SRM VALLIAMMAI ENGINEERING COLLEGE
An Autonomous Institution
SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF
ELECTRONICS AND INSTRUMENTATION ENGINEERING

QUESTION BANK

VI SEMESTER

EI3461 – ELECTRICAL MACHINES

Regulation – 2023

Academic Year 2024 – 25 (EVEN)

Prepared by

Mr. N.SOWRIRAJAN, M.E., (Ph.D)

Assistant Professor (Senior Grade) / Dept. of EIE

SRM VALLIAMMAI ENGINEERING COLLEGE

An Autonomous Institution

SRM Nagar, Kattankulathur – 603 203.

Department of Electronics and Instrumentation Engineering

SUBJECT: EI3461 – ELECTRICAL MACHINES

SEM / YEAR: IV/ II

UNIT I D.C. MACHINES				
SYLLABUS D.C. Machines: – Principle of operation and construction of motor and generator – EMF and torque equation – Various excitation schemes – Characteristics of Motor and Generator – Starting, Speed control and braking of D.C. Motor.				
PART –A				
Q.No	**Questions**	**BT Level**	**Competence**	**COs**
1.	Write the working principle of operation of a DC generator.	BTL 2	Understand	CO1
2.	Give the essential parts of DC generator.	BTL 2	Understand	CO1
3.	Classify the different types of DC generators.	BTL 1	Remember	CO1
4.	Sketch the external characteristics of a DC series generator.	BTL 2	Understand	CO1
5.	Give the function of commutator in a DC machine.	BTL 1	Remember	CO1
6.	What is the function of interpoles?	BTL 1	Remember	CO1
7.	What is meant by armature reaction in dc machines?	BTL 1	Remember	CO1
8.	Write the conditions which determine if a DC machine is generating or Motoring.	BTL 2	Understand	CO1
9.	Write the induced EMF equation when the machine acts as DC motor and DC generator.	BTL 2	Understand	CO1
10.	The starting current of a dc motor is high. Justify	BTL 2	Understand	CO1
11.	The starting torque of a dc series motor more than that of a dc shunt motor of same power rating. Justify	BTL 2	Understand	CO1
12.	Analyze on how can the direction of rotation of a DC shunt motor be reversed?	BTL 2	Understand	CO1
13.	How hysteresis and eddy current losses are minimized?	BTL 2	Understand	CO1
14.	What is the significance of back emf?	BTL 1	Remember	CO1
15.	What is the significance of back E.M.F. in a DC Motor?	BTL 1	Remember	CO1
16.	Write the speed equation and List the various methods of speed in DC series motor.	BTL 2	Understand	CO1
17.	Give the necessity of a starter for a dc motor.	BTL 2	Understand	CO1
18.	Why is the starting current high in a dc motor?	BTL 2	Understand	CO1
19.	Compare field and armature control methods.	BTL 2	Understand	CO1
20.	Point out the applications of DC series and shunt motors.	BTL 2	Understand	CO1
21.	What is meant by breaking in DC motor?	BTL 1	Remember	CO1
22.	List the different types of breaking.	BTL 1	Remember	CO1
23.	Define dynamic breaking.	BTL 1	Remember	CO1
24.	Define regenerative breaking.	BTL 1	Remember	CO1

