SRM VALLIAMMAI ENGINEERING COLLEGE
(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203.

DEPARTMENT OF

ELECTRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK

VI SEMESTER

1905601 – SOLID STATE DRIVES

Regulation – 2019

Academic Year 2022 – 2023 (EVEN)

Prepared by

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SUBJECT: 1905601-SOLID STATE DRIVES

SEM / YEAR: VI / III

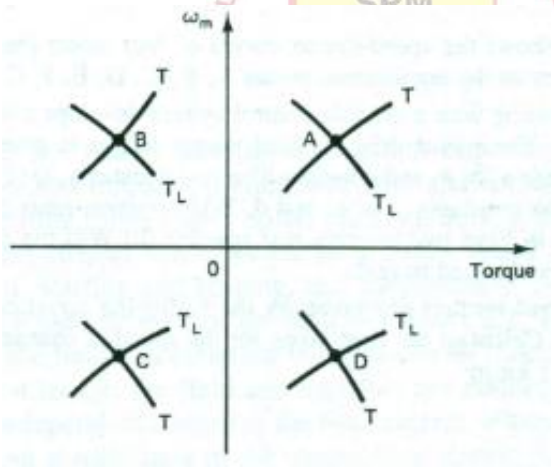
UNIT I - DRIVE CHARACTERISTICS

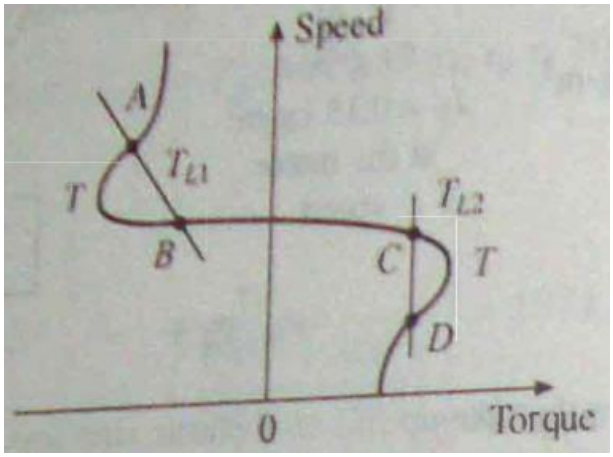
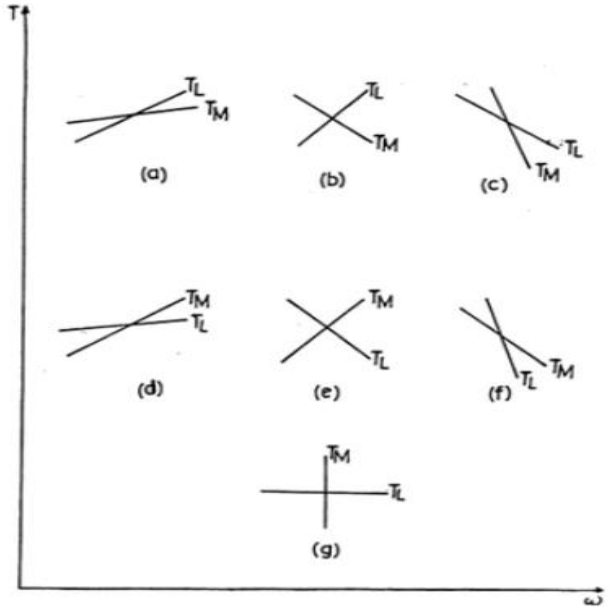
Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, starting & stopping – typical load torque characteristics – Selection of motor, modes of operation.

PART - A

Q.No	Questions	BT Level	Competence	Course outcome
1.	List the types of load torques.	BTL 1	Remember	CO1
2.	Compose the fundamental torque equation of motor load.	BTL 6	Create	CO1
3.	Explain the active load torques and passive load torques? Give example.	BTL 4	Analyze	CO1
4.	Explain the typical Elements of an Electric Drive.	BTL 4	Analyze	CO1
5.	Define electrical drive	BTL 1	Remember	CO1
6.	Define regenerative braking.	BTL 1	Remember	CO1
7.	Compose the condition for steady state stability of motor	BTL 6	Create	CO1
8.	Draw the torque speed characteristics of a hoist load Mechanism.	BTL 1	Remember	CO1
9.	Define Dynamic Braking	BTL 1	Remember	CO1
10.	Classify the different loads? Give the examples.	BTL 3	Apply	CO1
11.	Explain the Different mode of operation of an electric drive.	BTL 4	Analyze	CO1
12.	Discuss the necessary condition to obtain the three Modes of operation of an electric drive.	BTL 2	Understand	CO1
13.	Discuss all the conditions to be satisfied for the Regenerative braking operation to take place.	BTL 2	Understand	CO1
14.	Explain the types of electric braking.	BTL 5	Evaluate	CO1
15.	Give example is braking applicable for any type of motor.	BTL 2	Understand	CO1
16.	Give and label the block diagram of electrical drive Systems.	BTL 2	Understand	CO1
17.	Classify the multi quadrant dynamics in drive characteristics.	BTL 3	Apply	CO1
18.	Mention the different factors that are considered for the selection of an electrical drives.	BTL 1	Remember	CO1
19.	Illustrate a drive? How are they classified?	BTL 3	Apply	CO1

