SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF

ELECTRONICS AND INSTRUMENTATION ENGINEERING

QUESTION BANK

IV SEMESTER

1907401–ELECTRICAL MACHINES

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(EVEN SEMESTER)

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SUBJECT : 1907401 ELECTRICAL MACHINES
SEM / YEAR: IV / II

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

21.	Distinguish between shunt and series field coil construction.		**5**	Evaluate
22.	How does D.C. motor differ from D.C. generator in construction?		**4**	Analyze
23.	What is the function of no-voltage release coil in D.C. motor starter?		**3**	Apply
24.	Define critical field resistance of dc shunt generator.		**2**	Understand
		PART - B		
1.	**i)**	Draw and explain the construction and principle ofoperation of a DC generator.(7)	**5**	Evaluate
	ii)	Explain the armature reaction in a DC generator on no load and on load conditions. Also briefly explain the methods to overcome the adverse effects of the armature reaction.(6)	**2**	Understand
2.	**i)**	Draw and describe the different types of D.C. generators with its winding diagram. (10)	**1**	Remember
	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)	**2**	Understand
3.	A long shunt compound wound generator gives 240 V at full load output of 100 A. The resistances of various windings of the machine are armature (including brush contact) -0.1Ω, series field 0.02Ω, interpole field 0.025Ω, shunt field -100Ω, the iron loss at full load is 1000 W; windage a friction/losses total 500 W. Find the full load efficiency of the machine.(13)		**1**	Remember
4.	**i)**	Discuss in detail about armature reaction.(6)	**2**	Understand
	ii)	Derive the emf equation of DC generator.(7)	**6**	Create
5.	Draw and explain the no-load and load characteristics of DC shunt, series and compound generators.(13)		**4**	Analyze
6.	**i)**	Describe with neat sketch the construction of DC machines.(6)	**1**	Remember
	ii)	A 250 kW, 500 V, long shunt compound generator develops 480 V on no-load when running at 1000 rpm. The speed of the machine falls to 975 rpm on full load and the terminal voltage rises to 500 V. If the increase in flux from no-load to full load is 15%, calculate the value of the armature resistance. The series and shunt field resistances are 0.02 Ω and 100 Ω respectively. Assume a voltage drop of 1 V per brush. (7)	**3**	Apply

7.		A shunt generator delivers 50 kW at 250 V and 400 r.p.m. The armature and field resistances are 0.2 and 50 ohms respectively. Find the speed of the machine running as a shunt motor and taking 50 kW input at 250 V. (13)	**1**	Remember
8.	**i)**	Explain with a neat sketch the principle of operation of a dc motor. (8)	**4**	Analyze
	ii)	A 10 kW, 220 V, DC 6 pole shunt motor runs at 1000 rpm. Delivering full load. The armature has 534 lab connected conductors. Full load copper loss is 0.64 kW. The total brush drop is 1 volt. Determine the flux per pole neglecting shunt current. (5)	**5**	Evaluate
9.	**i)**	With neat schematic, explain the following methods for speed control of DC shunt motor (1) Armature Control Method (2) Field Control Method.(8)	**4**	Analyze
	ii)	A 4 pole, 240 V wave connected shunt motor gives 1119 kW when running at 1000 RPM and drawing armature and field currents of 50 A and 1.0 A respectively. It has 540 conductors; its resistance is 0.1 ohm. Find (1) total torque (2) useful torque (3) useful flux per pole (4) rotational losses and (5) efficiency. Assuming a drop of 1 volt per brush.(5)	**3**	Apply
10.	**i)**	Using step by step approach, develop a mathematical expression for torque developed in DC machine.(7)	**6**	Create
	ii)	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.(6)	**2**	Understand
11.	**i)**	Draw a neat diagram showing the salient parts of a DC motor. Explain the function of each in detail.(8)	**4**	Analyze
	ii)	Write the speed equation and explain how to control the speed of a shunt motor by flux control method. (15)	**3**	Apply
12.		With a neat sketch explain the operation of 4-point starter. What are the advantages of this starter over 3-point starter? (13)	**4**	Analyze
13.		A 250 V dc shunt motor has an armature resistance of 0.5 Ω and a field resistance of 250 Ω. When driving at 600 rpm, a load torque of which is constant, the armature current is 20 A. If it is desired to raise the speed from 600 rpm to 800 rpm, find the resistance that must be inserted in the shunt field circuit, assuming magnetization curve to be a straight line. (13)	**1**	Remember
14.		With the help of a neat sketch, compare the mechanical characteristics of different dc motors.(13)	**4**	Analyze

