INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

ELECTRCIAL AND ELECTRONICS ENGINEERING

TUTORIAL QUESTION BANK

Course Title	**ELECTRICAL MACHINES-I**				
Course Code	**AEEB11**				
Programme	**B.Tech**				
Semester	**III**	**EEE**			
Course Type	**Core**				
Regulation	**IARE - R18**				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Mr. K Devender Reddy, Assistant Professor				
Course Faculty	Dr. P Sridhar, Professor Mr. K Devender Reddy, Assistant Professor				

COURSE OBJECTIVES

This course examines the basic theory, construction, operation, performance characteristics and application of electromechanical energy conversion devices such as DC generators and motors. It also gives an in-depth knowledge on the operation of single phase and three phase transformers and it's testing. It also focus on the auto transformers, on-load, off-load tap changers which are widely used in real time applications.

COURSE OBJECTIVES:

The course should enable the students to:	
I	Understand the concepts of magnetic circuits and illustrate the theory of electromechanical energy conversion and the concept of co-energy.
II	Understand the operation of dc machines.
III	Analyze the differences in operation of different dc machine configurations
IV	Analyze single phase and three phase transformers circuits

COURSE OUTCOMES (COs):

CO1	Describe the basic concepts of electro-mechanical energy conversion, energy balance, energy stored in magnetic field, co-energy, single and multi excited systems.
CO2	Discuss the working principle, losses, efficiency, characteristics and various tests of DC generator.
CO3	Analyze the working principle, losses, efficiency, characteristics and various tests of DC motor.
CO4	Describe the working principle, EMF equation, phasor diagram, losses, efficiency, regulation, characteristics and various tests of single phase transformer.
CO5	Analyze the working principle, various connections of three phase transformer. Auto transformer, Scott connection, on load and off load tap changing transformer, cooling methods.

COURSE LEARNING OUTCOMES (CLOs):

Students, who complete the course, will have demonstrated the ability to do the following:

S. No	Description
AEEB11.01	Solve simple and complex problems related to electromagnetic circuits.
AEEB11.02	Describe the basic electromagnetic energy conversion process, energy storage and energy balance.
AEEB11.03	Derive the force and torque produced in singly excited, multi excited magnetic systems.
AEEB11.04	Outline the construction, operation and the windings used in DC machines
AEEB11.05	Illustrate the concept of armature reaction and study characteristics and applications of DC generators.
AEEB11.06	Examine the parallel operation of DC generators, importance of equalizer bars and load sharing.
AEEB11.07	Study the significance of back EMF, torque-speed characteristics and speed control of DC motors
AEEB11.08	Classify the different types of losses occurred in DC machines.
AEEB11.09	Determine the efficiency of DC machines by conducting direct and indirect tests.
AEEB11.10	Discuss the principles of operation, construction and EMF equation of single phase transformers.
AEEB11.11	Explain the operation of single phase transformer under no-load and on-load along with its phasor diagrams.
AEEB11.12	Calculate the efficiency and regulation of single phase transformers by conducting different tests.
AEEB11.13	Examine the parallel operation of single phase transformers and analyze the load sharing.
AEEB11.14	Summarize the different types of connections of three phase transformers.
AEEB11.15	Demonstrate the operation of open delta connection and Scott connection with two single phase transformers.
AEEB11.16	Explain the functioning of autotransformers, tap changing transformers and off-load, on-load tap changers.

TUTORIAL QUESTION BANK

MODULE-I				
MAGNETIC FIELDS AND MAGNETIC CIRCUITS				
Part –A (Short Answer Questions)				
S. No	**Question**	**Blooms Taxonomy Level**	**Course Outcomes**	**Course Learning Outcomes(CLOs)**
1	Define magnetic flux and magnetic flux density.	Remember	CO 1	AEEB11.01
2	State Fleming’s left hand rule.	Remember	CO 1	AEEB11.01
3	State Fleming’s right hand rule.	Remember	CO 1	AEEB11.01
4	Write energy balance equation for motor.	Understand	CO 1	AEEB11.03
5	Give the expression for energy density of magnetic field.	Remember	CO 1	AEEB11.03
6	Give the examples of singly excited and doubly excited electromechanical energy conversion devices.	Remember	CO 1	AEEB11.04
7	Give an expression for energy density in an electric field.	Remember	CO 1	AEEB11.03
8	Draw a diagram indicating flow of energy in motor.	Remember	CO 1	AEEB11.03
9	Draw a diagram indicating flow of energy in generator.	Understand	CO 1	AEEB11.03
10	Define energy and co energy.	Remember	CO 1	AEEB11.02
11	Define the principle of energy conversion.	Understand	CO 1	AEEB11.02
12	Draw the general representation of electro-mechanical conversion device.	Understand	CLO 1	AEEB11.02
13	Describe why energy storing capacity of magnetic field is much larger than that of electric field.	Understand	CO 1	AEEB11.03
14	Give the expression for energy density in an electric field.	Remember	CO 1	AEEB11.03
15	Write the expression for torque produced in doubly excited magnetic field system.	Remember	CO 1	AEEB11.04
Part – B (Long Answer Questions)				
1	Explain the principle of energy conversion. Draw the general representation of electromechanical conversion device.	Understand	CO 1	AEEB11.02
2	Define and explain the concept of transformer EMF and motional EMF in DC machines.	Remember	CO 1	AEEB11.01
3	Derive the relation for the magnetic stored energy in terms of reluctance in a singly excited magnetic system.	Understand	CO 1	AEEB11.03
4	Describe the concept of energy stored in singly excited and multiply excited magnetic field systems.	Understand	CO 1	AEEB11.03
5	Discuss and write an energy balance equation for a motor based on the principle of energy conversion.	Remember	CO 1	AEEB11.03
6	Discuss and write an energy balance equation for a generator based on the principle of energy conversion.	Understand	CO 1	AEEB11.03
7	Derive the expression for energy stored in singly excited magnetic field system using the concept of co energy.	Remember	CO 1	AEEB11.04