20.	Explain the speed – torque conventions used in multi Quadrant operation.	BTL 5	Evaluate	CO1
21.	List the advantages of an electric drives.	BTL 1	Remember	CO1
22.	Give the condition for acceleration of motor load system.	BTL 3	Apply	CO1
23.	Justify about the action of drive system "If load is driven by an electric motor, due to external disturbances, the speed change occurs and motor torque becomes greater than load torque."	BTL 5	Evaluate	CO1
24.	Justify about the action of drive system "If load is driven by an electric motor, due to external disturbances, the speed change occurs and load torque becomes greater than motor torque."	BTL 5	Evaluate	CO1
	PART – B			
1.	Label the essential parts of electric drive. Explain its Function. (13)	BTL 1	Remember	CO1
2.	(i) Discuss the speed-torque characteristics of various types of loads with neat diagram. (7) (ii) Discuss in detail about the multi quadrant dynamics of electric drives. (6)	BTL 2 BTL 2	Understand Understand	CO1 CO1
3.	Define how the following speed transitions are carried Out: (i) Increase in speed in same direction, (ii) Decrease in speed in same direction and (iii) Speed reversal. (13)	BTL 1	Remember	CO1
4.	(i) Show a motor is coupled to a load having the following characteristics: Motor: $T_m = 15 - 0.6\ \omega\alpha$ Load: $T_L = 0.5\ \omega\ \alpha^2$ Find out the stable operating point for this condition. (7) (ii) Explain in detail about steady state stability in electrical drive system. (6)	BTL 3	Apply	CO1 CO1
5.	Discuss the different modes of operation of an electrical drive. (13)	BTL 2	Understand	CO1
6.	(i)Explain the four quadrant operation of low speed hoist in detail. (6) (ii) Explain and derive an equation to find out equivalent Load torque in a motor load system with translational and rotational motion. (7)	BTL 5 BTL 5	Evaluate Evaluate	CO1 CO1
7.	Compose the mathematical condition to obtain steady State stability of equilibrium point. (13)	BTL 6	Create	CO1
8.	Explain in detail the multi quadrant operation of low Speed hoist in speed torque plane. (13)	BTL 4	Analyze	CO1

9.	Solve a motor drives two loads. One has rotational Motion. It is coupled to the motor through a reduction gear with a = 0.1 and efficiency of 90%. The load has a moment of inertia of 10 kg-m^2 and a torque of 10 N-m. Other load has translational motion and consists of 1000kg weight to be lifted up at a uniform speed of 1.5 m/s. coupling between this load and the motor has an efficiency of 85%. Motor has inertia of 0.2 kg-m^2 and runs at a constant speed of 1420 rpm. Determine equivalent inertia referred to the motor shaft and power developed by the motor. (13)	BTL 3	Apply	CO1
10.	Define in detail about the braking of DC drives and AC Drives. (13)	BTL 1	Remember	CO1
11.	Explain the operation of electrical drives in three Different modes. (13)	BTL 4	Analyze	CO1
12.	(i) Derive the fundamental torque equations of Motor load system. (6) (ii) Explain the multi quadrant operation of a motor driving a load. (7)	BTL 3 BTL 4	Apply Analyze	CO1 CO1
13.	(i) What are the factors governing selection of electric drives for any particular application? (7) (ii) Write equation governing motor load dynamics. (6)	BTL 2	Understand	CO1
14.	Figure below shows the speed-torque curves of the motor and load in the four quadrants. Comment on the stability of the equi1ibrium points A, B, C, and D. (13) 	BTL 1	Remember	CO1
15.	Discuss in detail the four quadrant dynamics in the speed –torque plane.	BTL 5	Evaluate	CO1
16.	List the possible forms of electrical drives and compare them.	BTL 2	Understand	CO1

17.	Figure below shows plots of speed vs motor and load torques. Comment on the stability of the operating points A, B, C, and D.  	BTL 5	Evaluate	CO1
	PART – C			
1.	Analyze the multi quadrant dynamics of any suitable Electrical drive in the speed-torque plane and sketch the directions of speed, load torque and motor torque. (15)	BTL 5	Evaluating	CO1
2.	Discuss with the suitable mathematical model, the Analysis of steady state stability of an electrical drive. (15)	BTL 6	Creating	CO1
3.	Summarize the factors governing the selection of electric Drives for any particular application. (15)	BTL 5	Evaluating	CO1
4.	Discuss in detail the different types of electrical barking Applied for low speed hoists. (15)	BTL 6	Creating	CO1
5.	Figure below shows the speed-torque curves of the motor and load. Comment the stability of a, b, c, d, e, f and g.  	BTL 5	Evaluating	CO1

UNIT II - CONVERTER / CHOPPER FED DC MOTOR DRIVE

Steady state analysis of the single and three phase converter fed separately excited DC motor drive–continuous and discontinuous conduction– Time ratio and current limit control – 4 quadrant operation of converter / chopper fed drive- Effect of ripples on the DC motor performance.