15.	Explain the speed control of a DC series motor by (1) field diverters method, and (2) variable resistance in series with the motor. (13)	**2**	Understand
16.	Explain with neat diagram, the working of a 3-point starter.(13)	**2**	Understand
17.	An 8-pole d.c. shunt generator with 778 wave-connected armature conductors and running at 500 r.p.m. supplies a load of 12.5Ω resistance at terminal voltage of 250 V. The armature resistance is 0.24Ω and the field resistance is 250Ω. Find the armature current, the induced e.m.f. and the flux per pole. (13)	**1**	Remember
	PART - C		
1.	**i)** In a 120 V compound generator, the resistance of the armature, shunt and series windings are 0.06 Ω, 25 Ω and 0.04 Ω respectively. The load current is 100 A at 120 V. Find the induced EMF and the armature current when the machine is connected as long shunt and as short shunt. (7)	**4**	Analyze
	ii) A shunt generator delivers 195 A at terminal potential difference of 250 V, the armature resistance and shunt field resistance are 0.02 Ω and 50 Ω respectively. The iron and friction losses equal 950 W. Find the (i) EMF generated (ii) Cu losses (iii) output of the prime motor (iv) electrical efficiencies. (8)		
2.	A 100 kW DC shunt generator driven by a belt from an engine runs at 750 rpm and is connected to 230 V dc mains. When the belt breaks, it continues to run as a motor drawing 9kW from the mains. At what speed would it run? Given: Armature resistance= 0.018 Ω and field resistance=115Ω (15)	**5**	Evaluate
3.	Develop the condition for maximum efficiency of the DC generator. (15)	**6**	Create
4.	A 220 V, 22 A, 1000 rpm dc shunt motor has armature circuit resistance of 0.1 ohm and field resistance of 100 ohm. Calculate the value of additional resistance to be inserted in the armature circuit in order to reduce the speed to 800 rpm. Assume the load torque to be (i) proportional to the speed and (ii) proportional to square of the speed (15)	**5**	Evaluate
5.	A DC series motor runs at 500 rpm on 220 V supply drawing a current of 50 A. The total resistance of the machine is 0.15Ω, Evaluate the value of the extra resistance to be connected in series with the motor circuit that will reduce the speed to 300 rpm. The load torque being then half of the previous to the current. (15)	**5**	Evaluate

UNIT II - TRANSFORMERS			
SYLLABUS Principle, Construction and Types of Transformer - EMF equation - Phasor diagrams - Regulation and efficiency of a transformer-Introduction to three phase transformer Connection. Applications of Current and Potential Transformer.			
PART - A			
Q.No	**Questions**	**BT Level**	**Competence**
1.	Classify the different types of transformer.	**4**	Analyze
2.	How transformers are classified according to their construction?	**4**	Analyze
3.	Draw a single phase shell type transformer and name the parts.	**3**	Apply
4.	Define transformer ratio.	**1**	Remember
5.	Write down the EMF equation of a transformer relative to the secondary winding.	**6**	Create
6.	Why transformer rating is in KVA?	**1**	Remember
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.	**2**	Understand
8.	Open circuit test is generally performed at rated voltage on LV side for a transformer. Justify	**5**	Evaluate
9.	Give the currents components of a transformer under load.	**2**	Understand
10.	Prove that the flux in the core remains constant even under load.	**5**	Evaluate
11.	Does transformer draw any current when secondary is open? Why?	**2**	Understand
12.	Draw the no-load phasor diagram of a transformer.	**3**	Apply
13.	Define voltage regulation of a transformer.	**1**	Remember
14.	Distinguish between power transformers and distribution transformers.	**3**	Apply
15.	Point out the different losses occurring in a transformer.	**4**	Analyze
16.	Write the two different components of core loss in a transformer.	**6**	Create
17.	At what condition does a transformer operate at its maximum efficiency?	**1**	Remember
18.	Give the different types of 3 phase transformer connections.	**2**	Understand
19.	What advantage is obtained with the delta-connection of three phase transformers?	**1**	Remember
20.	What happen when a DC supply is applied to a Transformer?	**1**	Remember
21.	Mention the difference between core and shell type transformers.	**3**	Apply