PART – B					
1.	Draw and explain the construction and principle of operation of a DC generator. **(13)**		BTL 4	Analyse	CO1
2.	**(i)**	A short-shunt compound generator delivers a load current of 30 A at 220 V, and has armature, series-field and shunt-field resistances of 0.05 Ω, 0.30 Ω and 200 Ω respectively. Calculate the induced e.m.f. and the armature current. Allow 1.0 V per brush for contact drop.**(8)**	BTL 4	Analyse	CO1
	(ii)	Discuss in detail about armature reaction. **(5)**			
3.	**(i)**	Draw and describe the different types of D.C. generators with its winding diagram.**(10)**	BTL 4	Analyse	CO1
	(ii)	The armature of a 4-pole wave wound D.C. shunt generator has 144 slots and 3 conductors per slot. If the armature in rotated with a speed of 1200 rpm in a field of 0.025 weber per pole, Estimate the emf generated**.(3)**			
4.	**(i)**	Derive the emf equation of DC generator. **(10)**	BTL 3	Apply	CO1
	(ii)	Sketch the characteristics of a DC shunt generator. **(3)**			
5.	Draw and explain the no-load and load characteristics of DC shunt, generators. **(13)**		BTL 3	Apply	CO1
6.	**(i)**	Derive the torque equation of a DC motor. **(8)**	BTL 3	Apply	CO1
	(ii)	List the application of various DC Motor. **(5)**			
7.	Explain with a neat sketch the principle of operation of a dc motor. **(13)**		BTL 3	Apply	CO1
8.	Discuss in detail about the N-I_a, T-I_a and N-T characteristics for a DC series motor, DC shunt motor and DC compound motor. **(13)**		BTL 3	Apply	CO1
9.	A shunt generator delivers 450 A at 230 V and the resistance of the shunt field and armature are 50 ohms and 0.03ohms respectively. Calculate the generated e.m.f. **(13)**		BTL 4	Analyse	CO1
10.	A long-shunt compound generator delivers a load current of 50 A at 500 V and has armature, series field and shunt field resistances of 0.05 Ω, 0.03 Ω and 250 Ω respectively. Calculate the generated voltage and the armature current. Allow 1 V per brush for contact drop. **(13)**		BTL 4	Analyse	CO1
11.	A short-shunt compound generator delivers a load current of 30 A at 220 V, and has armature, series-field and shunt-field resistances of 0.05 Ω, 0.30 Ω and 200 Ω respectively. Calculate the induced e.m.f. and the armature current. Allow 1.0 V per brush for contact drop. **(13)**		BTL 4	Analyse	CO1
12.	Explain with neat diagram, the working of a 4-point starter. **(13)**		BTL 4	Analyse	CO1
13.	**(i)**	A 4 pole, 32 conductor, lap-wound d.c. shunt generator with terminal voltage of 200 volts delivering 12 amps to the load has ra = 2 and field circuit resistance of 200 ohms. It is driven at 1000 r.p.m. Calculate the flux per pole in the machine. If the machine has to be run as a motor with the same terminal voltage and drawing 5 amps from the mains, maintaining the same magnetic field, find the speed of the machine. **(10)**	BTL 4	Analyse	CO1

	(ii)	A d.c. motor takes an armature current of 110 A at 480 V. The armature circuit resistance is 0.2 Ω. The machine has 6-poles and the armature is lap-connected with 864 conductors. The flux per pole is 0.05 Wb. Calculate (i), the speed and (ii) the gross torque developed by the armature. **(3)**			
14.	**(i)**	Explain the speed control of a DC series motor by (1) field diverters method, and (2) variable resistance in series with the motor. **(10)**	BTL 4	Analyse	CO1
	(ii)	List the applications of DC series motor. **(3)**			
15.	With neat schematic, explain the following methods for speed control of DC shunt motor (1) Armature Control Method (2) Field Control Method. **(13)**		BTL 3	Apply	CO1
16.	Explain with neat diagram, the working of a 3-point starter. **(13)**		BTL 4	Analyse	CO1
17.	Describe the various types breaking in a DC motor. **(13)**		BTL 3	Apply	CO1

UNIT II TRANSFORMERS

SYLLABUS

Principle, Construction and Types of Transformer - EMF equation – Equivalent Circuit-Phasor diagrams - Regulation and efficiency of a transformer-Introduction to three phase transformer Connection, Autotransformer.

PART – A

Q.No.	Questions	BT Level	Competence	COs
1.	Classify the different types of transformer.	BTL1	Remember	CO2
2.	How transformers are classified according to their construction?	BTL2	Understand	CO2
3.	Draw a single phase shell type transformer and name the parts.	BTL2	Understand	CO2
4.	Define transformer ratio.	BTL1	Remember	CO2
5.	Write down the EMF equation of a transformer relative to the secondary winding.	BTL2	Understand	CO2
6.	Why transformer rating is in KVA?	BTL2	Understand	CO2
7.	A single phase transformer has 40 primary and 1100 secondary turns. The net cross-sectional area of the core is 500 cm^2. If the primary winding be connected to 50 Hz supply at 400 V. Estimate the value of maximum flux density in the core and the emf induced in the secondary.	BTL2	Understand	CO2
8.	Open circuit test is generally performed at rated voltage on LV side for a transformer. Justify	BTL2	Understand	CO2
9.	Give the currents components of a transformer under load.	BTL2	Understand	CO2
10.	Prove that the flux in the core remains constant even under load.	BTL2	Understand	CO2
11.	Does transformer draw any current when secondary is open? Why?	BTL2	Understand	CO2
12.	Draw the no-load phasor diagram of a transformer.	BTL2	Understand	CO2
13.	Define voltage regulation of a transformer.	BTL1	Remember	CO2
14.	Distinguish between power transformers and distribution transformers.	BTL2	Understand	CO2
15.	Point out the different losses occurring in a transformer.	BTL2	Understand	CO2

