ST. ANNE'S COLLEGE OF ENGINEERING AND TECHNOLOGY
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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK

EE 3009 - SPECIAL ELECTRICAL MACHINES

V SEMESTER

Prepared by

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK

Subject Code & Name: EE 3009 - Special Electrical Machines
Semester/ Year : V / III

UNIT I - STEPPER MOTORS				
Constructional features –Principle of operation –Types – Torque predictions – Linear Analysis – Characteristics – Drive circuits – Closed loop control – Applications.				
1	What is stepper motor?	BTL 4	Analyze	CO2
2	Define step angle.	BTL 1	Remember	CO2
3	Define slewing.	BTL 4	Analyze	CO2
4	Classify the different types of stepping motor.	BTL 1	Remember	CO2
6	Summarize the principle of operation of a variable reluctance stepper motor.	BTL 2	Understand	CO2
7	Distinguish the half step and full step operations of a stepper motor.	BTL 5	Evaluate	CO2
8	Generalize single stack and multi stack configurations in stepping motors.	BTL 6	Create	CO2
9	Define the terms holding and detent torques as referred to stepper motor.	BTL1	Remember	CO2
10	What is the relationship between the step number and step angle in a stepper motor?	BTL 1	Remember	CO2
11	The stepper motor has a step angle of 1.8^o and is driven at 4000rps. Determine (a) Resolution (b) Rotor speed.	BTL 5	Evaluate	CO2
12	Define torque constant of a stepper motor.	BTL 1	Remember	CO2
13	Calculate the stepping angle for a 3phase, 24 pole permanent magnet stepper motor.	BTL 3	Apply	CO2
14	Draw the block diagram of the drive system of a stepping motor.	BTL 6	Create	CO2
15	What is the function of drive circuit in stepping motor?	BTL 1	Remember	CO1
16	Name the various driver circuits used in stepped motor.	BTL 2	Understand	CO1
17	Illustrate the need of suppressor circuits in stepper motor.	BTL 3	Apply	CO1
18	State the advantages of closed loop operation of stepper motor.	BTL 3	Apply	CO1
19	What is meant by Lead angle in stepper motors?	BTL 2	Understand	CO1
20	State some applications of stepper motor.	BTL 2	Understand	CO2

Part – B				
1	Describe in detail the construction and working of variable reluctance stepper motor. (13)	BTL 1	Remember	CO2
2	Explain the construction and working principle of hybrid stepper motor with neat diagrams. (13)	BTL 4	Analyze	CO2
3	Explain the operation of single stack and multi-stack stepper motor with a neat diagram. (13)	BTL 5	Evaluate	CO2
4	Discuss the principles of operation of permanent magnet stepper motor torque Vs angle characteristics. (13)	BTL 4	Analyze	CO2
5	Draw and explain in detail the static and dynamic characteristics of stepper motor. (13)	BTL 1	Remember	CO2
6	i) Explain the mechanism of static torque production in a variable reluctance stepping motor. (7) ii) Describe the dynamic characteristics of a variable reluctance stepper motor. (6)	BTL 2	Understand	CO2
7	i) Explain with a neat diagram the multi-stack construction of stepper motors. (7) ii) A stepper motor has a resolution of 180 steps per revolution. Find the pulse rate required in order to obtain a rotor speed of 2400 rpm. (6)	BTL 6	Create	CO2
8	Explain in detail linear analysis of stepper motor. (13)	BTL 2	Understand	CO2
9	Draw and explain drive circuits and their performance characteristics for stepper motor. (13)	BTL 1	Remember	CO1
10	A stepper motor driven by a bipolar drive circuit has following parameters: Winding inductance = 30mH, rated current = 3A, DC supply = 45V, total resistance in each phase = 15ohm. When the transistors are turned off, determine the time taken by the phase current to delay to zero and the proportion of the stored inductive energy returned to the supply. (13)	BTL 4	Analyze	CO2
11	i) Explain briefly closed loop control of stepper motor. (7) ii) A single stack 3 phase variable reluctance motor has a step angle of 15°.Find the number of stator and rotor poles. (6)	BTL 2	Understand	CO1
12	Explain in detail the concept of lead angle in stepper motor. (13)	BTL 1	Remember	CO1
13	(i) What is the motor torque T_m required to accelerate an initial load of $2*10^{-4}$ kgm^2 from f_1=500 Hz to f_2=1500 Hz during 50ms. The frictional torque T_f is 0.03Nm and step angle is 1.18°. (7)	BTL 3	Apply	CO1