22.	Define efficiency of the transformer.		2	Understand
23.	Can the voltage regulation goes negative? If so under what condition?		4	Analyze
24.	How does change in frequency affect the operation of a given transformer?		5	Evaluate
	PART - B			
1.	Describe the constructional details of different types of 1-phase transformer with neat diagrams. (13)		1	Remember
2.	**i)**	Draw a general schematic of a single phase transformer. Describe its working principle and deduce the expression for emf in secondary winding. (8)	1	Remember
	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	Understand
3.	Draw an ideal single phase transformer and explain the principle of operation, the concept of step up and step down transformer.(13)		4	Analyze
4.	A 25-kVA transformer has 500 turns on the primary and 50 turns on the secondary. 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. (13)		6	Create
5.	**i)**	Draw and explain the phasor diagram for a single phase transformer supplying a leading power factor load. (7)	4	Analyze
	ii)	Draw the phasor diagram indicating different voltage phasors in the primary and secondary of a Δ-Y transformer. (6)	3	Apply
6.	From the first principle, Evaluate the emf equation of a transformer and hence show that the number of turns on the HV and LV windings are in the ratio of their voltages. (13)		5	Evaluate
7.	The following data refers to a single phase transformer turn ratio 19.5:1, R1 = 25Ω, X1 = 100Ω, R2 = 0.06 Ω, X2 = 0.25 Ω, No load current = 1.25. A leading the flux by 30°. The secondary delivers 200 A at a terminal voltage of 500 V andpf of 0.8 lagging. Determine with the phasor diagram, the applied voltage, primary power factor and efficiency. (13)		3	Apply

8.		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 3) The approximate value of primary and secondary full load current.(13)	**3**	Apply
9.		The test results obtained on a 1 phase 20 kVA, 2200/220 volts transformer are: OC test : 220 V, 1.1 A, 125 W; SC test : 52.7 V, 8.4 A, 287 W The transformer is fully loaded. Find the load p.f. for zero voltage regulation. (13)		
10.	**i)**	The primary and secondary windings of a 30 kVA, 6.6 kV / 240 V transformer have resistances of 10 Ω and 0.013 Ω respectively. The leakage reactance of the windings are 17 Ω and 0.022 Ω. Estimate the percentage voltage regulation of the transformer when it is delivering full-load at 0.8 pf lagging at the rated voltage. (8)	**2**	Understand
	ii)	Calculate the regulation of a transformer in which ohmic loss is 1% of the output and the reactance drop is 5% of the voltage when the power factor is (1) 0.8 lagging, (2) unity, and (3) 0.8 leading. (5)	**3**	Apply
11.		The test results obtained on a 1 phase 20 KVA, 2200/220 Volts transformer are: OC test : 220 V, 1.1 A, 125 W; SC test : 52.7 V, 8.4 A, 287 W The transformer is fully loaded. Find the load p.f. for zero voltage regulation. (13)	**1**	Remember
12.	**i)**	Explain the conversion of three phase to two phase by Scott connection in detail. (8)	**1**	Remember
	ii)	A 150 KVA transformer has an iron loss of 1400 W and a full load copper loss of 1600 W . Find the efficiency of the transformer at 30% of full load for 1) Unity power factor 2) 0.8 power factor lagging (5)	**1**	Remember
13.		Explain in detail about various types of connections used in three phase transformer.(13)	**4**	Analyze
14.		Describe the constructional details and the applications of Current and Potential Transformer. (13)	**3**	Apply
15.		Define the term voltage regulation of a transformer and derive the expression for voltage regulation.(13)	**1**	Remember
16.		Draw and explain the phasor diagram of a single-phase transformer supplying a UPF load and a lagging power factor load. (13)	**4**	Analyze