8	Derive the expression for energy stored in singly excited magnetic field system by energy method.	Remember	CLO 1	AEEB11.04
9	Explain the concept of energy flow in electromechanical devices and draw the energy flow diagram for motor and generator.	Understand	CO 1	AEEB11.03
10	Derive the expression for magnetic force for a singly excited magnetic field system.	Remember	CO 1	AEEB11.04
11	Derive the expression of torque developed in doubly excited magnetic field system?	Understand	CO 1	AEEB11.04
12	Explain how electromotive force (EMF) is induced in a coil rotating in the magnetic field	Understand	CO 1	AEEB11.01
13	Derive the expression for energy stored in a doubly excited magnetic field system?	Remember	CO 1	AEEB11.04
14	Derive the expression of magnetic force developed in doubly excited magnetic field system?	Understand	CO 1	AEEB11.04
15	Derive the expression of magnetic force developed in doubly excited magnetic field system using the concept of co energy?	Remember	CO 1	AEEB11.04
	Part – C (Analytical Questions)			
1	The magnetic flux density on the surface of an iron face is 1.6 T which is a typical saturation level value for ferromagnetic material. Find the force density on the iron face.	Understand	CO 1	AEEB11.04
2	In an electromagnetic relay excited from a voltage source, the current and flux linkages are related as $i = \lambda^2 + 2\lambda(1-x)^2$; $x<1$. Find the force on the armature as a function of λ.	Understand	CO 1	AEEB11.04
3	Find the torque developed in a doubly excited magnetic field system, the current in stator winding is $\mathbf{i_1=1A}$, and current in rotor winding is $\mathbf{i_2 = 0.02A}$. the various inductances of the system are $L_{11} = (4+\cos 2\theta)$ mH $L_{12} = (0.15 \cos\theta)$ H $L_{22} = (20+5\cos 2\theta)$ H	Analyze	CO 1	AEEB11.04
4	Two coupled coils have self inductance and mutual inductance of $L_{11} = 2 + \frac{1}{2x}$; $L_{22} = 1 + \frac{1}{2x}$; $L_{12} = L_{21} = \frac{1}{2x}$ on a certain range of linear displacement x. The first coil is excited by a constant current of 20A and second by a constant current of -10A. Determine the mechanical work done and energy supplied by each source, if x changes from 0.5 to 1 m.	Understand	CO 1	AEEB11.04
5	The field winding of a DC electromagnet is wound with 960 turns and has resistance of 50 ohms. The exciting voltage is 230V and the magnetic flux linking the coil is 5mWb. Find the self inductance of the coil and energy stored in the magnetic field.	Analyze	CO 1	AEEB11.03
6	A coil is wound on an iron core to form a solenoid. A certain current is passed through the coil which is producing a flux of 40µWb. The length of the magnetic circuit is 75 cm. while it's cross sectional area is 3 sq.cm. Calculate energy stored per unit volume of the circuit and the total energy stored in the circuit.	Understand	CO 1	AEEB11.03
7	The various inductances of a doubly excited magnetic system are given as $L_{11} = (4+\cos 2\theta)$ mH $L_{12} = (0.15 \cos\theta)$ H $L_{22} = (20+5\cos 2\theta)$ H Determine the torque developed for a current flowing in the stator winding as 1A, and current flowing in the rotor winding as 0.01A.	Analyze	CO 1	AEEB11.04
8	An iron ring of mean diameter 15cm and cross sectional area of 10 sq.cm is wound with 200 turns of wire. There is an air gap of 2mm cut in the ring. For a flux density of $1 Wb/m^2$ and relative permeability of 500, determine the exciting current, inductance and the stored energy in the magnetic field.	Understand	CO 1	AEEB11.03

9	A coil of 500 ohm resistance is lying in a magnetic field of 1.5 Wb. Find the EMF induced in the coil and the current in the coil if the coil is moved from the given field to a field of 0.5mWb in 0.25 sec. the number of turns of the coil are 500.	Understand	CO 1	AEEB11.01
10	The inductance of a coil is 0.15H and the coil has 100 turns. Calculate the (i) total magnetic flux through the coil when the current is 4A. (ii) energy stored in the magnetic field (iii) Voltage induced in the coil when current is reduced to zero in 0.01sec.	Analyze	CO 1	AEEB11.03
11	An iron ring of 20cm mean diameter having cross sectional area of 100 sq.cm. is wound with 400 turns of wire. Calculate the exciting current require to establish a flux density of 1 Wb/m^2, if the relative permeability of iron is 1000. Calculate the value of energy stored in the magnetic field.	Understand	CO 1	AEEB11.03
12	A coil of 100 turns is wound on a torroidal magnetic core having a reluctance of 10^4 AT/Wb. When the coil current is 5A and is increasing at a rate of 200A/sec, determine the energy stored in the magnetic field and voltage applied across a coil. Assume coil resistance as zero.	Understand	CO 1	AEEB11.03
13	A solenoid has 1200 turns and carries a current of 2A. The iron core has a length of 0.4m, cross sectional area of 80 sq.cm and relative permeability of 1000. Calculate the self induced EMF in the solenoid, if the current is switched off in 0.001sec.	Analyze	CO 1	AEEB11.01
14	A coil of 300 turns wound on a core of non magnetic material has an inductance of 10mH. Calculate the (i) flux produced by a current of 5A, and (ii) the average value of EMF induced when a current of 5A is reversed in 8milli seconds.	Understand	CO 1	AEEB11.01
15	Find the inductance of the coil in which (i) current of 0.1 yields energy storage of 0.05J and (ii) a current of 0.1 A increasing at a rate of 0.5A/sec represents a power flow of 0.5 watt.	Understand	CO 1	AEEB11.03
MODULE-II				
DC GENERATORS				
Part– A (Short Answer Questions)				
1	State the principle of DC generator.	Remember	CO 2	AEEB11.05
2	Describe the functioning of Yoke, commutator and brushes in DC machine.	Understand	CO 2	AEEB11.05
3	List out the rotating parts and stationary parts in DC machine.	Remember	CO 2	AEEB11.05
4	Explain why electro magnets are preferred over permanent magnets in large DC machines?	Understand	CO 2	AEEB11.05
5	Explain why the armature core of a DC machine is laminated.	Remember	CO 2	AEEB11.05
6	List out the different types of armature winding used in DC machines.	Remember	CO 2	AEEB11.06
7	Differentiate between lap winding and wave winding.	Understand	CO 2	AEEB11.06
8	List out the different types of DC generators and write its applications.	Remember	CO 2	AEEB11.05
9	Write the EMF equation of a DC generator.	Remember	CO 2	AEEB11.05
10	Define commutation and commutation period.	Understand	CO 2	AEEB11.05
11	Classify the different types of DC generators.	Remember	CO 2	AEEB11.05