PART – A

Q.No	Questions	BT Level	Competence	Course outcome
1.	List the drawbacks of AC-DC Converter (rectifier) fed DC drives.	BTL 1	Remember	CO2
2.	Is it possible to operate a semi converter fed DC drive in quadrant IV? Justify your answer.	BTL 3	Apply	CO2
3.	Differentiate between continuous and discontinuous Conduction mode.	BTL 4	Analyze	CO2
4.	Evaluate the necessity of DC choke coil and freewheeling Diode in a converter circuit.	BTL 5	Evaluate	CO2
5.	Compose the speed torque equation of single phase fully Controlled converter fed separately excited DC motor.	BTL 6	Create	CO2
6.	Compose the speed torque equation of three phase fully Controlled converter fed separately excited DC motor.	BTL 6	Create	CO2
7.	Define the speed control methods of DC Motor	BTL 1	Remember	CO2
8.	Can a semi converter fed three phase DC drive operate in quadrant four? Justify your answer.	BTL 5	Evaluate	CO2
9.	Explain the Operation of a three phase fully controlled converter fed separately excited dc motor.	BTL 4	Analyze	CO2
10.	Explain the Operation of a single phase fully controlled Converter fed separately excited dc motor.	BTL 4	Analyze	CO2
11.	When is discontinuous conduction expected with the operation of converter fed dc drives.	BTL 1	Remember	CO2
12.	Tell whether discontinuous conduction will occur in the Operation of chopper fed dc drives.	BTL 1	Remember	CO2
13.	Illustrate the expression for the average output voltage of a Full converter fed dc drive.	BTL 3	Apply	CO2
14.	Illustrate the speed torque equation of dc separately excited Motor fed drive.	BTL 3	Apply	CO2
15.	Describe the advantages of chopper fed drive over converter Fed drive.	BTL 4	Understand	CO2
16.	Summarize the control strategies of chopper.	BTL 4	Understand	CO2
17.	What are the advantages in operating choppers at high Frequency?	BTL 1	Remember	CO2
18.	Describe the advantages of chopper fed DC drive.	BTL 4	Understand	CO2
19.	Discuss the Electrical and mechanical characteristics of separately excited dc motors.	BTL 4	Understand	CO2

20.	What are the applications of chopper fed DC drives?	BTL 4	Understand	CO2
21.	Illustrate the expression for the average output voltage of a Three phase bridge converter fed dc drive.	BTL 3	Apply	CO2
22.	Illustrate the expression for the motor speed of a single phase Full converter fed dc drive.	BTL 1	Remember	CO2
23.	Define the duty cycle of chopper.	BTL 4	Understand	CO2
24.	Illustrate the expression for the average output voltage and motor speed of a three phase Full converter fed dc drive.	BTL 1	Remember	CO2
	PART – B			
1.	Explain the steady state analysis of the single phase fully Controlled converter fed separately excited DC motor Drive for continuous current mode. Also explain its Operation in motoring and regenerative braking mode. (13)	BTL 5	Evaluate	CO2
2.	Solve a 450V separately excited dc motor has an armature Resistance of 4.5Ω when driving a load at 600 r.p.m. with constant torque, the armature takes 40 A. This motor is controlled by a chopper circuit with a frequency of 400 Hz and an input voltage of 450 V. (i) What should be the value of the duty ratio if one desires to reduce the speed from 600 to 540 r.p.m. with the load torque maintained constant? (ii) Find out the value of duty ratio for which the per unit ripple current will be maximum. (13)	BTL 3	Apply	CO2
3.	Describe about Electrical –mechanical characteristics of Commonly used electric motors. (13)	BTL 1	Remember	CO2
4.	Describe the steady state analysis of the single phase fully Controlled converter fed separately excited DC motor drive for continuous and discontinuous conduction mode. (13)	BTL 4	Understand	CO2
5.	(i) Explain in detail the single phase fully controlled rectifier control of dc separately excited motor with neat waveforms. (6) (ii) Solve a 440 V, 1500 rpm, 10 A separately excited DC motor has an armature resistance of. It is fed from a single phase fully controlled rectifier with a source voltage of 430 V 50 Hz. Assuming continuous load current. Compute (1) Motor speed at the firing angle of 30◦ and Torque of 5 Nm. (4) Developed Torque at the firing angle of 45◦ and speed of 1000 rpm. (7)	BTL 4 BTL 3	Analyze Apply	CO2 CO2
6.	(i) Define in detail about the regenerative operation of three phase fully controlled rectifier control of separately excited DC motor. (7) (ii) Define in detail about the four quadrant operation of chopper fed drive. (6)	BTL 1 BTL 1	Remember	CO2
7.	Compose the operation of single phase controlled converter Fed separately excited DC motor in continuous and Discontinuous modes with neat diagram, waveforms and Comment the steady state analysis. (13)	BTL 6	Create	CO2