	(ii) Write a detailed technical note on the bipolar drives for stepper motors. (6)			
14	Enumerate the various applications of stepper motor. (13)	BTL 3	Apply	CO2
	Part-C			
1	Develop single and multi-stack configured stepping motors for mechanical clock application. (15)	BTL 6	Create	CO2
2	A Variable Reluctance stepper motor has a step angle of 3˚, Determine the following: i) Resolution. ii) Number of steps per shaft to make 10 revolutions iii)Shaft speed if stepping frequency is 2400pulse/sec. (15)	BTL 5	Evaluate	CO2
3	Recommend suitable types of stepper motor for textile mill and explain the reason with the mechanical characteristics. (15)	BTL 5	Evaluate	CO2
4	Design a suitable driver circuit which employs unipolar and bipolar wiring arrangements of stepping motor and explain. (15)	BTL6	Create	CO2
	UNIT II - SWITCHED RELUCTANCE MOTORS (SRM)			
	Constructional features –Principle of operation- Torque prediction–Characteristics -Power controllers-Control of SRM drive- Speed control-current control-design procedure- Sensor less operation of SRM-Current sensing-rotor position- estimation methods - Applications.			
1	State the principle of operation of switched reluctance motor.	BTL 1	Remember	CO3
2	List out the advantages of switched reluctance motors.	BTL 1	Remember	CO3
3	Illustrate the different modes of operation of switched reluctance motor.	BTL 3	Apply	CO3
4	Differentiate switched reluctance motor and variable reluctance stepper motor.	BTL 5	Evaluate	CO3
5	Give basic features or characteristics of Switched Reluctance motor	BTL 2	Understand	CO3
6	What are the disadvantages of a switched reluctance motor?	BTL 2	Understand	CO3
7	Give the expression for torque of a switched reluctance motor	BTL 6	Create	CO3
8	Write the relations between the speed and fundamental switching frequency	BTL 1	Remember	CO3
9	Determine the step angle of a three phase switched reluctance motor having 12stator poles and 8 rotor poles. What is the commutation frequency in each phase of 6000rpm?	BTL 4	Analyze	CO3
10	Evaluate the speed-torque characteristics of SRM.	BTL 5	Evaluate	CO3
11	List out the basic requirements of power semiconductor switching circuits employed for switched reluctance motor.	BTL 2	Understand	CO1
12	Point out the different power controllers used for the control of switched reluctance motor.	BTL 4	Analyze	CO1