16.	Write the two different components of core loss in a transformer.		BTL1	Remember	CO2
17.	At what condition does a transformer operate at its maximum efficiency.		BTL2	Understand	CO2
18.	Give the different types of 3 phase transformer connections.		BTL2	Understand	CO2
19.	What advantage is obtained with the delta-connection of three phase transformers?		BTL1	Remember	CO2
20.	What happen when a DC supply is applied to a Transformer?		BTL1	Remember	CO2
21.	Mention the difference between core and shell type transformers.		BTL2	Understand	CO2
22.	Define efficiency of the transformer.		BTL1	Remember	CO2
23.	Can the voltage regulation goes negative? If so under what condition?		BTL2	Understand	CO2
24.	How does change in frequency affect the operation of a given transformer		BTL2	Understand	CO2
	PART – B				
1.	**(i)**	Draw a general schematic of a single phase transformer. Describe its working principle . **(8)**	BTL 4	Analyse	CO2
	(ii)	A single phase transformer has 400 primary and 1000 secondary turns. The net cross sectional area if the core is 60 cm^2. If the primary winding is connected to a 50 Hz supply at 520 volts, Estimate the following: (1) Peak value of the flux density in the core (2) The voltage induced in the secondary winding. **(5)**			
2.	Describe the constructional details of different types of 1-phase transformer with neat diagrams. **(13)**		BTL3	Apply	CO2
3.	Derive the EMF equation of a single-phase transformer with respect to its primary and secondary windings , voltage ratio and current ratio. **(13)**		BLT4	Analyse	CO2
4.	Deduce the expression and draw the equivalent circuit of a transformer.**(13)**		BLT4	Analyse	CO2
5.	Draw the phasor diagram indicating different voltage in the primary and secondary of a transformer on load at lagging power factor. **(13)**		BTL3	Apply	CO2
6.	Define the term voltage regulation of a transformer and derive the expression for voltage regulation. **(13)**		BTL3	Apply	CO2
7.	Draw the phasor diagram indicating different voltage phasors in the primary and secondary of a transformer on load at leading power factor. **(13)**		BLT4	Analyse	CO2
8.	**(i)**	A 25-kVA transformer has 500 turns on the primary and 50 turns on the secondary winding. The primary is connected to 3000-V, 50-Hz supply. Find the full-load primary and secondary currents, the secondary e.m.f. and the maximum flux in the core. Neglect leakage drops and no-load primary current. **(7)**	BLT4	Analyse	CO2
	(ii)	A single-phase transformer has 400 primary and 1000 secondary turns. The net cross-sectional area of the core is 60 cm2. If the primary winding be connected to a 50-Hz supply at 520 V, calculate (i) the peak value of flux density in the core (ii) the voltage induced in the secondary winding. **(6)**			
9.	A 50-kVA, 4,400/220-V transformer has R1 = 3.45 Ω, R2 = 0.009 Ω. The values		BLT4	Analyse	CO2