17.		A single-phase transformer has 500 turns on the primary and 40 turns on the secondary winding. The mean length of the magnetic path in the iron core is 150 cm and the joints are equivalent to an air-gap of 0.1 cm. When a potential difference of 3,000 V is applied to the primary, maximum flux density is 1.2 Wb/m^2. Calculate: i) The cross-sectional area of core ii) No-load secondary voltage iii) The no-load current drawn by the primary iv) Power factor on no-load. Given that AT/cm for a flux density of 1.2 Wb/m^2 in iron to be 5, the corresponding iron loss to be 2 watt/kg at 50 Hz and the density of iron as 7.8 $gram/cm^3$. (13)	**2**	Understand
PART - C				
1.	**i)**	A 5-kVA distribution transformer has full load efficiency at unity pf. Of 95% the copper and iron losses then being equal. Calculate its all-day efficiency if it is loaded throughout the 24 hours as follows: No load for 10 hours Quarter load for 7 hours Half load for 5 hours Full load for 2 hours Assume load p.f. of unity. (8)	**6**	Create
	ii)	Write short notes an all-day efficiency of the transformer. (7)	**3**	Apply
2.	**i)**	Explain how the primary current adjusts itself to the load on the secondary. (8)		
	ii)	What is meant by Inrush Currents in Transformer? Specify the nature of Inrush currents and its problem during Transformer Charging. (7)		
3.	**i)**	Derive the condition for maximum efficiency of a transformer. (8)	**6**	Create
	ii)	A 500KVA transformer has 95% efficiency at full load and also at 60% of full load both at UPF. a)Separate out the transformer losses. b) Determine the transformer efficiency at 75% full load, UPF. (7)	**5**	Evaluate
4.		A 3-phase step down transformer is connected to 6.6 KV mains and takes 10 Amps. Evaluate the secondary line voltage and line current for the (i) Δ/Δ (ii) Y/Y (iii) Δ/Y and (iv) Y/Δ connections. The ratio of turns per phase is 12 and neglect no load losses. (15)	**5**	Evaluate
5.		Derive the EMF equation of a single-phase transformer with respect to its primary and secondary windings.(15)	**6**	Create

UNIT III - SYNCHRONOUS MACHINES

SYLLABUS

Principle of Operation, type - EMF Equation and Phasor diagrams - Synchronous motor- RotatingMagnetic field Starting Methods , Torque V-Curves, inverted – V curves.

PART - A

Q.No	Questions	BT Level	Competence
1.	Which type of synchronous generators are used in hydroelectric plants and why?	**4**	Analyze
2.	What are the principal advantages of rotating field type construction in alternators?	**2**	Understand
3.	Classify the different types of alternators.	**3**	Apply
4.	Name the types of alternators based on their rotor construction.	**1**	Remember
5.	Give the advantages of salient pole type construction used for Synchronous machines.	**2**	Understand
6.	What is meant by synchronous impedance of an alternator?	**1**	Remember
7.	Define the distribution factor of alternator.	**1**	Remember
8.	Write the essential elements for generating EMF in alternators.	**6**	Create
9.	What is meant by synchronization?	**1**	Remember
10.	What is hunting in a synchronous machine? Explain.	**3**	Apply
11.	Define synchronous speed.	**1**	Remember
12.	Write the purpose of damper winding.	**6**	Create
13.	Discuss the effect of changing excitation of constant load on a synchronous motor.	**2**	Understand
14.	What is synchronous condenser? Explain.	**5**	Evaluate
15.	What is a synchronous capacitor?Explain.	**4**	Analyze
16.	Give the various torques associated with synchronous motors.	**2**	Understand
17.	Why a synchronous motor is not a self starting machine? Analyze.	**4**	Analyze
18.	List the methods of starting a synchronous motor.	**1**	Remember
19.	Alternators rated in kVA and not in kW. Justify	**5**	Evaluate
20.	Draw the 'V-curves' of the synchronous motor.	**3**	Apply
21.	Write the applications of synchronous motor.	**3**	Apply
22.	List the inherent disadvantages of synchronous motor.	**2**	Understand
23.	Give some merits and demerits of synchronous motor.	**5**	Evaluate
24.	In what way synchronous motor is different from other motors?	**4**	Analyze

PART – B

Q.No		Questions	BT Level	Competence
1.	**i)**	Draw and explain the constructional details and operating principles of an alternator. (7)	**4**	Analyze
	ii)	Derive the emf equation of a 3ϕ alternator.(6)	**6**	Create