13	What are the merits of classic converter or power controller in SRM?	BTL 2	Understand	CO1
14	What are the merits of Dump C – Converter?	BTL 1	Remember	CO1
15	Illustrate why SR machines popular in adjustable speed drives.	BTL 3	Apply	CO1
16	List out the advantages and disadvantages of the converter circuit with two power semiconductor devices and two diodes per phase?	BTL 1	Remember	CO1
17	What is the significance of closed loop control in switched reluctance motor?	BTL1	Remember	CO1
18	What are the two types of current control techniques?	BTL 6	Create	CO1
19	Give the advantages of sensorless operation of switched reluctance motor.	BTL 4	Analyze	CO3
20	Illustrate the applications of switched reluctance motor.	BTL 3	Apply	CO3
	Part-B			
1.	Draw the cross sectional view of switched reluctance motor and explain the principle of operation. State the advantages of switched reluctance motor. (13)	BTL 1	Remember	CO3
2.	(i) Explain the torque-speed characteristics of switched reluctance motors. (7) (ii) Derive the expressions for voltage and torque of SR machines. (6)	BTL 4	Analyze	CO3
3	i) What is the relationship between torque and current in synchronous reluctance motor? Derive the equation of torque developed in a switched reluctance motor. (7) ii) A switched reluctance motor with 8 stator poles and 6rotor poles has a stator polar arc of 30^o and rotor pole arc of 33^o. The aligned inductance is 10.5mH and unaligned inductance is 1.5mH. Saturation can be neglected. Calculate the instantaneous torque when the rotor is 30^o before the aligned position and phase current is 6A. Neglect fringing. (6)	BTL 1	Remember	CO3
4	Explain the steady state performance analysis of switched reluctance motor. (13)	BTL 5	Evaluate	CO3
5	i) Draw and explain the characteristics of switched reluctance motor in detail. (7) ii) Derive the expression of static torque in SRM. (6)	BTL 3	Apply	CO3
6	A SRM with 6 stator poles and 4 rotor poles has a stator pole arc of 30^o and rotor pole arc is 32^o. The aligned inductance is 10.7mH and unaligned inductance is 1.5mH. Saturation can be neglected. Calculate the instantaneous torque when the rotor is 30^o before the aligned	BTL 3	Apply	CO3

	position and phase current is 6A. What is the maximum energy conversion for one stroke, if the current is limited to 7A? Determine the average torque corresponding to this energy conversion. (13)			
7	Prepare the necessity of power electronic circuit in SR motor. Explain its different types of converter circuits. (13)	BTL 6	Create	CO1
8	Draw and explain four converter topologies for a three phase SRM. Write the merits and demerits of each topology. (13)	BTL 1	Remember	CO1
9	Draw a schematic diagram and explain the operation of a "C"-dump converter used for the control of SRM. (13)	BTL 4	Analyze	CO1
10	Describe the various converter topologies for a 3 phase switched reluctance motor with merits and demerits of each. Explain any two of them. (13)	BTL 2	Understand	CO1
11	(i) Describe with a neat circuit any two configuration of power converters used for the control of switched reluctance motor. (10) (ii) State the advantages of sensorless operation. (3)	BTL 2	Understand	CO1
12	Describe the closed loop control analysis of switched reluctance motor. (13)	BTL 1	Remember	CO1
13	Describe the following: (i) Role of microprocessors in control of switched reluctance motor (7) (ii) Sensorless operation. (6)	BTL 2	Understand	CO1
14	(i) Discuss the main advantages and disadvantages of switched reluctance motor. (7) (ii) Discuss the various applications of switched reluctance motor. (6)	BTL 4	Analyze	CO3
Part-C				
1.	Assess the features of rotary and linear switched reluctance motors and suggest suitable motor for bottling plant. (15)	BTL 5	Evaluate	CO3
2.	Build a suitable microprocessor based controller for switched reluctance motor. (15)	BTL 6	Create	CO3
3.	Summarize the various stages in sensorless control of SRM. (15)	BTL 5	Evaluate	CO3
4.	Plot the mechanical characteristics of SR motor and discuss the type of control strategy used for different regions of the curve. Also, draw the typical phase current waveforms. (15)	BTL 6	Create	CO3
UNIT III - PERMANENT MAGNET BRUSHLESS D.C. MOTORS				
Fundamentals of Permanent Magnets- Types- Principle of operation- Magnetic circuit analysis- EMF and Torque equations- Characteristics- Control design - Transfer function - Machine, Load and Inverter - Current and Speed Controller.				

