INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK

Course Name	:	**Static Drives**
Course Code	:	**A60225**
Class	:	**III-B.TECH II SEM**
Branch	:	**EEE**
Year	:	**2017 – 2018**
Course Faculty	:	**Mr. P Shiva Kumar, Assistant Professor**

OBJECTIVE:

This course is an extension of power electronics applications to AC and Dc drives. Control of DC Motor drives with single phase and three phase converters and choppers are given in detail. The control of AC motor drives with variable frequency converters and variable voltage are presented.

UNIT-I			
CONTROL OF DC MOTORS THROUGH PHASE CONTROLLED RECTIFIERS			
PART - A (SHORT ANSWER TYPE QUESTIONS)			
S. No	**Question**	**Blooms Taxonomy Level**	**Course Outcome**
1	What is meant by electrical drives?	Understand	1
2	What are the advantages of electric drives?	Remember	1
3	What are the functions performed by electric drives?	Remember	1
4	List the parts of electrical drives.	Remember	1
5	list the applications of electrical drives	Remember	1
6	What are the requirements of an electric drive?	Remember	1
7	Mention the different factors for the selection of electric drives?	Understand	1
8	What are the advantages of three phase controlled converter fed DC Drives?	Remember	1
9	What are the advantages of single phase controlled fed DC Drives?	Remember	1
10	Write output voltage equations for single phase controlled converters and three phase controlled converters	Remember	2
11	A separately excited dc motor is required to be controlled from a 3-phase source for operation in the first quadrant only. The most preferred converter	Remember	2

	would be		
12	List out the drawbacks of rectifier fed DC drive.	Understand	3
13	Draw the block diagram of a drive system	Remember	1
PART - B (LONG ANSWER QUESTIONS)			
1	Derive an expression relating speed and torque of a single phase full converter fed separately excited DC motor drive operating in the continuous current mode	Understand	1
2	Describe the operation of single phase fully controlled rectifier control of DC series motor and obtain the expression for motor speed for continuous mode of operation	Understand	1
3	Describe the operation of single phase semi controlled rectifier control of DC series motor and obtain the expression for motor speed for continuous mode of operation	Understand	1
4	Describe the operation of single phase Semi controlled rectifier control of DC separately excited motor and obtain the expression for motor speed for continuous mode of operation	Understand	1
5	Explain the use of freewheeling diode in the converter fed DC drives. Take an example of 1-phase fully controlled converter fed for explanation. How it is going to affect the machine performance.	Understand	1
6	What are the advantages of three phase drives over single phase drives	Understand	1,2
7	Explain the motoring and braking operation of three phase fully controlled rectifier control of dc separately excited motor with aid of diagrams and waveforms. Also obtain the expression for motor terminal voltage speed.	Understand	2
8	Explain the operation of three phase full controlled rectifier fed dc series motor drives with waveforms and characteristics	Understand	2
9	Explain the operation of three phase half controlled rectifier fed dc series motor drives with waveforms and characteristics	Understand	2
10	Explain the operation of three phase half controlled rectifier fed dc separately excited DC motor drives with waveforms and characteristics	Understand	2
11	Derive an expression for an average output voltage of a 1-phase semi-converter. Assuming a very highly inductive load, draw the waveforms of output voltage, load current and voltage across thyristors	Understand	3
12	Compare three phase drives and single phase drives	Remember	1, 2
13	A single phase fully controlled thyristor converter is supplying a DC separately excited DC motor. Draw the neat waveforms diagrams and explain various operating modes of the drive Both in motoring and regenerative braking for (a) $\gamma < \alpha$ (b) $\gamma > \alpha$ Where α is the firing angle, γ is the angle at which the source voltage equal to the motor back emf. Assume the armature of the separately excited dc motor can be replaced by simple R-L and back emf load	Understand	3
PART - C (ANALYTICAL QUESTIONS)			
1	The speed of a 15hp, 220V, 1000 rpm dc series motor is controlled using a single-phase half controlled bridge rectifier. The combined armature and field resistance is 0.2 Ω. Assuming continuous and ripple free motor current and speed of 1000 rpm and K=0.03 Nm/Amp2 determine a) motor current, b) motor torque for a firing angle $\alpha=30°$ AC source voltage is 250 V.	Understand	3