12	Define armature reaction in DC generators.	Understand	CO 2	AEEB11.05
13	Define the terms critical field resistance and critical speed in DC generators.	Understand	CO 2	AEEB11.05
14	List out the methods for improving the commutation in DC generators.	Remember	CO 2	AEEB11.05
15	List the advantages of operating the DC generators in parallel.	Remember	CO 2	AEEB11.07
Part – B (Long Answer Questions)				
1	Describe the principle of operation and constructional details of a DC machine with neat sketch.	Understand	CO 2	AEEB11.05
2	Explain why a commutator and brush arrangement is necessary for the operation of a DC machine.	Understand	CO 2	AEEB11.05
3	Define the principle of operation and derive the equation of EMF induced in a DC generator.	Remember	CO 2	AEEB11.05
4	Classify and explain the different types of DC generators with neat circuit diagrams.	Remember	CO 2	AEEB11.05
5	Explain the process of voltage build up in self excited DC generators and state the conditions for self excitation.	Understand	CO 2	AEEB11.05
6	Sketch the magnetization characteristics of a DC shunt generator and from the characteristics give the expression for determining the critical resistance.	Understand	CO 2	AEEB11.05
7	Classify and explain the different types of characteristics for a DC shunt generator.	Remember	CO 2	AEEB11.05
8	Classify and explain the different types of characteristics for a DC series generator.	Understand	CO 2	AEEB11.05
9	Describe the causes for the failure of voltage build up in self excited DC generator and suggest the remedies to overcome this problem.	Remember	CO 2	AEEB11.05
10	Explain armature reaction in DC generator with neat diagrams and show how cross magnetizing and demagnetizing MMF 's are produced.	Understand	CO 2	AEEB11.05
11	Describe the effects of armature reaction and the remedies employed for decreasing the effects of armature reaction.	Understand	CO 2	AEEB11.05
12	Derive the expressions for determination of demagnetizing and cross magnetizing ampere turns per pole in DC generators.	Remember	CO 2	AEEB11.05
13	Describe the process of commutation in DC generators with neat sketches and illustrate the methods for improving commutation.	Understand	CO 2	AEEB11.05
14	Explain the following: i) Ideal commutation i) Period of commutation ii) Reactance voltage during commutation	Remember	CO 2	AEEB11.05
15	Explain the parallel operation of DC shunt and series generators and load sharing.	Understand	CO 2	AEEB11.07
16	Explain the working of equalizer bar in parallel operation of DC series generators.	Understand	CO 2	AEEB11.07
Part – C (Analytical Questions)				
1	A 250V lap wound DC generator has full load armature current of 100A. The armature resistance is 0.2Ω and the number of armature conductors is 272. The contact drop for the two brushes is 2V and flux per pole is 0.05Wb. Determine the generated EMF and speed.	Understand	CO 2	AEEB11.05
2	A 4 pole DC shunt generator with wave connected armature has 41 slots and 12 conductors per slot. Ra = 0.5 Ω, Rsh = 200 Ω and flux per pole is 125Wb. When the generator is driven at a speed of 1000 rpm, calculate the voltage across 10 Ω load resistance connected across the armature terminals.	Analyze	CO 2	AEEB11.05

