply. The inverter is connected directly to the supply. If the motor is required to operate at 800 rpm, find the firing advance angle of the inverter. Voltage across the open-circuited slip rings at stand-still is 600 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?	[8M]
7	a)	Show that the torque of synchronous motor is independent of speed when it operates in current control mode?	[8M]
	b)	Explain the synchronous motor drive self-control operation with power factor improvement?	[8M]

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2. Answering the question in **Part-A** is compulsory
3. Answer any **THREE** Questions from **Part-B**

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PART –A

1	a)	What are the different load torque components, how they are approximated in deriving the torque equation of motor-load system?	[4M]
	b)	When discontinuous mode of operation is occurs in the operation of converter fed DC drives?	[4M]
	c)	How do you control DC series motor in the second-quadrant?	[4M]
	d)	Why it is required to maintain the ratio of V/f is constant in the control of induction motor?	[4M]
	e)	What are the two types of static Scherbius system?	[3M]
	f)	What are the advantages of self-control of synchronous motor?	[3M]

PART -B

2	a)	Discuss the different modes of operation of electric drive with suitable examples?	[8M]
	b)	A 220V, 900 rpm, 70 A DC separately excited motor has an armature resistance of 0.05 Ω. It is coupled to an overhauling load with a torque of 200 N-m. Determine the speed at which the motor can hold the load by regenerative braking.	[8M]
3	a)	Obtain the speed-torque characteristics of separately excited DC motor operated with 3-phase semi-converter and describe the effect of firing angle?	[8M]
	b)	A 250 V, 900 rpm, 100 A separately excited DC motor has armature and field resistances of 0.05 and 200 Ω respectively. Load torque is given by $T_L = 400 - 0.25\,x$ N-m. Where 'x' is the speed in rpm. Armature is fed from a three phase full controlled rectifier with AC source voltage (phase) of 220 V, 50 Hz and field is fed from a full controlled single phase rectifier with a single phase source voltage of 220 V, 50Hz. Drive operates in continuous conduction. Calculate the firing angles for speeds of 600 rpm and 1200 rpm.	[8M]
4	a)	Draw a neat sketch of a four-quadrant DC-DC converter for a variable speed reversible drive of DC series motor and discuss its operation?	[8M]
	b)	A 230 V separately excited DC motor takes 50 A at a speed of 800 rpm. It has armature resistance of 0.4 Ω. This motor is controlled by type-C chopper with an input voltage of 230 V and frequency of 800 Hz. Assuming the continuous conduction mode, calculate speed-torque characteristics for (i) motoring operation for duty ratios of 0.3 and 0.6 (ii) regenerative braking operation for duty ratios of 0.7 and 0.4	[8M]

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5	a)	For a 3-phase delta connected 6-pole 50 Hz 440 V, 905 rpm squirrel cage induction motor is having $R_s = 0.2\ \Omega$, $R_r = 0.3\ \Omega$, $X_s = 0.5\ \Omega$, and $X_r = 1.1\ \Omega$. The motor is operated from voltage source inverter with constant V/f ratio form 0 to 50 Hz and having the constant voltage of 440 V above 50 Hz frequency, calculate i) Speed for a frequency of 25 Hz with half full load torque ii) Torque for a frequency of 25 Hz for a speed of 600 rpm.	[8M]
	b)	Explain the closed loop operation of induction motor drive including both current and speed loop with the help of block diagram?	[8M]
6	a)	Explain the operation of induction motor speed control using rotor resistance variation?	[8M]
	b)	A three phase, 415 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. Assume that load torque is proportional to square of the speed equal to 450 N-m at 1415 rpm. i) For a minimum motor speed of 1000 rpm, calculate the value of chopper resistance R. ii) For the value of R obtained in part (i), if the speed is raised to 1300 rpm, calculate inductor current. iii) Duty cycle of the chopper. iv) Rectified output voltage.	[8M]
7	a)	Describe the advantages of self-controlled variable speed synchronous motor drive over the separate controlled drive?	[8M]
	b)	Describe the open-loop and closed loop methods of speed control of synchronous motor fed from VSI?	[8M]