2	A 1ϕ semi converter is operated from 220 V, 50 Hz supply. it is used for controlling the speed of a separately excited dc motor whose armature resistance is negligible. When the firing angle is 60° the motor is rotating at a speed of 800 rpm. The armature is coupled to constant torque load. The firing angle for a speed of 600 rpm is	Understand	3
3	A single phase full converter connected to 220 V, 50 Hz at supply is supplying power to a dc series motor. The combined armature resistance and field resistance is 0.5 Ω. The firing angle os the converter is 45°. The back emf is 100 V. The average current drawn by the motor is	Understand	3
4	A 220 V, 1500 rpm, 10 A separately excited dc motor has an armature resistance of 1 Ω. It is fed from a single phase full converter with an ac source voltage of 230 V, 50 Hz. The motor emf constant is 1.337 N-m/A. Assume continuous load current at the firing angle of 30° and torque of 5 N-m, the motor speed is	Understand	3
5	A 220 V, 1000 rpm, 60 A separately excited dc motor has an armature resistance of 0.1 Ω. It is fed from a single phase full converter withan ac source voltage of 230 V, 50Hz. Assuming continuous conduction. For 600 rpm and rated torque, the firing angle is	Understand	3
6	The speed of a separately excited dc motor is controlled by means of a 3 phase semi converter from a 3 phase, 415V, 50 Hz supply. The motor constants are inductance 10mH; resistance 0.9Ω and armature constant 1.5V-sec/rad. Calculate the speed of this motor at a torque of 50N-M when the converter is fired at 45 degrees.	Understand	3
7	The speed of a 10hp, 230V, 1000rpm dc series motor is controlled using a three phase fully controlled converter. The combined armature and field resistance is 0.2Ω. Assuming continuous and ripple free motor current and speed of 1000rpm and k=0.03Nm/A^2, determine a) motor current b) motor torque for a firing angle α=30^0. Ac voltage is 250V. Derive the formula used.	Understand	3
8	A 600V, 1500rpm, 80A separately excited dc motor is fed through a three-phase semi converter from 3-phase400supply. Motor armature resistance is 1 Ω the armature current assumed constant. For a firing angle of 45^0 at 1200rpm ,compute the rms value of source and thyristor currents, average value of thyristor current and the input supply power factor	Understand	3
9	A 100kW, 500 V, 2000 rpm separately excited dc motor is energized from 400 V, 50Hz, 3-phase source through a 3-phase full converter. The voltage drop in conducting thyristors is 2V. The dc motor parameters are as under: Ra =0.1Ω,Km=1.6V-s/rad, La=8mH. Rated armature current=21A. No-load armature current =10% of rated current. Armature current is continuous and ripple free. a) Find the no-load speed at firing angle of 30^0 b) Find the firirng angle for a speed of 2000 rpm at rated armature current. Determine also the supply power factor.	Understand	3
10	A 230V, 1500 rpm, 20A separately excited dc motor is fed from 3-phase full converter. Motor armature resistance is 0.6 Ω. Full converter is connected to 400V, 50Hz source through a delta-star transformer. Motor terminal voltage is rated when converter firing angle is zero. Calculate the transformer phase turns-ratio from primary to secondary	Understand	3
UNIT – II			
FOUR QUADRANT OPERATION OF DC DRIVES THROUGH DUAL CONVERTERS			
PART - A (SHORT ANSWER TYPE QUESTIONS)			
1	What is meant by regenerative braking?	Remember	5