	of reactances are X1 = 5.2 Ω and X2 = 0.015 Ω. Calculate for the transformer (i) equivalent resistance as referred to primary (ii) equivalent resistance as referred to secondary (iii) equivalent reactance as referred to both primary and secondary (iv) equivalent impedance as referred to both primary and secondary (v) total Cu loss, first using individual resistances of the two windings and secondly, using equivalent resistances as referred to each side. **(13)**			
10.	A 5 kVA 200/1000 V, 50 Hz, single-phase transformer gave the following test results : O.C. Test (L.V. Side) : 2000 V, 1.2 A, 90 W S.C. Test (H.V. Side) : 50 V, 5A, 110 W (i) Calculate the parameters of the equivalent circuit referred to the L.V. side. (ii) Calculate the output secondary voltage when delivering 3 kW at 0.8 p.f. lagging, the input primary voltage being 200 V. Find the percentage regulation also. **(13)**	BLT4	Analyse	CO2
11.	Obtain the equivalent circuit of a 200/400-V, 50-Hz, 1-phase transformer from the following test data : O.C test : 200 V, 0.7 A, 70 W – on L.V. side S.C. test : 15 V, 10 A, 85 W – on H.V. side Calculate the secondary voltage when delivering 5 kW at 0.8 p.f. lagging, the primary voltage being 200V. **(13)**	BLT4	Analyse	CO2
12.	A-100 kVA transformer has 400 turns on the primary and 80 turns on the secondary. The primary and secondary resistances are 0.3 Ω and 0.01 Ω respectively and the corresponding leakage reactances are 1.1 and 0.035 Ω respectively. The supply voltage is 2200 V. Calculate (i) equivalent impedance referred to primary and (ii) the voltage regulation and the secondary terminal voltage for full load having a power factor of 0.8 leading. **(13)**	BLT4	Analyse	CO2
13.	A 200-kVA transformer has an efficiency of 98% at full load. If the max. efficiency occurs at three quarters of full-load, calculate the efficiency at half load. Assume negligible magnetizing current and p.f. 0.8 at all loads. **(13)**	BLT4	Analyse	CO2
14.	Explain in detail about various types of connections used in three phase transformer.**(13)**	BLT4	Analyse	CO2
15.	Discuss about the autotransformer and saving of copper in autotransformer.**(13)**	BLT3	Apply	CO2
16.	**(i)** Write short notes an all-day efficiency of the transformer. **(7)**	BLT4	Analyse	CO2
	(ii) A 100-kVA lighting transformer has a full-load loss of 3 kW, the losses being equally divided between iron and copper. During a day, the transformer operates on full-load for 3 hours, one half-load for 4 hours, the output being negligible for the remainder of the day. Calculate the all-day efficiency. **(6)**			
17.	**(i)** Find "all day" efficiency of a transformer having maximum efficiency of 98 % at 15 kVA at unity power factor and loaded as follows : 12 hours – 2 kW at 0.5 p.f. lag 6 hours – 12 kW at 0.8 p.f. lag 6 hours – at no load **(7)**	BLT4	Analyse	CO2
	(ii) A40 kVA,3300/240V,50Hz,1Ø transformer has 660 turns on the primary. Determine 1) The number of turns on the secondary 2) The Maximum value of flux in the core			

		The approximate value of primary and secondary full load current. **(6)**			

UNIT III - SYNCHRONOUS MACHINES				
SYLLABUS Principle of Operation, types - EMF Equation and Phasor diagrams - Synchronous motor- Starting Methods, Torque equation- V Curves, inverted V curves.				
PART – A				
Q.No.	**Questions**	**BT Level**	**Competence**	**COs**
1.	Which type of synchronous generators are used in hydroelectric plants and why?	BTL2	Understand	CO3
2.	What are the principal advantages of rotating field type construction in alternators?	BTL1	Remember	CO3
3.	Classify the different types of alternators.	BTL1	Remember	CO3
4.	Name the types of alternators based on their rotor construction.	BTL1	Remember	CO3
5.	Give the advantages of salient pole type construction used for Synchronous machines.	BTL1	Remember	CO3
6.	What is meant by synchronous impedance of an alternator?	BTL1	Remember	CO3
7.	Define the distribution factor of alternator.	BTL1	Remember	CO3
8.	Write the essential elements for generating EMF in alternators.	BTL1	Remember	CO3
9.	What is meant by synchronization?	BTL1	Remember	CO3
10.	What is hunting in a synchronous machine? Explain.	BTL1	Remember	CO3
11.	Define synchronous speed.	BTL1	Remember	CO3
12.	Write the purpose of damper winding.	BTL2	Understand	CO3
13.	Discuss the effect of changing excitation of constant load on a synchronous motor.	BTL2	Understand	CO3
14.	What is synchronous condenser?	BTL1	Remember	CO3
15.	What is a synchronous capacitor?	BTL1	Remember	CO3
16.	Give the various torques associated with synchronous motors.	BTL2	Understand	CO3
17.	Why a synchronous motor is not a self starting machine? Analyze.	BTL2	Understand	CO3
18.	List the methods of starting a synchronous motor.	BTL1	Remember	CO3
19.	Alternators rated in kVA and not in kW. Justify	BTL2	Understand	CO3
20.	Draw the 'V-curves' of the synchronous motor.	BTL2	Understand	CO3
21.	Write the applications of synchronous motor.	BTL1	Remember	CO3
22.	List the inherent disadvantages of synchronous motor.	BTL1	Remember	CO3
23.	Give some merits and demerits of synchronous motor	BTL1	Remember	CO3
24.	In what way synchronous motor is different from other motors?	BTL2	Understand	CO3
1.	Draw and explain the constructional details of an alternator. **(13)**	BTL4	Analyse	CO3
2.	Draw and explain the principles operation of an alternator. List the advantages of rotating magnetic field. **(13)**	BTL4	Analyse	CO3

