EE8301 ELECTRICAL MACHINES – I
UNIT –I: MAGNETIC CIRCUITS AND MAGNETIC MATERIALS
PART: A

1. Define EMF and MMF.
2. Name the main magnetic quantities with their symbols having the following units:
Webers, Telsa , AT/Wb , H/m
3. Define statically and dynamically induced EMF.
4. Explain flux fringing at air gap.
5. Define magnetic field intensity, flux and flux density.
6. Define reluctance and permeance.
7. What is leakage flux and fringing?
8. Define inductance.
9. What is leakage flux and mutual flux?
10. Define magnetic reluctance.
11. What are quasi static fields?
12. How will you minimize hysteresis and eddy current losses?
13. What are the core losses and how can this loss be minimized?
14. Define Torque.
15. How is emf induced dynamically?
16. What is fringing effect?
17. Define stacking factor.
18. Draw the magnetization curve of ferromagnetic material.
19. Compare electric and magnetic circuits.
20. What is transformer and its basic principle?

PART: B

1. A magnetic circuit made of mild steel is arranged as shown in Fig.1. The central limb is wound with 500 turns and has a cross-sectional area of 800 mm2. Each of the outer limbs has a cross-sectional area of 500 mm2. The air-gap has a length of 1 mm. Calculate the current required to set up a flux of 1.3 mWb in the central limb assuming no magnetic leakage and fringing. Mild steel required 3800 AT/m to produce flux density of 1.625 T and 850 AT/m to produce flux density of 1.3 T.
2. Explain the similarities and dissimilarities between electric amd magnetic circuits.
3. For the magnetic circuit of fig.2. Various dimensions are also indicated in the fig. when the current flowing through the coil is 2 Ampere, number of turns N is 600 turns, calculate the flux and flux density in the two outer limbs and the central limb. The relative permeability of noncore is infinity.
4. A magnetic circuit of cast steel is arranged as shown in fig.3. Various dimensions are also indicated in the fig. The exciting coil, with N=600 turns, sets up a flux of 1 m Wb in the central limb. Find the coil Current if for cast steel, (a) μr = ∞ (b) μr = 6000. Neglect fringing and leakage.
5. a)Explain the AC operation of a magnetic circuits.
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b) Explain clearly the statically and dynamically induced EMF.
6. A ring composed of three sections. The cross section area is 0.001m2 for each section. The mean arc length are l a = 0.3 m, l b,= 0.2m, l c =0.1 m. an air gap length of 0.1 mm is cut in the ring. μr for sections a,, b and c are 5000, 1000 and 10000 respectively. Flux in the air gap is 7.5 × 10–4 Wb. Find (i) mmf (ii) exciting current if the coil has 100turns (iii) reluctance of the sections.
7. A metal rod wound with 3500 turns is 25 cm long and 2.5cm in diameter. It is bent in to a closed ring and when a current of 0.6A is passed through it, the flux density in it is 0.45Wb/m2.Assuming that all flux links with every turn of the coil, calculate relative

permeability of the metal, self inductance of the coil, emf induced in the coil when the current through the coil is interrupted and the value of flux in iron portion falls to 8 percent of its original value in 0.0015 sec.

8. Define the following: (a) magnetic flux and flux density (b) reluctance (c)permeance (d)mmf (e)magnetic field intensity (f) permeability of free space.

9. (i) Derive an expression for energy density in the magnetic field.

(ii) Explain in detail " Eddy-current loss".

(iii) The total core loss of a apecimen of silicon steel is found to be 1500W at 50 Hz. Keeping the flux density constant the loss becomes 3000 W when the frequency is raised to75 Hz. Calculate separately the hysteresis and eddy current loss at each of their frequencies.

10. Define the following terms.

(i) MMF and Lenz's Law.

(ii) Faraday's Law of Electro Magnetic Induction.

(iii) Parallel and series magnetic circuits.

(iv) Torque and Permeability.

UNIT –II: TRANSFORMERS
PART: A

1. Differentiate between a core and shell type transformer.
2. What is the basic purpose of tertiary winding?
3. Define regulation of a transformer.
4. State the advantages and applications of auto transformer.
5. What happens if DC supply is applied to the transformer?
6. Why all day efficiency is lower than commercial efficiency?
7. Give the principle of transformers.
8. What are the condition for parallel operation of a transformer?
9. Why is transformer rated in KVA?
10. Compare two winding transformer and auto transformer.
11. What is an auto transformer?
12. Mention the different types of three phase transformer connection.
13. What are the causes of stray losses?
14. What is the purpose of conducting open circuit test?
15. What is an ideal transformer?
16. Draw the no load phasor diagram of a transformer.
17. The emf per turn for a single-phase 2200/220 V, 50 Hz t ransformer is 11 V. Calculate the number of primary and secondary turns.
18. What is transformer and its basic principle?
19. Draw the phasor diagram of an ideal transformer.
20. Why the transformer rating is in KVA?

PART: B

1. Explain the principle of operation of a transformer. Draw the vector diagram to represent a load at UPF ,lagging and leading power factor.