2	What is meant by dynamic braking?	Remember	5
3	What is meant byplugging?	Remember	5
4	Which braking is suitable for reversing the motor?	Remember	5
5	Define four quadrant operations.	Remember	4
6	Mention different types of braking methods.	Remember	5
7	What are the advantages of closed loop control of dc drives?	Remember	4
8	What are the advantages of Dual converters?	Understand	6
9	which type of applications regenerative braking is more useful?	Understand	5
10	List the advantages of closed loop operation.	Remember	4
11	What are the conditions for the operation of motor in regenerative braking	Remember	5
12	Define counter current braking	Remember	5
13	What is the operation of converter in third and fourth quadrants	Remember	5
14	What is the operation of converter in first and second quadrants	Remember	5
PART - B (LONG ANSWER QUESTIONS)			
1	What is a dual converter? Explain the principle of operation of a dual converter in a circulating current mode. How the same is used for speed control of DC drive	Understand	6
2	What is 4-quadrant operation and explain with converters.	Understand	6
3	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.	Understand	5
4	Draw the circuit diagram and explain the operation of closed loop speed control with inner-current loop and field weakening.	Understand	4
5	Explain how four-quadrant operation is achieved by dual converter each of 3ϕ full wave configuration for DC separately excited motor.	Understand	4
6	Distinguish between circulating current and non-circulating current mode of operation.	Understand	6
7	Explain the principle of closed-loop control of a DC drive using suitable block diagram.	Understand	4
8	Draw and explain the torque-speed characteristics for dynamic braking operation of DC series motor. Why torque becomes zero at finite speed	Understand	5
9	With a neat diagram, explain the operation of a DC drive in all four quadrants when fed by a single phase dual converter with necessary waveforms and characteristics.	Understand	6
10	What are the advantages of electric braking over mechanical braking of DC motors? Explain with proper circuit diagram speed-torque characteristics of DC motor dynamic braking, for the following types Separately excited DC motor Series motor	Understand	5
11	Explain how four-quadrant operation is achieved by dual converter each of 1ϕ full wave configuration for DC separately excited motor.	Understand	6

12	Describe the operation of dual converter with circulation current mode	Understand	6
13	Describe the operation of dual converter with non-circulation current mode	Understand	6
PART - C (ANALYTICAL QUESTIONS)			
1	A 220V, 970rpm, 100A DC separately excited motor as an armature resistance of 0.05ohm. It is braked by plugging from an initial speed of 1000rpm. Calculate Calculate the resistance to be placed in armature circuit to limit breaking current to twice the full load value. Breaking torque and Torque when the speed has fallen to zero.	Understand	5
2	A 200V, 100A DC series motor runs at 1000rpm is operated under dynamic breaking at twice the rated torque and 800rpm. The resistance of armature and field winding is 0.1 ohm. Calculate the value of breaking current and resistance.	Understand	5
3	A 200V, 1500rpm, 50A separately excited motor with armature resistance of 0.5 ohm is fed from a circulating current dual converter with AC source voltage 165V. Determine converter firing angle for the following operating points i) Motoring operation at rated motor torque and 1000rpm. ii) Braking Operation at rated motor torque and 1000rpm	Understand	5
4	A220V DC series motor runs at 1200 rpm and takes an armature current of 100 A when driving a load with a constant torque. Resistances of the armature and field windings are 0.05 Ω each. DC series motor is operated under dynamic braking at twice the rated torque and 1000 rpm. Calculate the value of braking current and resistor. Assume linear magnetic circuit.	Understand	5
5	A 220V, 200A, 800 rpm dc separately excited motor has an armature resistance of 0.05Ω. The motor armature is fed from a variable voltage source with an internal resistance of 0.03 Ω. Calculate internal voltage of the variable voltage source when the motor is operating in regenerative braking at 80% of the rated motor torque and 600rpm.	Understand	4
6	A 220V, 750 rpm, 200A separately excited motor has an armature resistance of 0.05 Ω. Armature is fed from a three phase non-circulating current dual converter consisting of fully controlled rectifiers A and B. Rectifier A provides motoring operation in the forward direction and rectifier Vin reverse direction. Line voltage of ac source is 400V. Calculate firing angles of rectifiers for the following assuming continuous conduction. Motoring operation at rated torque and 600rpm. Regenerative braking operation at rated torque and 600 rpm.	Understand	6
7	Discuss in detail counter current and dynamic braking operations of DC shunt motors	Understand	5
8	Electrical braking of series motor is not straight forward as that of a separately excited DC motors – Justify	Understand	4
9	A230 V,1000rpm, 105 A separately excited dc motor has an armature resistance of 0.06 Ω. Calculate the value of flux as a percent of rated flux for motor speed of 1500 rpm when load is such that the developed motor power is maintained constant at rated value for all speeds above rated speed	Understand	5
10	Speed of a dc series motor coupled to a fan load is controlled by variation of armature voltage. When armature voltage is 400V, motor takes 20 A and the fan speed is 250 rpm. The combined resistance of armature and field is 1.0 Ω. Calculate Motor armature voltage for the fan speed of 350 rpm. Motor speed for the armature voltage of 250V	Understand	5