2.	**i)**	What are the reasons for the variation in terminal voltage, when the alternator in on load? Explain each Reason. (2+7=9)	**4**	Analyze
	ii)	Describe briefly the effect of various load power factor of an alternator.(4)	**1**	Remember
3.	**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)	**1**	Remember
	ii)	Draw the vector diagram of a 3ϕ alternator.(6)	**3**	Apply
4.	**i)**	Draw the phasor diagrams of a alternator for lagging power factor load conditions. (5).	**3**	Apply
	ii)	With the help of phasor diagrams, discuss the behaviour of synchronous motor with the constant field excitation and variable load. (8)	**2**	Understand
5.	**i)**	Draw and explain the principle of operation of a synchronous motor. (8)	**4**	Analyze
	ii)	Explain the advantages of stationary armature and rotating field in an alternator.(5)	**5**	Evaluate
6.	**i)**	Draw and explain the vector diagram, when the alternator is loaded with (1) Resistive (2) Inductive and (3) Capacitive (6)	**4**	Analyze
	ii)	Derive the equation for pull-out torque.(7)	**6**	Create
7.		Describe briefly the effect of varying excitation upon the armature current and power factor of a Synchronous Motor when the input real power to the motor is maintained constant. (13)	**1**	Remember
8.	**i)**	Show that the starting torque of a synchronous motor is zero.(7)	**3**	Apply
	ii)	A 3 phase, 500 V, synchronous motor draws a current of 50 A from the supply while driving a certain load. The stator is star connected with armature resistance of 0.4 Ω per phase and a synchronous reactance of 4 Ω per phase. Find the power factor at which motor would operate when the field current is adjusted to give the line values of generated emfas (a) 600 V, and (b) 380 V. (6)	**1**	Remember
9.		A 3.3 kV star connected synchronous motor has a synchronous reactance of 5.5 Ohms. It operates at rated terminal voltage and draws 750 kV from the supply at 0.8 leading p.f. Find its p.f. when the motor shafts load is 1000 kW with same excitation.(13)	**1**	Remember

10.	Discuss in detail the phenomenon of 'hunting' in a synchronous machine. How is it remedied?(13)	**2**	Understand
11.	Derive an expression for the power developed in an synchronous motor.(13)	**6**	Create
12.	Explain why 3ϕ synchronous motor is not self starting. Discuss the possible methods of starting a 3ϕ synchronous motor.(13)	**2**	Understand
13.	A synchronous motor having 40% reactance and a negligible resistance is to be operated at rated at (1) U.p.f (2) 0.8 p.f. lag (3) 0.8 p.f (lead) Find the values of induced e.m.f? Indicate assumptions made if any. (13)	**1**	Remember
14.	A 75 KW, 400 V, 4-pole, 3-phase, star connected synchronous motor has a resistance and synchronous reactance per phase of 0.04 Ω and 0.4 Ω respectively. Compute the open-circuit emf per phase for full load 0.8 p.f lead and gross mechanical power developed. Assume an efficiency of 92.5%. (13)	**3**	Apply
15.	A 3000 V, 3 phase synchronous motor running at 1500 r.p.m, has its excitation kept constant corresponding to no-load terminal voltage 0f 3000 V. Estimate the power input, power factor and torque developed for all armature current of 250 A if the synchronous reactance is 5 Ω per phase and armature resistance is neglected (13)	**2**	Understand
16.	Discuss in detail the procedure of constructing the 'V' curves and inverted 'V' curve of a synchronous motor.(13)	**2**	Understand
17.	Explain the role of damper winding in synchronous machines. Also draw load angle versus time. (13)	**5**	Evaluate
	PART - C		
1.	Analyze the different loading of a synchronous machine for draw a family of V curve and write the procedure to obtain the same experimentally in a lab. (15)	**4**	Analyze
2.	A 2000 V, three phase star connected synchronous motor has an effective resistance and synchronous reactance of 0.2 Ω and 2.2 Ω per phase respectively. The input is 800 KW at normal voltage and the induced line emf is 2500 V. Evaluate the line current and power factor. (15)	**5**	Evaluate
3.	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. (15)	**5**	Evaluate

4.	A 2000V, 3 phase, 4 pole, star connected synchronous motor runs at 1500rpm. The excitation is constant and corresponding to an open circuit voltage of 2000V. The resistance is negligible in comparison with synchronous reactance of 3.5Ω /ph. For an armature current of 200A. Evaluate (i) power factor (ii) power input (iii) torque developed. (15)	**5**	Evaluate
5.	A 400 V, 3 phase, star connected synchronous motor has an armature resistance of 0.2 Ω per phase and synchronous reactance of 2 Ω per phase. While driving a certain load, it takes 25 A from the supply. Find the back emf induced in the motor if it is working with (1) 0.8 power factor lagging, (2) 0.9 power factor leading, and (3) unity power factor. (15)	**5**	Evaluate