3	A 4 pole DC generator having wave wound armature has 50 slots and 25 conductors per slot. Find the generated EMF. if it is driven at 25rpm and useful flux per pole in the machine is 0.03 Wb.	Understand	CO 2	AEEB11.05
4	A 4 pole lap wound 750 rpm DC shunt generator has an armature resistance of 0.4 ohms and field resistance of 200 ohms. The armature has 720 conductors and the flux per pole is 30 mWb. If the load resistance is 10 Ω, determine the terminal voltage.	Analyze	CO 2	AEEB11.05
5	A 250 KW, 400 V, 6 pole lap connected armature has 720 conductors and it is given a brush lead of 2.5 degrees mechanical from its GNA. Calculate demagnetizing and cross magnetizing AT/pole. Neglect shunt field current.	Understand	CO 2	AEEB11.05
6	A 4pole generator has wave wound armature with 722 conductors, and it delivers 100A on full load. If the brush lead is 8 degrees, calculate the armature demagnetizing and cross magnetizing ampere turns per pole.	Understand	CO 2	AEEB11.05
7	The brushes of a certain lap connected 400 KW, 6 pole generator is given a lead of 18 degrees (electrical). calculate i) the demagnetizing ampere turns ii) the cross magnetizing ampere turns iii) series turns required to balance the demagnetizing component The full load current is 750 A, total numbers of conductors are 900 and the leakage coefficient is 1.4.	Analyze	CO 2	AEEB11.05
8	4 pole lap wound DC generator supplies a current of 143A. It has 492 armature conductors. When delivering full load, brushes are given an actual lead of 10 degrees. Calculate the demagnetizing ampere turns per pole. The field winding is shunt connected and takes 10A, calculate the number of extra shunt field turns required to neutralize the demagnetization.	Understand	CO 2	AEEB11.05
9	A 4 pole wave wound dc machine has an armature of 25cm diameter and runs at a speed of 1200rpm. If the armature current is 160A, thickness of brush is 12mm and the self inductance of each armature coil is 0.14mH. Calculate the average EMF induced in each coil during commutation.	Analyze	CO 2	AEEB11.05
10	Calculate the reactance voltage for a machine having the following particulars. Number of commutator segments = 55; Revolutions per minute = 900; Brush width in commutator segments = 1.74; Coefficient of self inductance = 153 x 10^{-6} H; Current per coil = 27A.	Understand	CO 2	AEEB11.05
11	A 440 V, 4 pole, 25KW dc generator has a wave connected armature winding with 846 conductors. The mean flux density in the air gap under the interpoles is 0.5 Wb/m^2 on full load and the radial gap length is 0.4cm. Calculate the number of turns required on each interpole.	Understand	CO 2	AEEB11.05
12	Two DC generators having Rectilinear external characteristics operate in parallel. One machine has the terminal voltage of 270V on no load and 220Vat the load current of 30A. The other has a voltage of 280V at no load and 220 V at a load current of 30A. calculate the output current and the bus voltage of ach machine when the i) total load current is 50A and ii) load resistance is 10 Ω.	Analyze	CO 2	AEEB11.07
13	Two shunt generators with straight line characteristics are operated in parallel. Their no load voltages being 240 V and 245 V respectively. The ratings of the above generators are 500 KW at 230 V and 250 KW at 220 V. If he total load supplied is 650 KW, calculate the i) the terminal voltage, and ii) Power supplied by each	Understand	CO 2	AEEB11.07

	machine in KW.			
14	The terminal voltage of DC shunt generator G1 falls from 500V at no load to 470V when delivering a current of 600A. For a second generator G2, the figures are 505V at no load and 470V at 400A. When connected in parallel generators supply a total load of 400KW. Assuming that the voltage/power characteristics are linear, determine the common bus voltage and the current delivered by each machine.	Understand	CO 2	CAEEB11.07
15	Two shunt wound generators running in parallel have each an armature resistance of 0.02 ohms and field resistance of 50 ohms. The combined external load current is 5000A. The fields are excited so that the EMF induced in one machine is 600V and in the second machine is 610V. Calculate the bus bar voltage and the output of the each machine.	Analyze	CO 2	AEEB11.07
MODULE-III				
DC MOTORS AND TESTING				
Part – A (Short Answer Questions)				
1	Differentiate DC motor from a DC generator.	Understand	CO3	AEEB11.08
2	Describe is the function of commutator in DC motor.	Remember	CO3	AEEB11.08
3	Define the principle of operation of DC motor.	Remember	CO3	AEEB11.08
4	Explain why the EMF generated in the armature of a DC motor is called the back EMF?	Remember	CO3	AEEB11.08
5	Write the expression for torque produced in DC motor.	Remember	CO 3	AEEB11.08
6	Describe how the direction of rotation of DC motor will be reversed?	Understand	CO3	AEEB11.08
7	Illustrate how the direction of rotation of DC motor is determined?	Remember	CO 3	AEEB11.08
8	List out the different types of DC motors.	Remember	CO 3	AEEB11.08
9	State the condition for maximum power developed in DC motor.	Understand	CO 3	AEEB11.08
10	Describe why a series motor should not be run without load.	Understand	CO 3	AEEB11.08
11	State the significance of back emf in DC motors?	Remember	CO 3	AEEB11.08
12	Illustrate the necessity of starter in DC motors.	Remember	CO 3	AEEB11.08
13	List the different types of starters used in starting of DC motor	understand	CO 3	AEEB11.08
14	List the different methods of speed control of DC shunt motor.	Remember	CO 3	AEEB11.08
15	List the different methods of speed control of DC series motor.	Remember	CO 3	AEEB11.08
1	List out the different types of losses occurred in DC motors.	Understand	CO 3	AEEB11.09
2	Define hysteresis and eddy current losses.	Understand	CO 3	AEEB11.09
3	List the factors on which hysteresis and eddy current losses will depend.	Remember	CO 3	AEEB11.09
4	Describe how the eddy current and hysteresis losses be minimized.	Remember	CO 3	AEEB11.09