UNIT – III			
CONTROL OF DC MOTORS BY CHOPPERS			
PART - A (SHORT ANSWER TYPE QUESTIONS)			
1	Mention different types of control strategies for choppers.	Understand	7
2	Define time ratio control.	Understand	7
3	Define current limit control.	Remember	7
4	Classify the choppers based on voltage level.	Remember	8
5	Classify the choppers based on quadrant operations.	Remember	8
6	Define constant frequency control.	Remember	7
7	Define variable frequency control.	Understand	7
8	Draw the circuit of Type-A Chopper drive.	Remember	8
9	What is dynamic braking in Choppers?	Remember	9
10	Draw the circuit of four quadrant chopper drive.	Remember	9
11	Write the output voltage equations for step down and step up choppers.	Remember	8
12	Which chopper drive regenerative braking occurs?	Remember	9
13	What is duty ratio?	Remember	7
14	Define regenerative braking?	understand	8
15	List types of control strategies of Dc chopper?	Remember	9
16	List the classifications of choppers?	understand	7
17	Draw the diagram of two quadrant type B chopper Drives	Remember	8
18	Draw the diagram of four quadrant chopper drives	understand	9
19	Draw the diagram of two quadrant chopper drives	understand	8
PART - B (LONG ANSWER QUESTIONS)			
1	Deduce the mathematical expression for minimum and maximum currents for a class A chopper operated DC motor with back emf.	Understand	8
2	Discuss with the suitable diagrams I quadrant and II quadrant choppers.	Understand	8
3	Distinguish between class A and class B choppers with suitable examples of speed control of motors	Understand	8
4	List the advantages offered by DC chopper drives over line commutated converter controlled DC drives.	Understand	8
5	Explain the operation of the two quadrant chopper fed DC drive system	Understand	9

6	Draw the diagram of regenerative chopper fed separately excited DC motor drive.	Remember	9
7	Describe the working of a single quadrant chopper fed DC series motor drive	Understand	8
8	Explain the different types of control strategies of DC chopper.	Understand	7
11	Describe the operation of type –B chopper with neat circuit and waveforms	Understand	8
12	Describe the operation of type –C chopper with neat circuit and waveforms	Understand	8
13	Describe the operation of type –D chopper with neat circuit and waveforms	Understand	8
14	Explain regenerative braking of DC series motor by chopper control	Understand	8
15	Explain dynamic braking of DC series motor by chopper control	Understand	8
16	Write short notes on Motoring control of series motor	Understand	8
17	Explain the operation of four quadrant DC chopper drive	Understand	8
18	Explain regenerative braking and dynamic braking of separately excited DC motor by chopper control	Understand	8
PART - C (ANALYTICAL QUESTIONS)			
1	A DC series motor is fed from 600V DC source through a chopper. The DC motor has the following parameters. Ra = 0.04 ohm, Rs = 0.06 ohm, k=$4x10^{-3}$ NM/A^2. Average armature current of 300A is ripple free. For a chopper duty cycle of 60% determine (a) input power from the source, (b) Motor speed and (c) Motor torque.	Understand	8
2	The chopper used for on-off control of a DC separately excited motor has supply voltage of 230V DC and on-time of 10ms and off-time of 15ms. Assuming continuous conduction calculate the average load current when the motor speed is 1500rpm and has a voltage constant of 0.5V-sec/Rad and the armature resistance is 3 ohm.	Understand	8
3	A DC chopper is used to control the speed of a separately excited DC motor. The DC supply voltage is 220V, armature is 0.2 ohm and motor constant is 0.08V/rpm. This motor drives a constant torque requiring an average armature current of 25A. Determine the (a) the range of speed control, (b) the range of duty cycle.	Understand	8
4	A DC chopper is used for regenerative breaking of a separately excited DC motor. The supply voltage is 400V. The motor has Ra=0.2 ohm, k=1.2V-Sec/Rad. The average armature current during regenerative breaking is kept constant at 300A with negligible ripple. For a duty cycle of 60% determine i) Power returned to the DC supply Min and Max permissible breaking speeds	Understand	8
5	A d.c. series motor, fed from 400 V dc source through a chopper, has the following parameters. Ra = 0.05 Ω, Rs = 0.07 Ω, k = 5* 10-3 Nm/amp2 The average armature current of 200a ripple free. or a chopper duty cycle of 50%. Determine Input power from the source and ii) Motor speed	Understand	8