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(Electrical and Electronics Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answering the question in **Part-A** is compulsory
3. Answer any **THREE** Questions from **Part-B**

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PART –A

1	a)	Enumerate all the conditions to be satisfied for regenerative braking operation takes place?	[4M]
	b)	Describe the draw backs if armature current in a DC motor is discontinuous?	[4M]
	c)	What are the advantages of DC-DC converter fed drives compared to converter fed drives?	[4M]
	d)	What is the effect on power factor at starting when an induction motor is operated with reduced voltage and frequency operation?	[4M]
	e)	In the static Kramer drive a diode bridge is replaced by thyristor bridge, what is speed range possible?	[3M]
	f)	In self-control of synchronous motor how the frequency is is controlled?	[3M]

PART -B

2	a)	Explain briefly, what are the factors involved in the selection of drives?	[8M]
	b)	A 220 V, 900 rpm, 70 A DC separately excited motor has an armature resistance of 0.05 Ω. It is coupled to an overhauling load with a torque of 200 N-m. If the motor is to be operated by dynamic braking, calculate the value of external resistance to be connected across the armature when the motor should carry the load at 600 rpm.	[8M]
3	a)	Explain the operation of DC series motor operated with 3-phase semi converter? Describe its speed control characteristics with respect to change of firing angle?	[8M]
	b)	A 250 V separately excited dc motor has an armature resistance of 2.5 Ω. When driving a load at 600 rpm with constant torque, the armature takes 40 A. This motor is controlled by a three phase full converter circuit a phase input voltage of 250 V with continuous current. What should be the value of firing angle to reduce the speed from 600 to 400 rpm, with the load torque maintained constant?	[8M]
4	a)	Discuss with suitable diagrams the first-quadrant and fourth-quadrant DC-DC converters?	[8M]
	b)	A 220 V, 900 rpm, 30 A separately excited DC motor has an armature resistance of 0.7 Ω and inductance of 50mH. The motor is controlled in regenerative braking by a chopper operating at a frequency of 800 Hz from a DC source of 220 V. Assuming continuous conduction, (i) Calculate duty ratio of chopper for rated torque and speed of 600 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?	[8M]

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5	a)	With necessary diagrams and theoretical principles explain stator voltage/frequency control of induction motor?	[8M]
	b)	A 3 phase, 4 pole, 50 Hz squirrel cage Induction motor has the following circuit parameters: $R_1 = 0.05\,\Omega$, $R_2 = 0.09\,\Omega$, $X_1 + X_2 = 0.55\,\Omega$. The motor is star connected and rated voltage is 440V. It drives a load whose torqueis proportional to the speed and is given as $T_L = 0.05\,\omega$ N-m. Determine the speed and torque of the motor for a firing angle of 60^0 of the AC Voltage Controller on a 440V, 50 Hz supply?	[8M]
6	a)	With relevant circuit and characteristics, explain the operation of static Scherbius drive?	[8M]
	b)	For a 3-phase delta connected 6-pole 50 Hz 440 V, 905 rpm squirrel cage induction motor is having $R_s = 0.2\,\Omega$, $R_r' = 0.3\,\Omega$, $X_s = X_r' = 1.2\,\Omega$, and $X_m = 50\,\Omega$. The stator to rotor turns ratio is 4. The motor is controlled by static rotor resistance control. Find the external resistance to be connected such that break down torque is produced at slip equal to 2, now the motor connections are changed from motoring to single phase AC dynamic braking with three connections (i.e. one phase is in series with other two phase in parallel). Calculate the braking current and torque for a speed of 600 rpm?	[8M]
7	a)	Describe separate control mode of operation of a synchronous motor drive in detail?	[8M]
	b)	Draw the block diagram of closed loop synchronous drive fed from VSI and explain its operation?	[8M]

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Code No: RT32026 **R13** SET - 4