8.	Explain the four quadrant operation of chopper fed DC Separately excited motor drive with necessary diagram. (13)	BTL 4	Understand	CO2
9.	Define in detail about the operation of single phase fully-Controlled converter fed dc separately excited motor in Continuous and discontinuous conduction modes of operation with Necessary waveforms and steady state analysis. (13)	BTL 1	Remember	CO2
10.	(i) Discuss the different control techniques of chopper in Detail. (6) (ii) Discuss the four quadrant operation of DC-DC converter. (7)	BTL 4 BTL 4	Understand	CO2
11.	(i)Explain the operation of four quadrant dc chopper drive. (6) (ii)Solve a 440 V, 40 A, 1000 rpm separately excited dc motor has an armature resistance of 4.5 Ω. The motor is controlled by a step-down chopper with a frequency of 1 kHz. The input dc voltage to the chopper is 450V. Identify what will be the duty cycle of the chopper for the motor to operate at a speed of 600 rpm delivering the rated torque. (7)	BTL 4 BTL 1	Analyze Remember	CO2 CO2
12.	(i)A 400V, 875 rpm, 150A separately excited dc motor has An armature resistance of 0.06 Ω. It is fed from a single phase fully controlled rectifier with an ac source voltage of 440V, 50Hz. Assuming continuous conduction, Calculate (i)Firing angle for rated motor torque and (-750) Rpm (ii) Motor speed for α=160◦ and rated torque. (7) (ii) A chopper used to control the speed of a separately excited dc motor, has supply voltage of 430 V, Ton=15ms, Toff=5ms. Assuming continuous conduction of motor current, Estimate the average load current when the motor speed is 3000rpm. Assume voltage constant Kv=0.5V/rad/sec and Ra=4ohms. (6)	BTL 3 BTL 4	Apply Understand	CO2 CO2
13.	(i) Describe how regenerative braking is obtained in series Motor with chopper control. (7) (ii) List the uses of phase controlled rectifiers in DC drives. (6)	BTL 4 BTL 1	Understand Remember	CO2
14.	Draw and explain the operation of a single phase dual converter fed separately excited dc motor drive. (13)	BTL 3	Apply	CO2
15.	Explain the ward – Leonard scheme of speed control of dc motor. (13)	BTL 4	Analyze	CO2
16.	Compare the single phase full converter and three phase bridge converter fed dc motor drives.	BTL 4	Analyze	CO2

17.	(i) A separately excited dc motor of 400V, 150A, R =0.06Ω, L=0.85mH is supplied from three phase, six phase Fully controlled converter. The line voltage connected to the Converter is 148V and if the motor back emf is 160V at Rated current, find SCR firing angle. (7) (ii) A 440V, 1500 rpm, 50A separately excited motor with armature resistance of 0.5Ω is fed from a three phase fully controlled rectifier. Available ac source has a line voltage of 440V, 50Hz. A star delta connected transformer is used to feed the armature so that motor terminal voltage equals rated voltage when converter firing angle is zero. Calculate transformer turns ratio. Determine the value of firing angle when i) motor is running at 1400 rpm and rated torque, ii) when motor is running at (-800) rpm and twice the rated torque. Assume the continuous conduction. (6)	BTL 1 BTL 1	Remember Remember	CO2 CO2
	PART – C			
1.	Analyze the steady state analysis of single phase converter Fed DC motor drive for continuous mode of conduction. (15)	BTL 5	Evaluating	CO2
2.	Discuss about the steady state analysis of three phase Converter fed DC motor drive for continuous mode of Conduction. (15)	BTL 6	Creating	CO2
3.	Summarize the methods of control of chopper fed DC drive. (15)	BTL 5	Evaluating	CO2
4.	Discuss in detail the four-quadrant operation of chopper fed DC drive. (15)	BTL 6	Creating	CO2
5.	Discuss the operation of a three phase dual converter fed separately excited dc motor drive (15)	BTL 6	Creating	CO2

UNIT III - INDUCTION MOTOR DRIVES

Stator voltage control–energy efficient drive–v/f control–constant air gap flux–field weakening mode–Voltage / current fed inverter – closed loop control-slip power recovery scheme- vector control-Applications.