5	How do various losses occurred in a DC machine vary with load?	Understand	CO 3	AEEB11.09
6	Describe about core losses and copper losses in DC machines.	Understand	CO 3	AEEB11.09
7	Define efficiency and give the condition for getting maximum efficiency in DC motor.	Remember	CO 3	AEEB11.09
8	Define the speed regulation for a DC motor.	Remember	CO 3	AEEB11.09
9	List the different types of tests which can be made for different types of DC motors.	Remember	CO 3	AEEB11.10
10	Write the merits and demerits of Brake test and Swinburne's test.	Remember	CO 3	AEEB11.10
11	Explain why Swinburne's test cannot be performed on DC series motor.	Understand	CO 3	AEEB11.10
12	Illustrate the drawbacks of Swinburne's test?	Remember	CO 3	AEEB11.10
13	Field's test is performed on which type of DC machines? List any two disadvantages of field's test.	Remember	CO 3	AEEB11.10
14	Explain why Hopkinson's test is also called as back to back test.	Understand	CO 3	AEEB11.10
15	Write the advantages and disadvantages of Regenerative test.	Remember	CO 3	AEEB11.10
Part – B (Long Answer Questions)				
1	Explain the principle of operation of DC motors.	Understand	CO 3	AEEB11.08
2	Derive the torque equation of a DC motor.	Remember	CO 3	AEEB11.08
3	Explain the different types of motors with equivalent circuits.	Understand	CO 3	AEEB11.08
4	Explain the armature reaction in DC motor indicating few remedies to its adverse effects.	Understand	CO 3	AEEB11.08
5	Explain the different characteristics of DC motors with neat sketches.	Understand	CO 3	AEEB11.08
6	List the applications of DC series, DC shunt and DC compound motors.	Remember	CO 3	AEEB11.08
7	What are the factors that affect the speed of a DC motor? Explain.	Understand	CO 3	AEEB11.08
8	Explain how the speed can be controlled above and below the normal speed in case of a DC shunt motor.	Understand	CO 3	AEEB11.08
9	Describe different methods of speed control of DC series motors with relevant circuit diagrams.	Remember	CO 3	AEEB11.08
10	Explain the necessity of starter in DC motors and list the different types of starters used in DC motors.	Understand	CO 3	AEEB11.08
11	Explain the operation of a three point starter with neat sketch.	Understand	CO 3	AEEB11.08
12	Make a neat sketch showing the internal wiring of a four point starter and explain the functioning of each part of the starter.	Remember	CO 3	AEEB11.08
13	Explain the Ward Leonard method of speed control of DC motors.	Understand	CO 3	AEEB11.08
14	Explain the different losses in a DC machine. Derive the condition for maximum efficiency of a DC machine.	Understand	CO 3	AEEB11.09
15	Explain how the efficiency of a DC machine is calculated from Swinburne's test.	Understand	CO 3	AEEB11.10
16	Explain with diagram how Hopkinson's test is performed in DC machines.	Remember	CO 3	AEEB11.10

17	Explain how brake test is conducted on DC machine to determine the efficiency.	Understand	CO 3	AEEB11.10
18	Explain how Field's test is conducted on DC series machines.	Understand	CO 3	AEEB11.10
19	Explain briefly the Retardation test conducted on DC machines.	Understand	CO 3	AEEB11.10
20	Explain how the losses in a DC machine are separated from total losses.	Understand	CO 3	AEEB11.10
Part – C (Analytical Questions)				
1	A 25KW, 250V DC shunt generator has armature and field resistances of 0.06ohms and 100ohms respectively. Determine the total armature power delivered when working (i) as generator delivering 25KW output and (ii) as motor taking 25KW input.	Understand	CO 3	AEEB11.08
2	A 230V series motor is taking 50A. Resistances of armature and series field windings are 0.2ohms and 0.1ohms respectively. Calculate i) Brush voltage ii) Back EMF iii) Power wasted in armature and mechanical power developed.	Understand	CO 3	AEEB11.08
3	A 250V shunt motor has armature and field resistances of 1ohm and 125ohms respectively. When running light, it takes a current of 5A and the speed is 1500rpm. i) Find the motor speed at full load, the input current being 25A. ii) Find also the speed at this load if a resistance of 2.5ohms is inserted in the armature circuit.	Analyze	CO 3	AEEB11.08
4	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 0.15 Ω, calculate the value of 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 value. Assume flux proportional to the current.	Understand	CO 3	AEEB11.08
5	A 220V, 4 pole shunt motor has 540 lap wound conductors. It takes 32A from the supply mains and develops output power of 5.595KW. The field winding takes 1A. The armature resistance is 0.9 ohms and the flux per pole is 30 mWb. Calculate i) the speed and ii) the torque developed in Newton meters.	Understand	CO 3	AEEB11.08
6	A 20KW, 250V dc shunt motor has full load armature current of 85A at 1100 rpm. the armature resistance is 0.18 ohms. Determine i) the internal torque developed ii) the internal torque if the field current is suddenly reduced to 80% of its original value. iii) the steady motor speed in part (ii) assuming the load torque remaining constant.	Analyze	CO 3	AEEB11.08
7	A 220V dc shunt motor runs at 760rpm and takes armature current of 48A. find the resistance to be added to the field circuit to increase the speed to 950 rpm at an armature current of 78A. Assume flux is proportional to field current. Armature resistance and field resistances are 0.15ohm and 250ohm respectively.	Understand	CO 3	AEEB11.08
8	A 220V shunt motor with an armature resistance of 0.5ohm is excited to give constant main field. At full load the motor runs at 500rpm and takes an armature current of 30A. If a resistance of 1ohm is placed in the armature circuit find the speed at (a) full load torque and (b) double full load torque.	Understand	CO 3	AEEB11.08
9	A dc series motor with unsaturated magnetic circuit and negligible resistance, when running at a certain speed on a given load takes 50A at 500V. if the load torque varies as the cube of the speed, find the resistance to be inserted to reduce the speed by 50%.	Analyze	CO 3	AEEB11.08