3.	**(i)**	What are the reasons for the variation in terminal voltage, when the alternator in on load? Explain each Reason. **(9)**	BTL3	Apply	CO3
	(ii)	Describe briefly the effect of various load power factor of an alternator.**(4)**			
4.	**(i)**	A 3ϕ, 16 pole, star connected alternator has 144 slots on the armature periphery. Each slot contains 10 conductors. It is driven at 375 rpm. The line value of emf available across the terminals is observed to be 2.657 kV. Find the frequency of the induced emf and flux per pole. **(7)**	BTL4	Analyse	Analyse
	(ii)	Draw the vector diagram of a 3ϕ alternator. **(6)**			
5.	With the help of phasor diagrams, discuss the behaviour of synchronous motor with the constant field excitation and variable load. **(13)**		BLT3	Apply	Apply
6.	Draw and explain the principle of operation of a synchronous motor. **(13)**		BTL4	Analyse	CO3
7.	Draw and explain the vector diagram, when the alternator is loaded with (1) Resistive (2) Inductive and (3) Capacitive **(13)**		BTL4	Analyse	CO3
8.	A 3-phase, star-connected alternator supplies a load of 10 MW at p.f. 0.85 lagging and at 11 kV (terminal voltage). Its resistance is 0.1 ohm per phase and synchronous reactance 0.66 ohm per phase. Calculate the line value of e.m.f. generated. **(13)**		BTL4	Analyse	CO3
9.	**(i)**	Draw the Equivalent Circuit of a Synchronous Motor. **(7)**	BTL4	Analyse	CO3
	(ii)	Derive the equation for Power Developed by a Synchronous Motor. **(6)**			
10.	With the help of phasor diagrams, discuss the behaviour of synchronous motor with the different field excitation. **(13)**		BTL3	Apply	CO3
11.	Discuss about the Different Torques of a Synchronous Motor. **(13)**		BTL3	Apply	CO3
12.	**(i)**	Derive an expression for the power developed in an synchronous motor**.(7)**	BTL3	Apply	CO3
	(ii)	Discuss 'V' and inverted 'V' curve of a synchronous motor**.(6)**			
13.	Describe the Effect of Excitation on Armature Current and Power Factor.**(13)**		BLT2	BTL3	Apply
14.	Describe the Effect of Excitation on Armature Current and Power Factor. **(13)**		BTL3	Apply	CO3
15.	**(i)**	A 3-φ, 3300-V, Y-connected synchronous motor has an effective resistance and synchronous reactance of 2.0 Ω and 18.0 Ω per phase respectively. If the open-circuit generated e.m.f. is 3800 V between lines, calculate (i) the maximum total mechanical power that the motor can develop and (ii) the current and p.f. at the maximum mechanical power. **(6)**	BTL4	Analyse	CO3
	(ii)	Write the comparison between the synchronous motor and Induction motor. **(7)**			
16.	Derive the torque equation of a synchronous motor. **(13)**		BTL4	Analyse	CO3

17.	A 6600V, 3 phase, star connected synchronous motor draws a full load current of 80A at 0.8pf leading. The armature resistance is 2.2Ω and reactance of 22Ω per phase. If the stray losses of the machine are 3200W. Evaluate (i) Emf induced (ii) Output power (iii) Efficiency of the machine. **(13)**	BTL4	Analyse	CO3

UNIT IV - THREE PHASE INDUCTION MOTORS

SYLLABUS

Construction – Production of rotating magnetic field- Principle of operation, Torque slip characteristics - Starting methods and Speed control of induction motors..