6	A chopper used for ON and OFF control of a dc separately excited motor has supply voltage of 230V$_m$ T$_{on}$ = 10ms, T$_{off}$ = 15ms. Neglecting armature inductance and assuming continuous conduction of motor current, Calculate the average load current when the motor speed is 1500 rpm, has a voltage constant Kv = 0.5 V/rad/sec. The armature resistance is 2 Ω.	Understand	8
7	A dc chopper is used to control the speed of a separately excited dc motor. The dc voltage is 220 V, R$_a$ =0.2 Ω and motor constant K$_e$φ = 0.08 V/rpm. The motor drives a constant load requiring an average armature current of 25 A. Determine The range of speed control The range of duty cycle, Assume – continuous conduction	Understand	8
8	A 230V, 960 rpm and 200 A separately excited dc motor has an armature resistance of 0.02 Ω. Calculate the duty ratio of the chopper for motoring operation at rated torque and 350 rpm	Evaluate	8
9	A 220V, 24A, 1000 rpm, separately excited DC motor having an armature resistance of 2 Ω 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 500 rpm	Understand	8
10	A DC chopper controls the speed of DC series motor. The armature resistance Ra = 0.04 Ω, field circuit resistance Rf = 0.06 Ω, and back emf constant K$_v$ = 35M v/RAD/SEC. The DC input voltage of the chopper V$_s$ = 600V. If it is required to maintain a constant developed torque of Td = 547 N-m, plot the motor speed against the duty cycle K of the chopper.	Understand	8
11	A 230v, 1200rpm ,15A separately excited 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. Calculate duty ratio of chopper for motor speed of 1000rpm and braking torue equal to 1.5 times rated motor torque.	Understand	8
12	A 230v, 1200rpm, 15A separately excited 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. What wii be the motor speed for duty ratio of 0.5 and motor torque equal to 1.5 times rated motor torque.	Understand	8
UNIT - IV			
SPEED CONTROL OF INDUCTION MOTORS			
PART - A (SHORT ANSWER TYPE QUESTIONS)			
1	What are advantages of induction motor?	Remember	10
2	What are the applications of slip ring induction motor?	Understand	10
3	Define rotor current frequency	Remember	12
4	Draw the equivalent circuit of an induction motor	Remember	10
5	What are the advantages of variable frequency control?	Remember	11
6	What are the disadvantages of variable frequency control?	Remember	11
7	What are the limitations of v/f control?	Remember	10, 11
8	What is constant torque mode operation?	Understand	11
9	What are the different types of rotor resistances control in induction motor	Remember	12