10	A shunt generator delivers 195A at terminal voltage of 250V, the armature resistance and shunt field resistance are 0.02ohms and 50ohms respectively. The iron and friction losses equals to 950W. Find (a) emf generated (b) copper losses (c) output of the prime mover (d) commercial, mechanical and electrical efficiencies.	Understand	CO 3	AEEB11.09
11	A 440 V Dc shunt motor takes a no load current of 2.5A. The resistance of shunt field and the armature are 550 Ω and 1.2 Ω respectively. The full load line current is 32 A. Find the full load output and the efficiency of the motor.	Understand	CO 3	AEEB11.09
12	In a brake test on dc shunt motor, the load on one side of the brake band was 35Kg and the other side 5Kg. the motor was running at 1300 rpm: its input being 70A at 420V dc. The pulley diameter is 1m. Determine the torque, output of the motor and efficiency of the motor.	Understand	CO 3	AEEB11.10
13	The results of Hopkinson's test on two similar DC machines are as follows: Line voltage 220V, motor armature current 23A, generator armature current 20A, generator field current 0.4A, and motor armature current 0.3A. armature resistance of each machine 0.5ohm. Calculate the efficiency of each machine.	Analyze	CO 3	AEEB11.10
14	A Field's test on two mechanically coupled series motors (with their field windings connected in series) gave the following test data; **Motor:** armature current-50A, armature voltage 500V, field wining voltage drop-38V **Generator:** armature current-38A, armature voltage 400V, field wining voltage drop-36V Resistance of each armature is 0.2 ohms. Calculate the efficiency of each machine at this load.	Understand	CO 3	AEEB11.10
15	The hysteresis and eddy current losses in a dc machine running at 100rpm are 250W and 100W respectively. If the flux remains constant, at what speed will the total iron losses be halved?	Analyze	CO 3	AEEB11.10
MODULE-IV				
SINGLE PHASE TRANSFORMERS				
Part – A (Short Answer Questions)				
1	State the principle of a transformer.	Remember	CO 4	AEEB11.11
2	Can we give the dc supply to a transformer? Explain.	Understand	CO 4	AEEB11.11
3	Classify the different types of losses in a transformer.	Remember	CO 4	AEEB11.11
4	Define the voltage regulation of a transformer and write its expression.	Remember	CO 4	AEEB11.11
5	Define efficiency of a transformer and write its expression.	Remember	CO 4	AEEB11.12
6	Give is the condition to get maximum efficiency of a transformer.	Remember	CO 4	AEEB11.12
7	Define eddy current loss and hysteresis loss.	Understand	CO 4	AEEB11.12
8	Describe an ideal transformer.	Remember	CO 4	AEEB11.11
9	Give the EMF equation of a transformer.	Remember	CO 4	AEEB11.11
10	Define transformation ratio.	Remember	CO 4	AEEB11.11

11	Draw the circuit symbol of a transformer and list the main components in it.	Remember	CO 4	AEEB11.11
12	Define step up and step down transformer.	Remember	CO 4	AEEB11.11
13	How to minimize the hysteresis and eddy current losses in a transformer.	Understand	CO 4	AEEB11.12
14	Define all day efficiency of a transformer.	Remember	CO 4	AEEB11.12
15	Explain why a transformer is rated in KVA.	Understand	CO 4	AEEB11.11
16	Draw the equivalent circuit of a transformer referred to primary side.	Remember	CO 4	AEEB11.11
Part – B (Long Answer Questions)				
1	Define a transformer. Explain the principle of operation of a transformer.	Understand	CO 4	AEEB11.11
2	Distinguish between core type and shell type transformer. Why the low voltage winding is placed near the core? Why the core of a transformer is laminated?	Remember	CO 4	AEEB11.11
3	Derive an expression for EMF induced in a transformer.	Remember	CO 4	AEEB11.11
4	What is an ideal transformer? Draw and explain the phasor diagram of an ideal transformer.	Understand	CO 4	AEEB11.11
5	Draw and explain the phasor diagram of a single phase transformer under zero lagging power factor	Understand	CO 4	AEEB11.11
6	Define voltage regulation of a transformer. Derive an expression for voltage regulation under lagging p.f. load.	Remember	CO 4	AEEB11.11
7	Derive the condition for zero voltage regulation and condition for maximum voltage regulation of a transformer,	Understand	CO 4	AEEB11.11
8	What are the objectives of testing a transformer? Discuss how polarity of a transformer is determined from polarity test.	Remember	CO 4	AEEB11.12
9	Explain why Sumpner's test is also called as back to back test.	Understand	CO 4	AEEB11.12
10	What are the conditions for parallel operation of transformers?	Remember	CO 4	AEEB11.13
11	What are the advantages of parallel operation of transformers?	Remember	CO 4	AEEB11.13
12	Discuss the procedure for conducting OC and SC tests on a single phase transformer. How can the equivalent circuit parameters are calculated from these tests.	Understand	CO 4	AEEB11.12
13	State the various losses which take place in a transformer. On what factors do they depend? Explain the steps taken to minimize these losses.	Remember	CO 4	AEEB11.12
14	Describe how the back-to-back test is conducted on two identical transformers.	Understand	CO 4	AEEB11.12
15	Briefly explain heat run test on a single phase transformer.	Understand	CO 4	AEEB11.12
Part – C (Analytical Questions)				
1	Find the cross sectional area of the core of a 10 turns transformer for a voltage of 50 V at 50 Hz. The flux density is 0.9 wb/m^2.	Understand	CO 4	AEEB11.11
2	The EMF per turn of a single phase 440/220 V, 50 Hz transformer is approximately 15 V. find i) The number of primary and secondary turns ii) The net cross sectional area of the core for a maximum flux density of 1 wb/ m^2.	Analyze	CO 4	AEEB11.11
3	A 300 KVA transformer having primary voltage of 3000 V at 50 Hz has 300 primary and 50 secondary turns. Calculate i) the full load primary and secondary currents	Understand	CO 4	AEEB11.11