UNIT IV - THREE PHASE INDUCTION MOTORS			
SYLLABUS Induction motor-principle of operation, Types - Torque-slip characteristics - Starting methods and Speed control of induction motors.			
PART - A			
Q.No	**Questions**	**BT Level**	**Competence**
1.	Classify the different type of rotors employed in an induction motor.	**4**	Analyze
2.	Compare squirrel cage rotor and slip ring rotor.	**4**	Analyze
3.	Give the advantages and disadvantages of three phase induction motor.	**2**	Understand
4.	Give the advantages of skewing of cage rotor conductors.	**2**	Understand
5.	The air gap between stator core and rotor of an induction motor is made very small. Analyze	**4**	Analyze
6.	Define the term slip of a 3-phase induction motor.	**1**	Remember
7.	Write the importance of slip in a three phase induction motor.	**6**	Create
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.	**3**	Apply
9.	Draw the slip-torque characteristics of a three phase induction motor.	**3**	Apply
10.	State condition at which starting torque developed in a 3 phase induction motor is maximum.	**1**	Remember

11.	Prove that 3 phase flux results in a rotating magnetic field using a phasor diagram.		**5**	Evaluate
12.	Name the test conducted for obtaining the equivalent circuit parameters of 3phase induction motor.		**1**	Remember
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.		**2**	Understand
14.	Write the various starters used for starting a 3 phase Induction motor.		**6**	Create
15.	Rotor resistance starting is preferred to reduced voltage starting of a rotor induction motor. Justify.		**5**	Evaluate
16.	List the methods available to control the speed of an induction motor.		**1**	Remember
17.	What is the speed of rotor field in space?		**1**	Remember
18.	Estimate the synchronous speed of an induction motor running at 2900 r.p.m. with 50 Hz supply?		**2**	Understand
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.		**3**	Apply
20.	Why an induction motor will never run at its synchronous speed?		**1**	Remember
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.		**3**	Apply
22.	What are the two fundamental characteristics of a rotating magnetic field?		**2**	Understand
23.	Under what condition, the slip in an induction motor is (a) Negative (b) Greater than one.		**4**	Analyze
24.	What is meant by synchronous watts?		**5**	Evaluate
		PART - B		
1.	**i)**	Describe in detail, the construction and working principle of three phase induction motor. (4+4)	**1**	Remember
	ii)	With neat diagram discuss the production of rotating magnetic field of three phase induction motor.(5)	**2**	Understand
2.	Draw and explain the construction and principle of operation of three phase slip ring induction motor. How is the construction different in squirrel cage induction motor? (13)		**4**	Analyze

3.	**i)**	List the advantages and disadvantages of an induction motor. (5)	**1**	Remember
	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. (4) The frequency of the rotor currents at stand still. (8)	**3**	Apply
4.	**i)**	Derive the relationship between" (1) Full load torque and maximum torque (3) (2) Starting torque and maximum torque. (3)	**6**	Create
	ii)	Derive the equation for torque under running conditions in a 3-phase induction motor.(7)	**6**	Create
5.	**i)**	Compare squirrel cage induction motor and slip ring induction motor.(6)	**4**	Analyze
	ii)	Derive the condition for maximum torque.(7)	**6**	Create
6.		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)	**1**	Remember
7.	**i)**	Describe the speed-torque characteristic of a three phase induction motor, clearly indicating the starting torque operating torque and maximum torque. (7)	**1**	Remember
	ii)	A 6 pole, 3 φ, 50 Hz induction motor runs on full-load with a slip of 4%. Given the rotor standstill impedance per phase as (0.01+j0.05) Ω, calculate the available maximum torque torque in terms of full load torque. Also Determine the speed at which the maximum torque occurs. (6)	**3**	Apply
8.		Draw and Discuss the slip-torque characteristics of 3-phase induction motor.(13)	**2**	Understand
9.		With a neat diagram, explain the starting of slip-ring induction motor.(13)	**5**	Evaluate
10.		Explain the star-delta method of starting of 3ϕ induction motor.(13)	**4**	Analyze
11.		Draw a neat schematic diagram of any one starter used with induction motor and explain its working. (13)	**3**	Apply
12.		Discuss in detail the various methods of speed control of induction motor.(13)	**2**	Understand