Part-A				
1.	List the permanent magnet materials used in PMBLDC motors.	BTL 1	Remember	CO4
2.	Compare conventional DC motor and PMBLDC motor.	BTL 4	Analyze	CO4
3.	Compare PMBLDC motor with PMSM.	BTL 5	Evaluate	CO4
4.	Define permeance coefficient.	BTL 1	Remember	CO4
5.	Comment on demagnetization in PMBLDC motor.	BTL 4	Analyze	CO4
6.	Describe the principle of operation of PMBLDC motor.	BTL 2	Understand	CO4
7.	List out the different classifications of BLPM DC motor.	BTL 3	Apply	CO4
8.	Plot the magnetic equivalent circuit of PMBLDC motor.	BTL 6	Create	CO4
9.	What are the differences between mechanical and electronic commutator?	BTL 3	Apply	CO4
10.	Give the torque and emf equation of square wave brushless motor.	BTL 2	Understand	CO4
11.	Justify the statement: PMBLDC motor is called electronically commutated motor.	BTL 5	Evaluate	CO4
12.	How the demagnetization occurs in PMBLDC motor?	BTL 4	Analyze	CO4
13.	Summarize the merits of the brushless DC motor drives.	BTL 2	Understand	CO4
14.	List out the power controllers used in permanent magnet brushless DC motor.	BTL 1	Remember	CO1
15.	What are the ways by which demagnetization can be limited in permanent magnet?	BTL 1	Remember	CO4
16.	Name the position sensors that are used for PMBLDC motor.	BTL 1	Remember	CO1
17.	How are the directions of rotations reversed in PMBLDC motor?	BTL 2	Understand	CO4
18.	Sketch the ideal phase voltage and current waveform of PMBLDC machine.	BTL 6	Create	CO4
19.	A permanent magnet DC commutator motor has a stallingtorque of 2 Nm. The stall current is 5 A.Compute the motor's no-load speed if it is fed with 28 V DC supply.	BTL 3	Apply	CO4
20.	Mention some of the applications of PMBLDC motor.	BTL 1	Remember	CO4
Part-B				
1.	(i) Derive an expression for permeance coefficient of PMBLDC motor. (10) (ii) State the advantages of BLPM DC motor over conventional DC motor. (3)	BTL 2	Understand	CO4
2.	Derive the torque equation and torque ratio of permanent magnet brushless DC motor. (13)	BTL 3	Apply	CO4
3.	Explain the construction PMBLDC also compare conventional DC motor and PMBLDC motor. (13)	BTL 1	Remember	CO4

4.	(i) Elucidate in detail about the operation of PMBLDC motor with 180˚ magnet arcs and 120˚ square-wave phase currents. (7) (ii) Describe the constructional aspects of mechanical and electronic commutators of PMBLDC motors. (6)	BTL 1	Remember	CO4
5.	Discuss in detail about magnetic circuit analysis of PMBLDC motor. Also draw its characteristics. (13)	BTL 4	Analyze	CO4
6.	Derive the expression for emf and torque of a PMBLDC motor. Draw the relevant characteristics. (13)	BTL 2	Understand	CO4
7.	Explain the operation of electronic commutator in PMBLDC motor with necessary diagrams. Explain the operation of the same. (13)	BTL 4	Analyze	CO4
8.	Write a note on power controllers used for PMBLDC motor and explain the each blocks associated in it. (13)	BTL 1	Remember	CO1
9.	Discuss the hysteresis type current regulation of PMBLDCmotor with neat diagram? (13)	BTL 2	Understand	CO1
10.	Discuss the use of Hall sensors for position sensing in PMBLDC motor with necessary block diagram. (13)	BTL 6	Create	CO1
11.	(i) Explain the speed-torque characteristics of PMBLDC motor. (7) (ii) Differentiate between mechanical and electronic commutators. (6)	BTL 4	Analyze	CO4
12.	(i) A permanent magnet DC commutator motor has a no-load speed of 6000 rpm when connected to a 120 V supply. The armature resistance is 2. Ω and rotational and iron losses may be neglected. Determine the speed when the supply voltage is 60 V and the torque is 0.5 Nm. (7) (ii) Prove that the torque equation in BLDC motor is similar to that of conventional DC motor. (6)	BTL 5	Evaluate	CO4
13.	(i) Explain in detail about various types of PMBLDC motor with necessary diagrams. (7) (ii) A PMBLDC motor has torque constant of 0.12 Nm/A referred to DC supply. Find the motor's no-load speed when connected to 48 V DC supply. Find the stall current and stall torque if armature resistance is0.15 Ω/phase & drop in controller transistor is 2 V. (6)	BTL 3	Apply	CO4
14.	Explain the closed loop control scheme of a PMBLDC motor drive with a suitable schematic diagram. (13)	BTL 1	Remember	CO1
Part-C				
1.	Identify appropriate power controllers for PMBLDC motor and explain with neat diagram. (15)	BTL 5	Evaluate	CO1