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2. Answering the question in **Part-A** is compulsory
3. Answer any **THREE** Questions from **Part-B**

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PART –A

1	a)	Write the torque equation of the motor-load system? What is meant by deceleration mode of the electric drive?	[4M]
	b)	What are the advantages of continuous current conduction mode of operation DC motor?	[4M]
	c)	What are the advantages of four-quadrant DC-DC converter fed DC drives?	[4M]
	d)	What are disadvantages of AC voltage controller fed induction motor drive?	[4M]
	e)	In the static Kramer drive a diode bridge and DC motor are used, what is speed range possible?	[3M]
	f)	In separate control of synchronous motor how the frequency of the supply to motor is is changed?	[3M]

PART -B

2	a)	Explain the multi-quadrant operation of an electric motor with relevant characteristics when the motor is driving a hoist load?	[8M]
	b)	The electric motor drive develops a torque expressed by $T_m = a\omega + b$ where a and b are positive constants, the motor is supposed to drive the load torque which is given by $T_L = c\omega^2 + d$ where c and d are other positive constants, The total inertia of the rotating masses is$J$, Determine the relation among the among a, b, c and d in order to start the motor and load together and have an equilibrium operating speed and also calculate this equilibrium operating speed?	[8M]
3	a)	Explain the operation of DC series motor operated with 3-phase full converter? Describe its speed control characteristics with respect to change of firing angle?	[8M]
	b)	A 250 V, 900 rpm, 100 A separately excited motor has armature and field resistances of 0.05 and 200 Ω respectively. Load torque is given by $T_L = 400 - 0.25\,x$ N-m. Where 'x' is the speed in rpm. Armature is fed from a three phase semi controlled rectifier with AC source voltage (phase) of 220 V, 50 Hz and field is fed from a full controlled single phase rectifier with a single phase source voltage of 220 V, 50Hz. Drive operates in continuous conduction. Calculate the firing angles for speeds of 700 rpm and 1500 rpm.	[8M]

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4	a)	Discuss the closed loop operation of DC series motor drive fed with suitable DC-DC converter?	[8M]
	b)	A DC chopper is used for regenerative braking of a separately excited DC motor. The supply input voltage is 250 V, armature resistance is 0.4 Ω, $K_m = 1.2\,V - sec/rad$. The average armature current during regenerative braking is kept constant at 100 A. For a duty cycle of 60% of chopper, determine the following: i) Power fed back to the supply. ii) Minimum and maximum braking speeds. iii) Speed during regenerative braking.	[8M]
5	a)	With necessary diagrams and theoretical principles explain the control induction motor with stator constant voltage and variable frequency for below and above rated speeds?	[8M]
	b)	A 3 phase, star connected, 50 Hz, 4-pole induction motor has the following parameters in ohms per phase referred to the stator: $R_s = R_r' = 0.034\,\Omega$, $X_s = X_r' = 0.15\,\Omega$. The motor is controlled by variable frequency control with a constant (V/f). Determine the following for an operating frequency of 25 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.	[8M]
6	a)	Draw the speed-torque characteristics of rotor resistance controlled induction motor and explain the effect of rotor resistance?	[6M]
	b)	A 415V, 50 Hz, 6 Pole star connected slip ring induction motor is controlled by static Kramer drive. The effective phase turns ratio from rotor to stator is 0.7, the transformer turns ratio from l.v side to h.v side is 0.4. The load torque is proportional to the square of the speed and it is equal to 250 N-m at 870 rpm. To operate at 750 rpm calculate (i) rotor rectifier voltage (ii) delay angle of the inverter (iii) efficiency, if the inductor resistance is 0.02 Ω, stator and rotor resistances are 0.01 Ω and 0.03 Ω respectively. Assume losses in diode rectifier, inductor and transformer are negligible.	[10M]
7	a)	Explain the working of synchronous motor operating in self-controlled mode?	[8M]
	b)	Explain the closed loop control of PWM fed synchronous motor drive employing variable frequency control?	[8M]

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