13.	Describe in detail about any one method of speed control of an induction motor with respect to stator and rotor side each. (13)	**2**	Understand
14.	Briefly describe the speed control of three phase induction motors by (i) frequency, and (ii) number of poles. (13)	**1**	Remember
15.	The power input to a 400 volts, 60 Hz, 6-pole, 3-phase induction motor running at 1140 rpm is 40 KW at 0.8 pf lag. Stator losses are 1 KW and the friction and windage losses are 2 KW. Find the following: (1) Slip (2) Rotor copper loss (3) The brake h.p. (4) Efficiency and (5) Input current (13)	**1**	Remember
16.	Discuss briefly different methods of stator side control of speed of a 3ϕ induction motor.(13)	**2**	Understand
17.	Explain the working of autotransformer starter of a 3 phase induction motor with a neat diagram.(13)	**4**	Analyze
	PART - C		
1.	Design the step by step test procedure to obtain the equivalent circuit parameters of a three phase induction motor and draw the equivalent circuit. (15)	**4**	Analyze
2.	The power input to the rotor of a 3 phase, 50 HZ, 6 pole induction motor is 80 KW. The rotor emf makes 100 complete alternations per minute. Evaluate i. Slip ii. Motor Speed iii. Mechanical power developed iv. Rotor copper loss per phase v. Rotor resistance per phase if rotor current is 65 A vi. Torque developed. (15)	**5**	Evaluate
3.	A 100kW, 330V, 50Hz, 3 phase, star connected induction motor has a synchronous speed of 500 rpm. The full load slip is 1.8% and full load power factor 0.85. Stator copper loss is 2440W, iron loss is 3500W, rotational losses is 1200W. Evaluate (i) rotor copper loss, (ii) the line current and (iii) the full load efficiency. (15)	**5**	Evaluate
4.	A 440 V, 3 phase, 8 pole, 50 Hz, star connected induction motor has the following parameters: Stator resistance = 0.1 Ω; Stator reactance = 0.4 Ω Equivalent rotor resistance referred to stator = 0.15 Ω Equivalent rotor reactance referred to stator = 0.44 Ω The stator core loss is 1250 W while mechanical loss is 1000 W. It draws a no load current of 20 A at a p.f. of	**6**	Create

	0.09 lagging. While running at a speed of 727.5 rpm, Calculate: 1) Input line current and p.f.; 2) Torque developed; 3) Output power; 4) Efficiency. Draw approximate equivalent circuit. (15)		
5.	Correlate the operation of a transformer and induction motor in detail. (15)	**5**	Evaluate

UNIT V - SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES			
SYLLABUS Types of single phase induction motors –Double field revolving theory- Capacitor start capacitor run motors – Shaded pole motor – Repulsion type motor – Universal motor – Hysteresis motor – Switched reluctance motor – Brushless D.C motor.-Stepper motor.			
PART - A			
Q.No	**Questions**	**BT Level**	**Competence**
1.	Classify the types of single Phase induction motor.	**3**	Apply
2.	Why a single phase induction motor is not self starting?	**1**	Remember
3.	State principle that the double revolving field theory make use of.	**1**	Remember
4.	Differentiate between "capacitor start" and Capacitor start capacitor run" Single Phase Induction Motor.	**3**	Apply
5.	State any two application of Universal motor.	**1**	Remember
6.	Draw the speed –torque characteristics of a shaded pole motor.	**3**	Apply
7.	How is single phase spilt in a induction motor?	**1**	Remember
8.	Mention the applications of shaded pole motor.	**4**	Analyze
9.	Is it possible to change the direction of rotation of a shaded pole type induction motor? Justify your answer.	**5**	Evaluate
10.	Write the use of shading coil in the shaded pole motor.	**6**	Create
11.	Explain the principle behind repulsion motor.	**5**	Evaluate
12.	How can an universal motor be reversed?	**1**	Remember
13.	What is hysteresis motor?	**1**	Remember
14.	Describe the principle of operation of reluctance motors?	**2**	Understand
15.	Mention the application of switched reluctance motor.	**4**	Analyze
16.	Give the advantages of brushless DC motor.	**2**	Understand
17.	Compare PMBL DC motor and switched reluctance motor.	**4**	Analyze
18.	How universal motor is different from DC motor?	**4**	Analyze
19.	What is a Steppermotor?	**2**	Understand