PART-A

Q.No	Questions	BT Level	Competence	COs
1.	Classify the different type of rotors employed in an induction motor.	BTL1	Remember	CO4
2.	Compare squirrel cage rotor and slip ring rotor.	BLT2	Understand	CO4
3.	Give the advantages and disadvantages of three phase induction motor.	BTL1	Remember	CO4
4.	Give the advantages of skewing of cage rotor conductors.	BTL1	Remember	CO4
5.	The air gap between stator core and rotor of an induction motor is made very small. Analyze	BLT2	Understand	CO4
6.	Define the term slip of a 3-phase induction motor.	BTL1	Remember	CO4
7.	Write the importance of slip in a three phase induction motor.	BTL1	Remember	CO4
8.	Two three-phase inductions when connected across a 400 V, 50 Hz supply runs at 1440 r.p.m. and 940 r.p.m. respectively. Determine which of the two motors is running at higher slip.	BLT2	Understand	CO4
9.	Draw the slip-torque characteristics of a three phase induction motor.	BLT2	Understand	CO4
10.	State condition at which starting torque developed in a 3 phase induction motor is maximum.	BLT2	Understand	CO4
11.	Prove that 3 phase flux results in a rotating magnetic field using a phasor diagram.	BLT2	Understand	CO4
12.	Name the test conducted for obtaining the equivalent circuit parameters of 3phase induction motor.	BTL1	Remember	CO4
13.	A three phase slip ring induction motor gives a reading of 60 V across slip rings when at rest with normal voltage applied. The rotor is star connected and has an impedance of (0.8+j6) Ω per phase. Estimate the rotor current when the machine is at standstill with the slip rings joined to a star connected starter with a phase impedance of (4+j3) Ω.	BLT2	Understand	CO4
14.	Write the various starters used for starting a 3 phase Induction motor.	BTL1	Remember	CO4
15.	Rotor resistance starting is preferred to reduced voltage starting of a rotor induction motor. Justify.	BLT2	Understand	CO4
16.	List the methods available to control the speed of an induction motor.	BLT2	Understand	CO4
17.	What is the speed of rotor field in space?	BTL1	Remember	CO4

18.	Estimate the synchronous speed of an induction motor running at 2900 r.p.m. with 50 Hz supply?	BLT2	Understand	CO4
19.	A three phase 4 pole, 440 V, 50Hz induction motor runs with a slip of 4%. Calculate the rotor speed and frequency of the rotor current.	BLT2	Understand	CO4
20.	Why an induction motor will never run at its synchronous speed?	BLT2	Understand	CO4
21.	A 3-phase induction motor is wound for 4 poles and is supplied from 50 Hz system. Calculate the speed at which the magnetic field of the stator is rotating.	BLT2	Understand	CO4
22.	What are the two fundamental characteristics of a rotating magnetic field?	BTL1	Remember	CO4
23.	Under what condition, the slip in an induction motor is (a) Negative (b) Greater than one.	BLT2	Understand	CO4
24.	What is meant by synchronous watts?	BTL1	Remember	CO4
	PART – B			
1.	Describe in detail, the construction and working principle of three phase induction motor. **(13)**	BTL3	Apply	CO4
2.	(i) List the advantages of a 3 phase induction motor. **(5)**	BTL4	Analyse	CO4
	(ii) A 4-pole 3-phase induction motor operates from a supply whose frequency is 50 Hz. Determine the following: (1) The speed at which the magnetic field of the stator is rotating. (2) The speed of the rotor when the slip is 0.04. (3) The frequency of the rotor currents when the slip is 0.03. The frequency of the rotor currents at stand still.**(8)**			
3.	With neat diagram discuss the production of rotating magnetic field of three phase induction motor.**(13)**	BTL3	Apply	CO4
4.	Discuss about about the Frequency of Rotor Current. **(8)**	BTL4	Analyse	CO4
	A 12-pole, 3-phase alternator driven at a speed of 500 r.p.m. supplies power to an 8-pole, 3-phase induction motor. If the slip of the motor, at full-load is 3%, calculate the full-load speed of the motor. **(5)**			
5.	**(i)** Derive the Relation Between Torque and Rotor Power Factor, if rotor is assumed non-inductive and inductive.**(6)**	BLT3	Analyse	CO4
	(ii) Derive the equation for torque under running conditions in a 3-phase induction motor. **(7)**			
6.	Derive the equation for torque under starting conditions in a 3-phase induction motor and condition for maximum torque. **(13)**	BTL3	Apply	CO4
7.	**(i)** Explain the relation between the Torque and slip with necessary diagram. **(7)**	BTL4	Analyse	CO4
	(ii) Derive the relationship between" (1) Full load torque and maximum torque (2) Starting torque and maximum torque. **(6)**			