	ii) The no load secondary induced EMF iii) The maximum flux in the core (neglecting all losses).			
4	A 1000 KVA transformer has primary and secondary turns of 4000 and 1000 respectively and induced voltage in secondary is 1000 V. find i) the primary volt ii) the primary and secondary full load current iii) the secondary current when 100 KW load at 0.8 p.f. is connected at the output.	Understand	CO 4	AEEB11.11
5	a 200/400 V, 50 Hz transformer has peak flux density of 1.1 wb/ m^2 in the core and net area of cross section of the core is 0.02 sq.meter. If the current density in the conductor is 3 A/$mm^2$and conductor diameter of primary coil is 3 mm. determine the KVA rating of the transformer and the number of primary and secondary turns.	Understand	CO 4	AEEB11.11
6	A 17.5 KVA, 460/115 V single phase, 50 Hz transformer has primary and secondary resistances of 0.36 ohms and 0.02 ohms respectively, and leakage reactance of these windings are 0.82 ohms and 0.06 ohms respectively. Determine the voltage to be applied to the primary to obtain full load current with the secondary winding short circuited. Neglect the magnetizing current.	Analyze	CO 4	AEEB11.11
7	A transformer has 4% reactance and 6% reactance drop. Find the voltage regulation at full load (a) 0.8 p.f. lagging, (b) 0.8 p.f. leading, and (c) unity p.f.	Understand	CO 4	AEEB11.12
8	A 40 KVA, 2500/500 V single phase transformer has the following parameters: R_1=8 ohms, R_2=0.5ohms, X_1=20ohms, X_2=0.8 ohms. Find the voltage regulation and secondary terminal voltage at full load for a p.f. of 0.8 lagging. The primary voltage is held constant at 2500 V.	Understand	CO 4	AEEB11.12
9	The a 20 KVA, 2000/200 V single phase transformer has a primary resistance of 2.1 ohms and secondary resistance of 0.026 ohms. If the total iron loss is 200 W, find the efficiency on (a) full load and at a p.f. of 0.5 lagging, (b)half load and a p.f. of 0.8 leading.	Analyze	CO 4	AEEB11.12
10	A 4 KVA, 200/400 V, 50 Hz single phase transformer has equivalent resistance referred to primary as 0.15 Ω. Calculate i) The total copper losses on full load. ii) The efficiency while supplying full load at 0.9 p.f. lagging. iii) The efficiency while supplying half load at 0.8 p.f. leading. Assume total iron losses equal to 60 W.	Understand	CO 4	AEEB11.12
11	In a 20 KVA, 2000/200 V transformer, the iron and copper losses are 340 and 410 watts respectively. (a) Calculate the efficiency o u.p.f. at full load and half load (b) Determine the load for maximum efficiency and the iron and copper losses in this case.	Analyze	CO 4	AEEB11.12
12	A single phase 200/400 V, 6 KVA, 50 Hz transformer gave the following results. OC test(lv side) : 200 V, 0.8 A, 80 W SC test(hv side) : 25 V, 10 A, 90 W Determine (i) the circuit constants referred to L.V side. (ii) the efficiency at full load with 0.8 lagging p.f.	Understand	CO 4	AEEB11.12
13	A 5 KVA, 500/250 V, 50 Hz, single phase transformer gave the following results. O.C. Test : 500 V, 1 A, 50 W (L.V. side open) S.C. Test : 25 V, 10 A, 60 W(L.V. side shorted)	Understand	CO 4	AEEB11.12

	Draw the equivalent circuit referred to primary and insert all values in it. Also find the efficiency on full load, 0.8 lagging p.f.			
14	Two transformers P and Q are connected in parallel and supply a common load, open circuit emf of P and Q are 6000 V and 5800 V respectively. Equivalent impedance in terms of secondary of P and Q are (0.4+j4) Ω and (0.2+j2)Ω. The load impedance is (20+j4)Ω. Find the current supplied by each transformer.	Understand	CO 4	AEEB11.13
15	Two single phase transformers with equal turns have the impedances of (0.5+j3) ohms and (0.6+j10) ohms with respect to the secondary. If they operate in parallel, determine how they will share the load of 100 KW at p.f. 0.8 lagging?	Analyze	CO 4	AEEB11.13
16	In a 400 V, 50Hz transformer the total iron loss is 2500 watts. When the supply voltage and frequency reduced to 200 V and 25 Hz respectively the corresponding loss is 850 watts. Calculate the eddy current loss at normal voltage and frequency.	Understand	CO 4	AEEB11.12
MODULE-V				
THREE PHASE TRANSFORMERS				
Part – A (Short Answer Questions)				
1	What is the advantage of the star connection over delta connection?	Understand	CO 5	AEEB11.14
2	What is the advantage of delta connection of three single phase transformers?	Understand	CO 5	AEEB11.14
3	List he advantages and disadvantages of star-star connection.	Remember	CO 5	AEEB11.14
4	List he advantages and disadvantages of delta-delta connection.	Remember	CO 5	AEEB11.14
5	Calculate the turns ratio of an 11,000/415 Volt, delta/star connected three phase transformer.	Understand	CO 5	AEEB11.14
6	Draw the physical connection and phasor diagrams of star/star and star/delta connection.	Remember	CO 5	AEEB11.14
7	Draw the physical connection and phasor diagrams of delta/star and delta/delta connection.	Remember	CO 5	AEEB11.14
8	List the different schemes employed for three phase to six phase conversion.	Remember	CO 5	AEEB11.14
9	List the advantages of three phase transformers over single phase transformers.	Understand	CO 5	AEEB11.14
10	What is meant by vector group of transformers?	Remember	CO 5	AEEB11.14
11	Give the applications of open delta connection.	Remember	CO 5	AEEB11.15
12	List out the conditions of parallel connection of three phase transformers.	Understand	CO 5	AEEB11.14
13	Give the applications of scott connection.	Remember	CO 5	AEEB11.15
14	Define an autotransformer and mention its applications.	Understand	CO 5	AEEB11.16
15	Why tapings are generally provided on the high voltage side of a transformer?	Understand	CO 5	AEEB11.16
Part – B (Long Answer Questions)				
1	Discuss the star - delta, delta –delta connections of 3-phase transformers with relevant relations among the voltages and currents.	Understand	CO 5	AEEB11.14
2	Discuss the delta - star, star – star connections of 3-phase transformers with relevant relations among the voltages and currents.	Understand	CO 5	AEEB11.14