PART – A

Q.No	Questions	BT Level	Competence	Course Outcome
1.	Justify Why stator voltage control is suitable for speed Control of induction motors in fan and pump drives.	BTL 5	Evaluate	CO3
2.	Summarize different methods of braking applied to induction motor.	BTL 5	Evaluate	CO3
3.	What are the advantages of induction motor over DC Motor	BTL 4	Analyze	CO3
4.	Discuss different methods of speed control of induction motor.	BTL 4	Understand	CO3
5.	Tell the drawbacks of stator voltage controlled Induction Motor drive.	BTL 1	Remember	CO3
6.	Define three regions in speed vs torque characteristics of induction motor.	BTL 1	Remember	CO3
7.	List any two applications of ac drives.	BTL 1	Remember	CO3
8.	Show the various applications of rotor resistance control.	BTL 5	Apply	CO3
9.	Explain the soft start.	BTL 5	Apply	CO3
10.	Discuss stator voltage control method.	BTL 4	Understand	CO3

11.	What do you mean by field weakening mode control?	BTL 1	Remember	CO3
12.	Compare CSI fed drives and VSI fed drives	BTL 4	Analyze	CO3
13.	Discuss the advantages of PI controller used in closed loop Control of induction motor drives.	BTL 4	Understand	CO3
14.	Compose the merits and demerits of voltage fed inverters Controlled drives.	BTL 6	Create	CO3
15.	Give the advantages of vector control method.	BTL 4	Analyze	CO3
16.	What are the drawbacks of ward-Leonard system?	BTL 1	Remember	CO3
17.	Write any two advantages of closed loop control system.	BTL 6	Create	CO3
18.	Illustrate features from which slip controlled drive is developed.	BTL 5	Apply	CO3
19.	Discuss the slip controlled device.	BTL 4	Understand	CO3
20.	What are the applications of vector control method?	BTL 1	Remember	CO3
21.	List the scherbius systems of speed control methods,	BTL 1	Remember	CO3
22.	Give the applications of Kramer electrical drive.	BTL 2	Understand	CO3
23.	List the advantages of v/f speed control of induction motor.	BTL 4	Analyze	CO3
24.	Illustrate the different speed control techniques employed for controlling the speed of an induction motor.	BTL 5	Apply	CO3
	PART - B			
1.	Discuss in detail with suitable diagrams and waveforms of the v/f control technique of speed control method of Induction motor. (13)	BTL 4	Understand	CO3
2.	(Discussl Why a cyclo-converter fed induction motor drive is Preferred over inverter controlled synchronous motor drive for low speed applications. (13)	BTL 1	Remember	CO3
3.	Explain the four modes of operation of a Static Scherbius Drive with diagram. (13)	BTL 4	Analyze	CO3
4.	(i) Describe the VSI fed induction motor drive. (6) (ii)What are the drawbacks of Stator Voltage Control Method? (7)	BTL 4 BTL 4	Understand Analyze	CO3 CO3
5.	Explain in detail about the vector control for a three phase induction motor. (13)	BTL 5	Evaluate	CO3
6.	(i) Describe the concept of v/f control scheme. (7) (ii) Describe the variable frequency operation of induction Motor in closed loop with constant - gap flux. (6)	BTL 1 BTL 1	Remember	CO3
7.	Describe the v/f control scheme of induction motor dive with a neat diagram. (13)	BTL 4	Understand	CO3
8.	(i) Explain the speed control scheme of induction motor drive With stator voltage control and state its advantages. (6) (ii) Compare VSI and CSI fed induction motor drive. (7)	BTL 5 BTL 4	Apply Analyze	CO3 CO3
9.	Compose in detail about the closed loop operation of Armature voltage control method with field weakening mode control in detail. (13)	BTL 6	Create	CO3
10.	(i) Define the VSI fed induction motor drives. (7) (ii) Define the CSI fed induction motor drives. (6)	BTL 1 BTL 1	Remember	CO3

11.	(i)A 4.8 kW, 400 V, 50Hz, 4 pole, 570 rpm, delta connected squirrel cage induction motor has following parameters referred to the stator: Rs=4Ω, Rr`=5Ω, Xs=Xr`=5Ω, Xm=80Ω. Motor speed is controlled by stator voltage control. Estimate the motor terminal voltage, current and torque at 1400 rpm. (7) (ii)Predict v/f control of induction motor drives. (6)	BTL 4	Understand	CO3
12.	Describe the closed loop speed control of VSI fed and CSI fed induction motor drives. (13)	BTL 1	Remember	CO3
13.	(i)Describe the working of static scherbius drive in detail. (7) (ii)Why the power factor of the slip power recovery scheme of speed control of induction motor is low?(6)	BTL 5	Apply	CO3
14.	(i) Explain the operation of constant slip speed control. (6) (ii) Explain the stator voltage control scheme for speed control of three phase induction motor. (7)	BTL 4	Analyze	CO3
15.	Show and explain with a neat diagram the field weakening mode control of induction motor drives. (13)	BTL 4	Analyze	CO3
16.	Define in detail about the principle of vector control of Induction motor drive. (13)	BTL 1	Remember	CO3
17.	Discuss the static Kramer drive system of speed control of an induction motor. (13)	BTL 4	Analyze	CO3
	PART – C			
1.	A three phase 50Hz Induction motor has the following Parameters for its equivalent circuit R1 = R4 = 0.04 ohm and X1 = X4 = 0.1 ohm is to be operated at one half of its rated voltage and 45 Hz frequency. Calculate (i) the maximum torque at this reduced voltage and frequency operation in terms of its normal value and (ii) the starting torque at this reduced frequency and the voltage in terms of its normal value. (15)	BTL 5	Evaluating	CO3
2.	Analyze t h e operation of Voltage source inverter fed Induction motor drives. (15)	BTL 6	Creating	CO3
3.	Describe the closed loop control of speed of induction motor drive fed by current source Inverter. (15)	BTL 5	Evaluating	CO3
4.	Discuss various types of the speed control scheme of induction motor drive. (15)	BTL 6	Creating	CO3
5.	Explain the closed loop control of static scherbius system of speed control with four possible modes of operation. (15)	BTL 4	Analyze	CO3