8.	The efficiency of a 400 V, 3 phase, 6 pole induction motor drawing a line current of 80 A at 0.75 p.f. at 4% slip is 85%. Find the shaft output and shaft torque .**(13)**		BTL4	Analyse	CO4
9.	Explain the working of autotransformer starter of a 3 phase induction motor with a neat diagram. **(13)**		BTL4	Analyse	CO4
10.	Discus about Torque Developed by an Induction Motor and Derive an equation for Torque, Mechanical Power and Rotor Output. **(13)**		BTL3	Apply	CO4
11.	Explain the working of star-Delta starter of a 3 phase induction motor with a neat diagram. **(13)**		BTL4	Analyse	CO4
12.	**(i)**	The power input to the rotor of 440 V, 50 Hz, 6-pole, 3-phase, induction motor is 80 kW. The rotor electromotive force is observed to make 100 complete alterations per minute. Calculate (i) the slip, (ii) the rotor speed, (iii) rotor copper losses per phase.**(8)**	BTL4	Analyse	CO4
	(ii)	A 12-pole, 3-phase alternator driven at a speed of 500 r.p.m. supplies power to an 8-pole, 3-phase induction motor. If the slip of the motor, at full-load is 3%, calculate the full-load speed of the motor. **(5)**			
13.	Discuss in detail the various methods of speed control of induction motor.**(13)**		BLT3	Analyse	Analyse
14.	**(i)**	Explain the working of DOL of a 3 phase induction motor with a neat diagram.**(10)**	BLT3	Analyse	CO4
	(ii)	Discuss about the Torque and speed characteristics. **(3)**			
15.	Design the step by step test procedure to obtain the equivalent circuit parameters of a three phase induction motor and draw the equivalent circuit. **(13)**		BTL4	Analyse	CO4
16.	A 440-V, 3-φ, 50-Hz, 4-pole, Y-connected induction motor has a full-load speed of 1425 rpm. The rotor has an impedance of (0.4 + J 4) ohm and rotor/stator turn ratio of 0.8. Calculate (i) full-load torque (ii) rotor current and full-load rotor Cu loss (iii) power output if windage and friction losses amount to 500 W (iv) maximum torque and the speed at which it occurs (v) starting current and (vi) starting torque. **(13)**		BTL4	Analyse	CO4
17.	Explain the working of Rotor résistance of a 3 phase induction motor with a neat diagram. **(13)**		BTL4	Analyse	CO4

UNIT V - NGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES				
SYLLABUS Types of single-phase induction motors –Double field revolving theory- Capacitor start motors – Shaded pole motor – Repulsion type motor – Universal motor –Hysteresis motor - Switched reluctance motor – Brushless D.C motor-Stepper motor- Permanent magnet synchronous motor.				
PART – A				
Q.No	**Questions**	**BT Level**	**Competence**	**COs**