2.	Develop a power semiconductor base inverter circuit for star connected PMBLDC Motor and sketch the firing sequence and phase current waveform for any mode. (15)	BTL 6	Create	CO1
3.	Select suitable sensors for position sensing in MBLDC motors and explain the operation with neat sketch. (15)	BTL 5	Evaluate	CO1
4.	Prepare the relationship between magnetising force and flux density by performing the magnetic circuit analysis of a brushless dc motor on open circuit. (15)	BTL 6	Create	CO4
UNIT IV - PERMANENT MAGNET SYNCHRONOUS MOTORS (PMSM)				
Permanent Magnet ac Machines, Machine Configurations, PMSM -Principle of operation – EMF and Torque equations - Phasor diagram - Torque speed characterisitcs - evaluation of control characteristics - design of current and speed controllers –Constructional features, operating principle and characteristics of synchronous reluctance motor.				
1.	Distinguish PM synchronous motor from BLPM DC motor.	BTL 4	Analyse	CO5
2.	List out the merits and demerits of PMSM.	BTL 1	Remember	CO5
3.	Classify the different types of PMSM.	BTL 3	Apply	CO5
4.	Express the torque and EMF equation of PMSM.	BTL 5	Evaluate	CO5
5.	Enumerate the assumptions to be made in deriving theEMF equation of PMSM.	BTL 3	Apply	CO5
6.	Briefly explain about synchronous reactance. Also write the expression for self and synchronous reactance of PMSM.	BTL 6	Create	CO5
7.	Define load angle.	BTL 1	Remember	CO5
8.	State the power controllers for PM synchronous machines.	BTL 2	Understand	CO5
9.	Describe load commutation and mention its advantages.	BTL 2	Understand	CO5
10.	Describe the features of closed loop speed control of loaded commuted inverter fed synchronous motor drive.	BTL 2	Understand	CO1
11.	Differentiate square wave and sine wave motor.	BTL 1	Remember	CO5
12.	Distinguish between self-control and vector control PMSM.	BTL 2	Understand	CO5
13.	Draw the output phasor diagram of PMSM.	BTL 4	Analyze	CO5
14.	Define synchronous reactance in PMSM.	BTL 1	Remember	CO5
15.	Explain the difference between SYNREL motor and PM synchronous motor.	BTL 4	Remember	CO5
16.	Prepare the important features of permanent magnet synchronous motor.	BTL 6	Create	CO5
17.	What is meant by slotless motor?	BTL 1	Remember	CO5
18.	Summarize the distribution factor for PMSM.	BTL 5	Evaluate	CO5
19.	Examine the Volt-ampere requirements of PMSM.	BTL 3	Apply	CO5
20.	List few applications of PMSM.	BTL 1	Remember	CO5
Part-B				