UNIT IV-SYNCHRONOUS MOTOR DRIVES

V/f control and self-control of synchronous motor: Margin angle control and power factor control- Three phase voltage/current source fed synchronous motor- Applications, Effects of Harmonics.

PART - A

Q.No	Questions	BT Level	Competence	Course Outcome
1.	Justify why a self controlled synchronous motor is free from hunting oscillations?	BTL 5	Evaluate	CO4
2.	Discuss why v/f ratio is kept constant up to base speed and V constant above base speed in variable frequency control.	BTL 4	Understand	CO4
3.	Explain self control of synchronous motor.	BTL 4	Analysis	CO4
4.	List any two applications of synchronous motor drives.	BTL 1	Remember	CO4
5.	Compose the merits and demerits of PMSM	BTL 6	Create	CO4
6.	Illustrate when a synchronous motor said to be self controlled?	BTL 1	Remember	CO4
7.	Show the necessity of delay unit in an open loop v/f control of synchronous motor.	BTL 5	Apply	CO4
8.	Why is damper winding absent in self controlled Synchronous motors?	BTL 5	Apply	CO4
9.	Explain the modes of adjustable frequency control in synchronous motor drives.	BTL 5	Evaluate	CO4
10.	Explain when a synchronous motor can be load commutated.	BTL 4	Analysis	CO4
11.	What are the different types of controls used in Synchronous motor drives?	BTL 5	Apply	CO4
12.	Formulate the expression for torque equation of salient pole synchronous motor.	BTL 6	Create	CO4
13.	Define torque angle	BTL 1	Remember	CO4
14.	What is slip power recovery scheme?	BTL 4	Understand	CO4
15.	Name the two controllers employed in the closed loop control of synchronous motor drives.	BTL 1	Remember	CO4
16.	Discuss the disadvantages of load commutation in the CSI fed synchronous motor drive.	BTL 4	Understand	CO4
17.	What are the types and advantages of permanent magnet AC synchronous motor drives?	BTL 1	Remember	CO4
18.	List the merits and demerits of VSI fed synchronous motor drives.	BTL 1	Remember	CO4
19.	Define margin angle control of synchronous motor drive.	BTL 4	Analysis	CO4
20.	What is meant by super synchronous operation?	BTL 4	Understand	CO4
21.	Define the power factor control of synchronous motor drive.	BTL 4	Analysis	CO4
22.	List the different harmonics injected to ac system when 6 pulse converter is used to control the speed of synchronous	BTL 4	Analysis	CO4
23.	Discuss the basic principle of synchronous motor.	BTL 1	Remember	CO4

24.	Explain synchronous reluctance motor.	BTL 1	Remember	CO4
	PART - B			
1.	(i)Discuss briefly separate controlled mode of synchronous motor in detail. (7) (ii) Explain self control of synchronous motor drive in detail. (6)	BTL 4 BTL 4	Understand Analysis	CO4 CO4
2.	Explain margin angle control of synchronous motor drive. (13)	BTL 4	Analysis	CO4
3.	(i)Explain Commutator less Dc motor. (6) (ii)Describe closed loop speed control of load commutated inverter synchronous motor drive and explain it. (7)	BTL 4 BTL 1	Analysis Remember	CO4 CO4
4.	(i)Describe the open loop v/f control of VSI fed synchronous motor in detail. (7) (ii)Describe the CSI fed synchronous motor drive in detail. (6)	BTL 1 BTL 1	Remember Remember	CO4 CO4
5.	Describe the closed loop operation of permanent magnet synchronous motor drive in details. (13)	BTL 1	Remember	CO4
6.	Discuss in detail the construction, Principle of operation and application of permanent magnet synchronous motor. (13)	BTL 4	Understand	CO4
7.	Discuss the Various application of three phase voltage source inverter fed synchronous motor drive. (13)	BTL 1	Remember	CO4
8.	A 5phase, 400V, 50Hz, 6pole star connected round rotor synchronous motor has Zs=0+j4Ω Load torque proportional to speed squared is 540Nm at rated synchronous speed. The speed of the motor is lowered by keeping v/f constant and maintaining unity power factor by field control of the motor. For the motor operation at 600 rpm, calculate a) supply voltage b) armature current c) excitation angle d) load angle e) pull out torque. Neglect rotational losses. (13)	BTL 5	Apply	CO4
9.	A 7MW, three phase 14 kV star connected 6 pole 50Hz 0.9 leading power factor synchronous motor has Xs= 10Ω and Rs=0. The rated field current is 40A. The machine is controlled by variable frequency control at constant V/f ratio up to the base speed and at constant V above base speed. Evaluate (i) Torque (ii) The field current for the rated armature current 750rpm and 0.8 leading power factor. (13)	BTL 5	Evaluate	CO4