20.	Design the step angle of a four phase stepper motor with 12 stator teeth and 3 rotor teeth.	**6**	Create
21.	Name the two windings of a single-phase induction motor.	**2**	Understand
22.	Why single-phase induction motor has low power factor?	**5**	Evaluate
23.	Give two advantages and two applications of stepper motor.	**3**	Apply
24.	What types of motor is used in computer drives and wet grinders?	**2**	Understand
	PART - B		
1.	Explain double-field revolving theory of a single phase induction motor.(13)	**4**	Analyze
2.	Write short notes on: (7+6) (1) Hysterisis motor. (2) Universal motors.	**6**	Create
3.	Describe in detail the working, principle of (1) Capacitor start capacitor run motors (7) (2) Repulsion type motor. (6)	**1**	Remember
4.	A small 60 Hz hysteresis motor possesses 32 poles. In making one complete turn with respect to the revolution field, the hysteresis loss in the rotor amount to 0.8 J. Calculate (i) the hysteresis torque, (ii) the maximum power output before the motor stall, (iii) the rotor losses when the motor is stalled, and (iv) the rotor losses when the motor runs at synchronous speed. (13)	**3**	Apply
5.	Describe the construction, working principle and applications of shaded-pole single phase induction motor with neat diagrams.(13)	**1**	Remember
6.	Explain the construction, working principle, characteristics and applications of Universal motor with relevant diagrams.(13)	**5**	Evaluate
7.	With a neat diagram describe the working principle of Brushless DC motor. (13)	**2**	Understand
8.	Describe the construction and principle of working of switched reluctance motor with neat diagrams and mention its applications.(13)	**1**	Remember
9.	Discuss briefly about Brushless DC motor with neat sketch.	**2**	Understand
10.	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. (13)		

11.	With neat sketches, using the double field revolving field theory, explain why a single phase induction motor is not self starting. (13)	**4**	Analyze
12.	A 400 W, 230 V, 50 Hz Capacitor start single-phase induction motor has the following standstill constants for the main and auxiliary windings: Main winding, Zm = 8+j6.8 Ω Auxiliary winding, Za = 17 + j6.0 Ω. Find the value of the starting capacitance that will place the main and auxiliary winding currents in quadrature. (13)	**1**	Remember
13.	A universal series motor has a resistance of 30 Ω and an inductance of 0.5 H. when connected to a 250 V dc supply and loaded to take 0.8 A it runs at 2000 rpm. Determine the speed, torque and power factor, when connected to a 250 V, 50 Hz ac supply and loaded to take the same current. (13)	**3**	Apply
14.	Explain with neat sketch the construction and principle of operation of various types of Stepper Motor. (13)	**4**	Analyze
15.	Describe any one type of single-phase induction motor with necessary diagram.(13)	**1**	Remember
16.	Write short notes on the working principle of Reluctance Motors with diagram. (13)	**6**	Create
17.	Explain with neat sketch the construction and principle of operation of variable reluctance Stepper Motor. (13)	**4**	Analyze
	PART - C		
1.	A 220 , 6-pole, 50 Hz, single-winding single-phase induction motor has the following equivalent circuit parameters as referred to the stator. $R_{1m} = 3.0\Omega$, $X_{1m} = 5.0\Omega$ $R_2 = 1.5\Omega$, $X_2 = 2.0\Omega$ Neglect the magnetizing current. When the motor runs at 97% of the synchronous speed, Evaluate the following: (1) The ratio E_{mf}/E_{mb}. (2) The ratio T_f/T_b. (3) The gross total torque. (15)	**5**	Evaluate
2.	With the derivation of the relevant equation, evaluate the static torque production in SRM? (15)	**5**	Evaluate
3.	There are DC generator and induction motor, each in one number are used many years in the industry. Now, the industry want to modify the existing DC generator and induction motor into AC generator/alternator and synchronous motor, respectively. With necessary construction diagram, explain, what are all the modifications required to perform satisfactorily. Also explain, why induction motor is also called as rotating transformer. (15)	**4**	Analyze

4.	A three phase, four pole BLPM motor has 36 stator slots. Each phase winding is made up of three coils per pole with 20 turns per coil. The coil span is seven slots. If the fundamental component of magnetic flux is 1.8 mwb. Estimate the open circuit phase emf Eg at 3000 rpm. (15)	**5**	Evaluate
5.	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. (15)	**6**	Create

************ALL THE BEST************