1.	Explain the construction and working principle of operation of PMSM. (13)	BTL 1	Remember	CO5
2.	For an ideal sinewave permanent magnet motor derive the torque and EMF equations. (13)	BTL 3	Apply	CO5
3.	Enumerate the design considerations of permanent magnet synchronous motor. (13)	BTL 6	Analyze	CO5
4.	Describe the construction of phasor diagram of surface magnet sinewave motor. (13)	BTL 3	Apply	CO5
5.	With necessary phasor diagram and circle diagram, describe the torque speed characteristics of PMSM. (13)	BTL 4	Analyze	CO5
6	Derive the expression for power input and torque of a PMSM. Explain how its torque speed characteristics are obtained. (13)	BTL 4	Analyze	CO5
7.	Discuss PMBLDC and PMSM with respect to torque/ampere and KVA of converter/ kW of power tomotor for 4 Pole, 3 Phase motor system. (13)	BTL 5	Create	CO5
8.	Analyze and justify, the power output of PMBLDC motor is more than PMSM for the same size. (13)	BTL 4	Analyze	CO5
9.	With necessary diagrams, discuss about various power controllers used for PMSM. (13)	BTL 2	Understand	CO1
10.	(i) Discuss the current control scheme of permanent magnetsynchronous motor in detail. (7) (ii) Derive self and mutual inductance of permanent magnet synchronous motor. (6)	BTL 2	Understand	CO1
11.	(i) What is armature reaction? Discuss its effects on PMSM. (3) (ii) Explain the concept of vector control and how it achieved in PMSM. (10)	BTL 1	Remember	CO5
12.	With a neat sketch, explain the microprocessor based speedcontrol of PMSM. (13)	BTL 1	Remember	CO5
13.	(i) Discuss in detail about various rotor configurations of permanent magnet synchronous machines. (6) (ii) With necessary block diagram explain in detail about FOC for PMSM. (7)	BTL 2	Understand	CO5
14.	(i) State the applications of PMSM. (3) (ii)Discuss in detail about Volt-ampere requirements of PMSM. (10)	BTL 1	Remember	CO5
	Part-C			
1.	A brush PM sine wave motor has an open circuit voltage of 173V at its corner point speed of 3000rpm. It is supplied from a PWM converter whose maximum voltage is 200V. Neglecting resistance and all other losses, estimate the maximum speed at which maximum current can be supplied to the motor. (15)	BTL 5	Evaluate	CO5

2.	Integrate a suitable microprocessor for the control of permanent magnet synchronous motor. (15)	BTL 6	Create	CO1
3	A 3 ϕ, 4 pole, brushless PM rotor has 36 stator slots. Each phase winding is made up of three coils per pole with 10 turns per coil. The coil span = 7 slots. Ifthe fundamental component of magnet flux is 1.8mWb. Estimate the open circuit phase emf (E_q) at 3000 rpm. (15)	BTL 5	Evaluate	CO5
4.	Clarify in detail the field oriented control of permanent magnet synchronous motor. (15)	BTL 6	Create	CO5

UNIT V-STUDY OF OTHER SPECIAL ELECTRICAL MACHINES

Principle of operation and Characteristics of Hysteresis motor-AC series motors –Linear motor- Applications.

Part - A

Q.No.	Questions	BT Level	Competence	Course Outcome
1.	List the applications of synchronous reluctance motors.	BTL 1	Remember	CO4
2.	Develop the voltage and torque characteristics of synchronous reluctance motor.	BTL 6	Create	CO4
3.	Describe in short about SYNREL motors.	BTL 2	Understand	CO4
4.	Compare synchronous reluctance motor and induction motor.	BTL 5	Evaluate	CO4
5.	Give the voltage and torque equation of synchronous reluctance motor.	BTL 2	Understand	CO4
6.	Define cogging.	BTL 4	Analyze	CO4
7.	Order the different types of synchronous reluctance motor.	BTL 4	Analyze	CO4
8.	Point out any two advantages of synchronous reluctance motors.	BTL 3	Apply	CO4
9.	Tabulate the types of rotor available in synchronous reluctance motor.	BTL 1	Remember	CO4
10.	Define reluctance torque with reference to synchronous reluctance motor.	BTL 1	Remember	CO4
11.	Show some potential applications of synchronous reluctance machine.	BTL 3	Apply	CO4
12.	What is linear synchronous speed?	BTL 1	Remember	CO4
13.	Quote the properties of linear induction motor.	BTL 1	Remember	CO4
14.	An electric train driven by a linear motor4 moves with 200km/hr when stator frequency is 100Hz.Assuming negligible slip, calculate the pole pitch of the linear motor.	BTL 3	Apply	CO4
15.	Describe the principle of operation of hysteresis motor.	BTL 2	Understand	CO4
16.	Mention the disadvantages of hysteresis motor.	BTL 2	Understand	CO4
17.	Plot the torque speed characteristics of hysteresis motor.	BTL 6	Create	CO4
18.	What is the basic principle behind the working of repulsion motor?	BTL 1	Remember	CO4