10.	A 500kW, 5 phase, 5.5 kV, 50 Hz, 0.8 lagging power factor, 4 pole, star connected synchronous motor has the following parameters Xs=15Ω, Rs=0.Rated field current is 10A. Calculate armature current and power factor at half the rated torque and field current. (13)	BTL 5	Apply	CO4
11.	Explain the constant marginal angle control technique of self controlled synchronous motor drive employing load commutated thyristor inverter. (13)	BTL 4	Analysis	CO4
12.	Compose the closed loop control of synchronous motor with neat block diagram (13)	BTL 6	Create	CO4
13.	Describe using a diagram the working of a voltage source inverter fed synchronous motor Drive. (13)	BTL 4	Understand	CO4
14.	Explain using a circuit and phasor diagram how the speed of a synchronous motor is controlled in the true synchronous mode. (13)	BTL 4	Analysis	CO4
15.	Describe briefly the power factor angle control of synchronous motors with relevant vector diagram. (13)	BTL 4	Analysis	CO4
16.	A 8 MW, 3 phase , 15 KV star connected 6 pole,0.9 leading power factor synchronous motor has Xs equal to 10 ohms and Rs equal to zero. The rated field current is 65 Amps. The motor is controlled by variable frequency control at constant V/f ratio upto base speed and at constant V above base speed. Identify the torque and field current for rated armature current, 750 rpm and 0.8 leading power factor. (13)	BTL 4	Analysis	CO4
17.	Discuss the forced commutated CSI fed synchronous motor drive. (13)	BTL 1	Remember	CO4
	PART - C			
1.	Explain the forward motoring and braking operation of open loop V/f control of multiple PMSM with relevant phasor diagram. (15)	BTL 5	Evaluating	CO4
2.	(i) Discuss using a block diagram the operation of a voltage source inverter fed synchronous motor in the true Synchronous mode. (8) (ii) Explain the self-control of Synchronous motor in detail. (7)	BTL 6	Creating	CO4
3.	Compare in detail V/F control strategies of induction motor and synchronous motor drive. (15)	BTL 5	Evaluating	CO4
4.	Discuss in detail with help of block diagram the closed loop control load commutated inverter fed synchronous motor drive. (15)	BTL 6	Creating	CO4
5.	Explain the margin angle control and power factor control of synchronous motor drives. (15)	BTL 5	Evaluating	CO4

UNIT V - DESIGN OF CONTROLLERS FOR DRIVES

Transfer function for DC motor / load and converter – closed loop control with Current and speed feedback–armature voltage control and field weakening mode – Design of controllers; current controller and speed controller- converter selection and characteristics.

PART - A

Q.No	Questions	BT Level	Competence	Course Outcome
1.	Discuss the roles of inner current control and outer speed control loops?	BTL 4	Understand	CO5
2.	List the methods of speed sensing.	BTL 1	Remember	CO5
3.	Write down the transfer function expression of converter.	BTL 5	Apply	CO5
4.	Give the advantages of Pi controller.	BTL 4	Understand	CO5
5.	Describe field weakening mode control.	BTL 1	Remember	CO5
6.	Name any four simulation software packages that can be used for electrical drives.	BTL 1	Remember	CO5
7.	Give the real and reactive power equations of a balance 5 phase ac system.	BTL 4	Understand	CO5
8.	List the advantages of closed loop speed control.	BTL 1	Remember	CO5
9.	Discuss the role of current limiter in the closed loop control of DC drives.	BTL 4	Understand	CO5
10.	When can a synchronous motor be load commutated?	BTL 1	Remember	CO5
11.	Name any four simulation packages that can be used for electrical drives	BTL 4	Analysis	CO5
12.	Show the transfer function of DC motor load system.	BTL 5	Apply	CO5
13.	Show the mechanical and electrical time constant of DC machines.	BTL 5	Apply	CO5
14.	Explain how speed feedback achieved in speed controller design?	BTL 4	Analysis	CO5
15.	Explain armature voltage control.	BTL 4	Analysis	CO5
16.	What are the modes of adjustable frequency control in synchronous motor drives?	BTL 5	Evaluate	CO5
17.	Draw and label the basic block diagram of closed loop control system.	BTL 1	Remember	CO5
18.	What is the design procedure for a closed loop speed control system?	BTL 6	Create	CO5
19.	Write the transfer function expression for speed controller	BTL 5	Evaluate	CO5
20.	Compose the disadvantages of phase controlled converter fed DC motor drives.	BTL 6	Create	CO5
21.	Give the transfer function relating speed and armature current of a dc motor.	BTL 1	Remember	CO5
22.	List the functions of feedback loops in an electrical drive.	BTL 2	Understand	CO5