10	Draw the speed torque characteristics of rotor resistances control	Remember	12
11	Draw the speed torque characteristics of induction motor	Understand	10
12	What are the applications of variable frequency drives?	Remember	11
13	What are the types of slip power recovery system	Remember	12
14	What are the advantages of Kramer system	Remember	12
15	What are the advantages of static scherbius drive	Remember	12
PART - B (LONG ANSWER QUESTIONS)			
1	Why stator voltage control is an inefficient method of induction motor speed control	Understand	10
2	Constant torque loads are not suitable for AC voltage controller fed induction motor drive. Why?	Understand	10
3	Using 3-phase solid state AC voltage controllers explain clearly how it is possible to achieve 4-quadrant operation of 3-phase induction motors	Understand	10
4	Draw a closed loop block diagram for the above speed control technique. Mention the merits of the above method of speed control	Remember	10
5	Explain the mechanical characteristics of a three phase induction motor with stator frequency control.	Understand	11
6	Explain in detail the speed control scheme for a three phase induction motor using PWM inverter.	Understand	11
7	Sketch the mechanical characteristics of a there phase induction motor with V/f method	Understand	11
8	Draw the speed-torque characteristics of a rotor resistance controlled induction motor and explain the effect of rotor resistance variation	Understand	12
9	Draw and explain closed loop operation for a static Kramer controlled drive	Remember	12
10	Draw and explain static scherbius drive	Understand	12
11	What happens to the performance of AC motor if the stator voltage control technique is adopted with frequency being constant	Understand	10
12	Explain how voltage and frequency are varied in voltage source inverter fed induction motor drives	Understand	11
13	In which way a static Kramer control is different from static scherbius drive	Remember	12
PART - C (ANALYTICAL QUESTIONS)			
1	A three phase SCIM drives a blower type load. No load rotational losses are negligible. Show that rotor current is maximum when the motor runs at a slip of 1/3. Find also an expression for maximum rotor current	Understand	11
2	If three phase SCIM runs at a speed of (i) 1455rpm (ii) 1350rpm, determine the maximum current in terms of rated current at these speeds. The induction motor drives a fan and no load rotational losses are ignored.	Understand	10
3	A 3-phase, 400V, 50Hz, 4-pole, 1440 rpm delta connected squirrel cage induction motor has a full load torque of 48.13 N-m. Motor speed is controlled by stator voltage control. When driving a fan load it runs at rated speed at rated voltage. Calculate the motor torque at 1200rpm.	Understand	10

4	A 400V, 50Hz, 3-phase squirrel cage induction motor develops full load torque at 1470 rpm. If supply voltage reduces to 340 V, with load torque remaining constant, calculate the motor speed. Assume speed torque characteristics of the motor to be linear in the stable region. Neglect stator resistance.	Understand	10
5	A 3-ph 20KW, 4-pole, 50Hz, 400V delta connected induction motor has the following parameters per phase R1=0.6 ohm, R2=0.4 ohm, X1=X2=1.6 ohm. If magnetizing reactance is neglected and operated at 200V, 25Hz with DOL starting. Calculate the current and power factor at the instant of starting and under the maximum torque conditions. Compare the results	Understand	11
6	A 400V, 4 pole, 50Hz, 3-ph star connected induction motor has R_1=0, X_1=X_2=1 ohm, R_2=0.4 ohm, X_m=50 ohm. This induction motor is fed from a constant voltage source of 231V/ph and (ii) a constant current source of 28A. for both parts (i) & (ii) calculate Slip for maximum torque Starting and maximum torques. The supply voltage required to sustain the constant current at the maximum torque.	Understand	11
7	A three phase squirrel cage induction motor is developing torque of 1500 synchronous watts at 50 Hz and 1440 rpm (synchronous speed is 1500 rpm). If the motor frequency is increased to 75Hz using constant power mode, determine the new value of torque developed by the motor at constant slip.	Understand	11
8	At 50 Hz the synchronous speed and full load speed are 1500 rpm and 370 rpm respectively. Calculate the approximate value speed for a frequency of 30 Hz and 80% of full load torque for inverter fed induction motor drive.	Understand	11
9	**A** 440V, 50Hz, 6 pole star connected wound rotor motor has the following parameters. R_S=0.5 ohm, R'r=0.4 ohm, X_S=X_r'=1.2 ohm, Xm=50 ohm, stator to rotor turns ratio is 3.5. Motor is controlled by static rotor resistance control. External resistance is chosen such that the breakdown torque is produced at standstill for a duty ratio of zero. Calculate the value of external resistance. How duty ratio should be varied with speed so that the motor accelerates at maximum torque.	Understand	12
10	**A** 440V, 50Hz, 6 pole, 970rpm star connected 3-ph wound rotor motor has the following parameters referred to stator. Rs=0.1 ohm, R'r=0.08 ohm, Xs=0.3 ohm, Xr'=0.4 ohm, stator to rotor turns ratio is 2. Motor speed is controlled by static scherbius drive. Drive is designed for a speed range of 25% below the synchronous speed. Max. value of firing angle 165 deg, calculate (i) transformer turns ratio, (ii) torque for a speed of 780rpm and α=140 deg.	Understand	12
UNIT - V			
CONTROL OF SYNCHRONOUS MOTORS			
PART - A (SHORT ANSWER TYPE QUESTIONS)			
1	Write torque equation of synchronous motor	Remember	13
2	What are the different methods for variable frequency control in synchronous motor	Remember	13
3	What are the advantages of voltage source inverter	Remember	14
4	What are the advantages of current source inverter	Remember	15
5	What are the possible methods to provide variable voltage variable frequency to synchronous motor fed from VSI	Remember	14
6	What is square wave inverter	Remember	14
7	What is PWM inverter	Remember	14