19.	Compare synchronous reluctance motor with conventional Synchronous motor.	BTL 5	Evaluate	CO4
20.	Where are repulsion motor used?	BTL 4	Analyze	CO4
	Part – B			
1.	(i) Give a detailed technical note on the variable reluctance motor and the advantages. (7) (ii) Investigate the performance of the synchronous reluctance motor with neat phasor diagram. (6)	BTL 6	Create	CO4
2.	(i) Draw and explain the phasor diagram of synchronous reluctance motor. (3) (ii) Explain the construction and operation of axial and radial flux machines. Discuss the advantages and disadvantages of each construction. (10)	BTL 5	Evaluate	CO4
3.	Differentiate between axial and radial airgap synchronous reluctance motors. Compare the performance of synchronous reluctance motor with switched reluctance motor. (13)	BTL 2	Understand	CO4
4.	Summarize the design considerations of synchronous reluctance motor. (13)	BTL 2	Understand	CO4
5.	A three phase 230V,60Hz,4 pole star connected synchronous reluctance motor with negligible armature resistance has X_{sd} = 22.5ohm and X_{sq} = 3.5ohm.The load torque is 12.5Nm.The voltage frequency ratio is maintained constant at rated value. If the supply frequency is 60Hz,determine (i) torque angle (5) (ii) line current (4) (iii)input power factor (4)	BTL 3	Apply	CO4
6.	Describe the constructional features and operation of variable reluctance synchronous reluctance motor. (13)	BTL 2	Understand	CO4
7.	Explain with neat diagram, the construction, working principle and types of synchronous reluctance motor. (13)	BTL 1	Remember	CO4
8.	Explain the torque speed characteristics of synchronous reluctance motor in detail. (13)	BTL 1	Remember	CO4
9.	(i) Discuss the main advantages and disadvantages of synchronous reluctance motor. (7) (ii) Discuss the various applications of synchronous reluctance motor. (6)	BTL 3	Apply	CO4
10.	Describe circle diagram and torque–speed characteristics of synchronous reluctance motor. (13)	BTL 1	Remember	CO4
11.	Explain the working of linear induction motor and also write its applications. (13)	BTL 4	Analyze	CO4

12.	Describe briefly about the repulsion motor. (13)	BTL 1	Remember	CO4
13.	Summarize the constructional details, principle of operation and the application of Hysteresis motor. (13)	BTL 4	Analyze	CO4
14.	Summarize applications of linear induction motor and repulsion motor. (13)	BTL 4	Analyze	CO4
	Part – C			
1.	Recommend a suitable type of synchronous reluctance motor for rewinding mill. (15)	BTL 5	Evaluate	CO4
2.	Formulate a suitable saliency ratio of synchronous reluctance motor and how it can be improved. (15)	BTL 6	Create	CO4
3.	A three phase, 220Volts, 50Hz, 4 pole Star Connected Reluctance Motor has X_d=25Ω and X_q=2.5Ω. The Armature Resistance is negligible. The Load torque is T_L=24.5Nm.The voltage to frequency ratio is maintained constant at the rated value. If the supply frequency is 50 Hz. Determine i) Torque Angle δ (5) ii) Line current (5) iii) Input Power Factor. (5)	BTL 5	Evaluate	CO4
4.	Substitute a suitable reluctance motor for replacing induction motor and synchronous motor and explain (15)	BTL 6	Create	CO4