23.	Give the factors to be considered for the selection of controller.	BTL 2	Understand	CO5
24.	List the factors controlling the speed of dc motor.	BTL 5	Evaluate	CO5
	PART - B			
1.	Derive and explain from basic principles the transfer function for separately excited DC motor load system with converter fed armature voltage control. (13)	BTL 5	Evaluate	CO5
2.	Explain the closed loop operation of armature voltage control method and field weakening mode control for Dc drive. (13)	BTL 4	Analysis	CO5
3.	(i) Discuss the design procedure for current controller of an electric drive. (7) (ii) Mention the factors involved in converter selection and equations involved in controller characteristics. (6)	BTL 1	Remember	CO5
4.	Give the design procedure for speed controller of an electrical drive system with necessary diagrams. (13)	BTL 6	Create	CO5
5.	Discuss the use of simulation software package for design of controller for drives (13)	BTL 1	Remember	CO5
6.	List the factors involved in converter selection and equations involved in controller characteristics. (13)	BTL 1	Remember	CO5
7.	A 50KW, 440V, 1700 rpm separately excited DC motor is controlled by a converter. The field current is maintained at If=1.4A and the machine back EMF constant is Kv=.91VA rad/sec.The armature resistance is Rm=0.1Ω and thev is constriction constant is B=0.5Nm/rad/sec. The amplification of the speed sensor is K1=95mV/rad/sec and the gain of the power controller is K4=100. Calculate (i)The reference voltage Vr to drive the motor at the rated speed. (7) (ii)If the reference voltage is kept unchanged, determine the speed at which the motor develops rated torque. (6)	BTL 5	Apply	CO5
8.	Describe the current controller design using (i)P controller (6) (ii)PI controller for a separately excited dc motor drive systems. (7)	BTL 1	Remember	CO5
9.	Design a speed controller Dc motor drive maintaining the field flux constant. The motor parameters and ratings are as follows. 440V, 8.5A, 1470 rpm, Ra = 4Ω, J = 0.0607 kg-m4, La = 0.074H,Bt = 0.0869 Nm/rad/sec, Kb = 1.46V/rad/sec The converter is supplied from 450V, 5phase AC at 60 Hz. The converter is linear and its maximum control input voltage is ±10 V. The tacho generator has the transfer function Gw(s) =(0.065)/(1+0.004s).The speed reference voltage has a maximum of 10V. The maximum current permitted in the motor is 40A. (13)	BTL 4	Understand	CO5

10.	Using suitable block diagram explain the following control (i)Current limit control (ii)Closed loop torque control (iii)Closed loop speed control. (13)	BTL 4	Analysis	CO5
11.	(i)Derive the transfer function of DC Motor-load system with armature voltage control. (7) (ii)How do you select the rating of the converter based on the drive application? (6)	BTL 4	Understand	CO5
12.	(i)Write in detail about the design of controller. (6) (ii)Derive the closed loop transfer function of Dc motor with current feedback. (7)	BTL 5	Apply	CO5
13.	Derive the transfer function of separately excited dc motor with armature voltage control. (13)	BTL 4	Analysis	CO5
14.	Design the speed controller of converter fed separately excited dc motor with inner current control and outer speed control loops. (13)	BTL 4	Understand	CO5
15.	Design a current controller for a small capacity constant speed drive.	BTL 6	Creating	CO5
16.	Explain the step by step procedure of design of speed controller for closed loop control of separately excited de motor with armature voltage control.	BTL 5	Apply	CO5
17.	Explain the design procedure and derive the transfer function of the current controller.	BTL 5	Apply	CO5
	PART – C			
1.	Design a current controller for small capacity constant speed drive. (15)	BTL 5	Evaluating	CO5
2.	Explain the design procedure and derive the transfer function of the Speed and Current controller. (15)	BTL 6	Creating	CO5
3.	Summarize the factors involved in converter selection and equations involved in controller characteristics. (15)	BTL 5	Evaluating	CO5
4.	Derive the transfer function of DC motor load system with Converter fed system. (15)	BTL 6	Creating	CO5
5.	Explain in detail the design of speed controller of closed loop speed control system of separately excited dc motor. (15)	BTL 5	Evaluating	CO5

Course Outcomes:

Cos	Course Outcome
CO1	Ability to understand drive characteristics.
CO2	Ability to understand chopper fed drive.
CO3	Ability to understand induction motor drives.
CO4	Ability to understand synchronous motor drives.
CO5	Ability to understand design of controllers for drives.