8	What is chopper with square wave inverter	Remember	13
9	Define torque angle	Remember	13
10	What is the advantage of constant margin angle control	Remember	13
11	What are the factors effecting speed of synchronous motor?	Remember	13
12	What are the advantages of cyclo converter drives?	Remember	13
13	What are the applications of cyclo converter drives?	Remember	13
PART - B (LONG ANSWER QUESTIONS)			
1	Draw the block diagram of a closed loop synchronous motor drive fed from VSI and explain	Remember	14
2	Describe the open-loop and closed loop methods of speed control of a synchronous motor using VSI	Understand	14
3	Discuss the VSI method of speed control of synchronous motor describe the operation of the converter with waveforms.	Remember	14
4	How is the output voltage of a VSI improved by PWM techniques? Explain how you will use this converter for speed control of a synchronous motor.	Remember	14
5	Describe self-controlled and a loop commutated inverter controlled synchronous motor drives in detail and compare them	Understand	13
6	Describe separate controlled mode and self-controlled mode of operation of a synchronous motor drive in detail and compare them	Understand	13
7	Explain how three phase synchronous motor fed by a three phase inverter can be making to behave like a simple dc motor. Hence is it proper to call them as a commutator less DC motor	Understand	14
8	Explain the operation of a open loop V/f control of multiple synchronous motor with schematic diagram	Understand	13
9	Describe the converter used for low frequency high power synchronous motor drives with relevant waveforms.	Understand	15
10	a) Derive the torque equation of synchronous b) What is the necessary of damper winding	Understand	13
11	Describe cyclo converter fed synchronous motor with neat diagrams	Understand	13
12	Compare VSI and CSI fed drives	Understand	14,15
PART - C (ANALYTICAL QUESTIONS)			
1	A 500KW, 3-ph, 3.3KV, 50Hz, 0.8(lag) pf, 4 pole star connected synchronous motor has a following parameters. Xs=15 ohm, Rs=0, rated field current is 10A calculate (i) Armature current and pf at half the rated torque and rated field current (ii) Field current to get upf at the rated torque.	Understand	13
2	A 6MW, 3-ph, 11KV,Y connected, 6 pole, 50Hz, 0.9(lead) pf synchronous motor has Xs=9ohm, Rs=0, rated field current is 50A. Machine is controlled by variable frequency control at constant V/F ratio upto the base speed and at constant V above base speed determine the Torque and field current for the rated armature current, 750rpm and 0.8 leading pf.	Understand	13