1.	Classify the types of single Phase induction motor.	BTL1	Remember	CO5
2.	Why a single phase induction motor is not self starting?	BLT2	Understand	CO5
3.	State principle that the double revolving field theory make use of.	BLT2	Understand	CO5
4.	Differentiate between "capacitor start" and Capacitor start capacitor run" Single Phase Induction Motor.	BLT2	Understand	CO5
5.	State any two application of Universal motor.	BTL2	Understand	CO5
6.	Draw the speed –torque characteristics of a shaded pole motor.	BTL2	Understand	CO5
7.	How is single phase spilt in a induction motor?	BTL2	Understand	CO5
8.	Mention the applications of shaded pole motor.	BTL1	Remember	CO5
9.	Is it possible to change the direction of rotation of a shaded pole type induction motor? Justify your answer.	BLT2	Understand	CO5
10.	Write the use of shading coil in the shaded pole motor.	BTL1	Remember	CO5
11.	Write the principle behind repulsion motor.	BTL1	Remember	CO5
12.	How can an universal motor be reversed?	BTL1	Remember	CO5
13.	What is hysteresis motor?	BLT2	Understand	CO5
14.	Write the principle of operation of reluctance motors?	BTL1	Remember	CO5
15.	Mention the application of switched reluctance motor.	BTL1	Remember	CO5
16.	Give the advantages of brushless DC motor.	BTL1	Remember	CO5
17.	Compare PMBL DC motor and switched reluctance motor.	BLT2	Understand	CO5
18.	How universal motor is different from DC motor?	BLT2	Understand	CO5
19.	What is a Stepper motor?	BTL1	Remember	CO5
20.	Design the step angle of a four phase stepper motor with 12 stator teeth and 3 rotor teeth.	BLT2	Understand	CO5
21.	What is permanent magnet synchronous motor?	BTL1	Remember	CO5
22.	Give two advantages and two applications of stepper motor.	BTL1	Remember	CO5
23.	Give two advantages and two applications of permanent magnet synchronous motor	BTL1	Remember	CO5
24.	Name the two windings of a single-phase induction motor.	BTL1	Remember	CO5
PART B				
1.	Explain double-field revolving theory of a single phase induction motor. **(13)**	BTL4	Analyse	CO5
2.	How to make Single-phase Induction Motor Self-starting.Explain (i) Split phase machine (ii) capacitor stat machine. **(13)**	BTL3	Apply	CO5
3.	Describe the construction, working principle and applications of shaded-pole single phase induction motor with neat diagrams. **(13)**	BTL3	Apply	CO5
4.	Explain the construction, working principle, characteristics and applications of Universal motor with relevant diagrams. **(13)**	BTL4	Analyse	CO5
5.	With a neat diagram describe the working principle of Brushless DC motor. **(13)**	BTL3	Apply	CO5

6.		Describe the construction and principle of working of switched reluctance motor with neat diagrams and mention its applications. **(13)**	BTL3	Apply	CO5
7.		Describe the construction, working principle and applications of repulsion motor with neat diagrams. **(13)**	BTL3	Apply	CO5
8.		Describe the construction, working principle and applications of AC series motor with neat diagrams. **(13)**	BTL3	Apply	CO5
9.		In a 6 pole, single phase induction motor, the gross power absorbed by the forward and backward fields are 160W and 20 w respectively, if the motor speed is 950 rpm amd the no-load frictional loss is 75 W, find the shaft torque. **(13)**	BTL4	Analyse	CO5
10.	**(i)**	Compare the single induction motor and three phase induction motor. **(7)**	BTL4	Analyse	CO5
	(ii)	Discuss the differences between capacitor-start and capacitor-start capacitor-run induction motors. Why is the auxiliary winding of a capacitor-start motor disconnected after the motor has picked up speed? **(6)**			
11.	**(i)**	A 250 W, 230 V, 50 Hz single phase Capacitor Start induction motor has the following constants for the main and auxiliary windings. Main Winding, Zm = (4.5+j3.7) Ω, Auxiliary winding, Za = (9.5+j3.5) Ω. Estimate the value of the capacitor that will place the main and auxiliary winding currents in quadrature at starting. **(7)**	BTL4	Analyse	CO5
	(ii)	Discuss about the cross field theory. **(6)**			
12.	**(i)**	Determine the stepping angle for a (i) three phase twenty pole permanent magnet stepper motor (ii) three stack twelve tooth variable reluctance stepper motor. **(7)**	BTL4	Analyse	CO5
	(ii)	A variable reluctance stepper motor has 4 poles with 10 teeth in each, Determine the stepping angle if the rotor has 60 teeth. **(6)**			
13.		Design the step by step the no-load and blocked rotor test procedure to obtain the equivalent circuit parameters of a single phase induction motor. **(13)**	BTL4	Analyse	CO5
14.		Explain with neat sketch the construction and principle of operation of various types of Stepper Motor. **(13)**	BTL3	Apply	CO5
15.		Discus about the hysteresis motor. **(13)**	BTL3	Apply	CO5
16.		Write short notes on the working principle of permanent magnet synchronous with diagram. **(13)**	BTL3	Apply	CO5
17.		Explain with neat sketch the construction and principle of operation of variable reluctance Stepper Motor. **(13)**	BTL4	Analyse	CO5