3	Explain the different schemes of three-phase to six-phase conversion with neat diagrams.	Remember	CO 5	AEEB11.14
4	Explain the open-delta connection with a suitable diagram and list the advantages of this connection?	Understand	CO 5	AEEB11.15
5	Explain with neat circuit diagram how a Scott connection is used to obtain two-phase supply from three-phase supply.	Remember	CO 5	AEEB11.15
6	Why are tapings provided in transformers? Give the reasons for tapings being generally provided on the high-voltage side of the transformer.	Understand	CO 5	AEEB11.16
7	Explain the operation of off-load and on-load tap changers with the help of connection diagram.	Understand	CO 5	AEEB11.16
8	Define an auto transformer. State its merits and demerits over a two-winding transformer. What are the applications of an auto transformer?	Remember	CO 5	AEEB11.16
9	In an auto transformer, the power transferred from primary to secondary circuit is partly by conduction and partly by induction. Explain.	Understand	CO 5	AEEB11.16
10	Derive an expression for the rating of an auto transformer as a fraction of the rating of a two winding transformer, when the auto transformer has a transformation ratio of α.	Understand	CO 5	AEEB11.16
Part – C (Analytical Questions)				
1	A three-phase step-down transformer is connected to 6600 V on the primary side. The ratio of turns per phase is 12 and the line current drawn from the mains is 20A. find the secondary line voltage, line current and output if the transformer is i) Y-Y ii) Y-D iii) D-Y iv) D-D	Understand	CO 5	AEEB11.14
2	A 3-phase step down transformer is connected to 6.6 KV mains and takes 10 A. Calculate the secondary line voltage, line current and output for the following connections: i) Δ/Δ ii) Y/Y iii) Δ/Y iv) Y/ Δ	Understand	CO 5	AEEB11.14
3	A three phase transformer is assembled by connecting three 1000 VA, 330/110 V single phase transformers. Determine the nominal voltage and power rating of the three phase transformer for Y/Y, Δ/Δ, Y/ Δ, Δ/Y.	Analyze	CO 5	AEEB11.14
4	Two T-connected transformers are used to supply a 440V, 88 KVA balanced load to form a balanced three phase supply of 8.8 KV. Determine a) Voltage and current rating of each coil b) KVA rating of the main and teaser transformers.	Understand	CO 5	AEEB11.14
5	Three 1100/110 V transformers connected in Δ/Δ supply a lighting load of 100 KW. One of these transformers is damaged and hence removed for repairs. What currents will be flowing in each transformer when i) Three transformers are in service. ii) The two transformers are in service.	Analyze	CO 5	AEEB11.14
6	Two transformers are connected in open delta and supply a balanced three phase load of 240 KW at 400 V and a p.f. of 0.866, determine i) The secondary line current ii) The KVA load on each transformer iii) The power delivered by the individual transformers.	Understand	CO 5	AEEB11.14

7	A balanced three phase, 100 W load at 400 V and 0.8 p.f. lagging is to be obtained from a balanced two phase 1100 V lines. Determine the KVA rating of each unit of the Scott connected transformer.	Analyze	CO 5	AEEB11.14
8	A three phase 1000 KVA, 6000/600 V, Y-Y, 50Hz transformer has an iron loss of 1000 W. the maximum efficiency occurs a) The efficiency of transformer at full load and 0.85 p.f. b) The maximum efficiency at unity p.f.	Understand	CO 5	AEEB11.14
9	A 20KVA, 200/500 V, 50 Hz single phase transformer is connected as autotransformer, where V1=200 V and V2=700V. Calculate its voltage ratio and KVA rating. Show the current distribution when it delivers the rated KVA to load.	Understand	CO 5	AEEB11.16
10	The primary and secondary voltages of an autotransformer are 600 V and 300 V respectively. With the help of the diagram, show the current distribution in the winding. When the secondary current is 100 A, also find the percentage savings in conductor material.	Analyze	CO 5	AEEB11.16
11	A 2200/220 V transformer is Rated at 10 KVA as a two winding transformer. It is connected as an auto transformer with low voltage winding connected additively in series with high voltage winding. The autotransformer is excited from a 2500 V source. The auto transformer is loaded so that the rated currents of the windings are not exceeded. Find i) current distribution in the windings ii) KVA output iii) KVA transferred conductively and inductively from input to output iv) savings in conductor material as compared to a two winding transformer of same VA rating.	Understand	CO 5	AEEB11.16
12	An auto transformer supplies a load of 5 KW at 125 V and at unity power factor. If the primary voltage is 250 V, determine i) transformation ratio ii) primary and secondary currents iii) Number of turns across secondary if total number of turns is 250. iv) power transformed.	Understand	CO 5	AEEB11.16
13	Two single phase Scott connected transformers supply a 3-phase 4-wire 50Hz distribution system with 400V between lines. The HV windings are connected to a 2-phase 6000V (per phase) system. The core area is 250 sq.cm. while the maximum allowable flux density is 1.2 T. determine the number of turns on each winding and the point of to be tapped for the neutral wire on the 3-phase side.	Understand	CO 5	AEEB11.15
14	A balanced 3-phase, 100 KW load at 400V and 0.8 p.f lagging is to be obtained from a balanced two phase 1100V lines. Determine the KVA rating of each unit of the Scott connected transformer.	Understand	CO 5	AEEB11.15
15	Two transformers connected in open delta supply a 400 KVA balanced load operating at 0.866 p.f lagging. The load voltage is 440V. Calculate the KVA supplied by each transformer and KW supplied by each transformer.	Understand	CO 5	AEEB11.15

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