3	A 6MW, 3-ph, 11KV,Y connected, 6 pole, 50Hz, 0.9(lead) pf synchronous motor has Xs=9ohm, Rs=0, rated field current is 50A. Machine is controlled by variable frequency control at constant V/F ratio upto the base speed and at constant V above base speed determines the armature current and power factor for half the rated motor torque, 1500rpm and rated field current.	Understand	13
4	A3 phase, 400V, 50Hz, 6 pole, star connected round-rotor synchronous motor has Z_S=0+j2Ω. Load torque, proportional to speed squared, is 340N- m at rated synchronous speed. The speed of the motor is lowered by keeping V/f constant and maintaining unity Pf by field control of the motor. For the motor operation at 600rpm, calculate a) supply voltage b) armature current.	Understand	14
5	A 6MW, 3-phase, 11KV, star connected, 6-Pole, 50Hz, 0.9 (leading) power factor synchronous motor has Xs = 8 Ω and Rs = o. Rated field current is 45A. Machine is controlled by variable frequency control at constant (v/f) ratio up to the base speed and at constant V above base speed. Determine, i) Torque and field current for the rated armature current, 700 rpm and 0.58 leading power factor. ii) Armature current and power factor for half the rated motor torque, 1400 rpm and rated field current,	Understand	14
6	A 6MW, 3-phase, 11KV, star connected, 6-Pole, 50Hz, 0.9 (leading) power factor synchronous motor has Xs = 8 Ω and Rs = o. Rated field current is 45A. Machine is controlled by variable frequency control at constant (v/f) ratio up to the base speed and at constant V above base speed. Determine, i) Armature current and power factor for regenerative braking power output of 4.2MVA at 700 rpm and rated field current, ii) Torque and field current for regenerative braking operation at rated armature current, 1400 rpm and unity power factor	Understand	14
7	A synchronous motor is controlled by a load commutated inverter, which in turn is fed from a line commutated converter. Source voltage is 6.6kV, 50Hz. Load commutated inverter operates at a constant firing angle α1 of 130.º and when rectifying $\alpha\gamma = 0^{o}$ dc li nk inductor resistance Rd = 0.2 Ω. Drive operates in self control mode with a constant (V/f) ratio. Motor has the details; 8MV, 3 phase 6600V, 6pole, 50Hz unity power factor, star connected, Xs = 2.6 Ω, Rs = o. Determine source side converter firing angles for the following i) Motor operation at the rated and 500rpm. What will be the power developed by motor	Understand	15
8	A synchronous motor is controlled by a load commutated inverter, which in turn is fed from a line commutated converter. Source voltage is 6.6kV, 50Hz. Load commutated inverter operates at a constant firing angle α1 of 130.º and when rectifying $\alpha\gamma = 0^{o}$ dc link inductor resistance Rd = 0.2 Ω. Drive operates in self control mode with a constant (V/f) ratio. Motor has the details; 8MV, 3 phase 6600V, 6pole, 50Hz unity power factor, star connected, Xs = 2.6 Ω, Rs = o. Determine source side converter firing angles for the following i) Regenerative braking operation at 600 rpm and rated motor current. Also calculate power supplied to the source	Understand	15
9	A3 phase, 400V, 50Hz, 6 pole, star connected round-rotor synchronous motor has Z_S=0+j2Ω. Load torque, proportional to speed squared, is 340N-m at rated synchronous speed. The speed of the motor is lowered by keeping V/f constant and maintaining unity Pf by field control of the motor. For the motor operation at 600rmp, a) Excitation angle b) load angle c) the pull-out torque. Neglect rotational losses	Understand	13

10	A synchronous motor is controlled by a load commutated inverter, which in frorn is fed from a line commutated converter,. Source voltage is 606KV, 50Hz. Load commutated inverter operates at a constant firing angle α of 140^{o} and when rectifying $\alpha = 0^{o}$ dc link inductor resistance Rd = 0.1Ω. Drive operates in self control mode with a constant (V/f) ratio. Motor hs the details; 8MW, 3-phase, 6600V, 6pole, 50Hz, unity power factor, star connected, Xs = 2.8Ω Rs = 0. Determine source side converter firing angles for the following.	Understand	14

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