2. Obtain the equivalent circuit of a single phase transformer referred to primary and secondary.

3. A single phase transformer has 500turns on the primary and 40 turns on the secondary winding. The mean length of the magnetic path in the iron core is150cm and the joints are equivalent to an air gap of 0.1mm. When a p.d. of 3000v is applied to the primary, maximum flux density is 1.2 Wb/m2. Calculate the cross sectional area of the core,no load secondary voltage, no load current drawn by the primary, the power factor on no load. Given that AT/cm for a flux density 1.2 tesla in iron to be 5, the corresponding iron loss to be 2 watt/kg at 50 Hz and the density of the iron as7.8 gram/cm3.

4. i) Develop an equation for induced emf in a transformer winding in terms of flux and frequency.

ii) A 230/460V transformer has a primary resistance of 0.2 ohm and reactance of 0.5ohm and the corresponding values for the secondary are 0.75 and 1.8 ohms respectively. Find the secondary terminal voltage when supplying 10A at 0.8 p.f. lagging.

5. The parameters of a 2300/230v, 50Hz transformer are given below: $R_1 = 0.286\Omega$, $R'_2 = 0.319$ Ω, $R_0 = 250 \Omega$, $X_1 = 0.73 \Omega$, $X'_2 = 0.73 \Omega$, $X_0 = 1250 \Omega$. The secondary load impedance $Z_L = 0.387 + j0.29$. Solve the exact equivalent circuit across the primary.

6. A 50KVA ,4400/220V transformer has R1=3.45 R2=0.009 Ω. The values of the Ω reactance are x1=5.2 Ω and x2=0.015 Ω. Calculate equivalent resistance as referred to primary, equivalent resistance as referred to secondary, equivalent reactance referred to both primary and secondary, equivalent impedance referred to both primary and secondary, total cu loss first using individual resistances of the two windings and secondly using equivalent resistances as referred to each side

7. Explain the construction and working principle of a transformer.

8. With neat sketch explain the working of transformer under noload and lagging power factor load.

9. The equivalent circuit referred to the low tension side of a 250/2500 V single phase transformer is shown in fig.4.the load impedance connected to the high voltage terminal is 380 + j230 For a primary voltage of 250 V, compute, (a) the secondary terminal voltage, (b) primary current and power factor, and (c) power output and efficiency.

10. (i) Derive an expression for maximum efficiency of a transformer.

(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.

UNIT –III: ELECTROMECHANICAL ENERGY CONVERSION AND CONCEPTS IN ROTATING MACHINES
PART: A

What are the advantages of analyzing energy conversion devices by field energy concept?

Draw the general block diagram of electromechanical energy conversion device.

In a linear system prove that field energy and coenergy are equal.

Write an expression for stored energy in the magnetic field.

What are the basic magnetic field effects that result in the production of mechanical forces?

6. What are the assumptions made to determine the distribution of coil mmf?

7. Define winding factor.

8. What do you mean by coenergy?

9. What are the requirements of the excitation systems?

10. What is meant by reactance voltage?

11. Why fractional pitched winding is preferred over full pitched winding?

12. Why do all practical energy conversion devices make use of the magnetic field as a coupling medium rather than an electric field?

13. What is meant by SPP? What is its significance?

14. Enumerate the advantages of using short pitched winding in a synchronous machine.

15. Why synchronous machine does not produce torque at any other speed?

16. Give example for singly and multiply excitation systems.

17. State the principle of electromechanical energy conversion.

18. Define pitch factor and distribution?

19. Write down the expression for torque in round rotor machine.

20. State the assumptions made while obtaining m.m.f space wave.

PART: B

1. Obtain an expression for the mechanical force of field origin in a typical Attracted armature relay.

2. Find an expression for the magnetic force developed in a doubly excited magnetic systems.

3. (i) Describe the flow of energy in electromechanical devices.

(ii) Discuss about the 'field energy' and 'coenergy' in magnetic system.

(iii) 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.

4. Two windings, one mounted on the stator and the other mounted on a rotor have self and mutual inductances of $L_{11} = 4.5H, L_{22} = 2.5H$ and $L_{12} = 2.8\cos\theta$ H, where θ is the angle between the axes of the windings. The resistance of the windings may be neglected. Winding 2 is short circuited and the current in winding 1 as a function of time is $i_1 = 10\sin\omega t$ A. Derive an expression for the numerical value of the instantaneous torque on the rotor in N-m in terms of the angle θ.

5. Draw and explain the m.m.f space wave of one phase of distributed a.c. winding.

6. i) Explain the concept of rotating magnetic field.

ii) Derive the torque equation in round rotor machines.

7. (i) For a certain relay, the magnetization curves for open and closed positions of the armature are linear. If the armature of the relay moves from open to closed position at constant current (i.e. very slowly), show that the electrical energy input is shared equally between field energy and the mechanical work done.

(ii) In an electromagnetic relay, functional relation between the current i in the exciting coil, the position of armature x and the flux linkages ψ is given by

$i = 2\psi^3 + 3\psi (1 - x + x^2), x > 0.5$

Find the force on the armature as a function of ψ.

8. Derive an expression for co-energy density of an electromechanical energy conversion device.

9. The doubly excited magnetic field has coil self- and mutual inductances of $L_{11} = L_{22} = 2, L_{21} = L_{12} = \cos\theta$, where θ is the angle between the axes of the coils. The coils are connected in parallel to a voltage source $V = V_m \sin\omega t$. Derive an expression for the instantaneous torque as a function of the angular position θ. Find the time – average torque. Evaluate for $\theta = 30^o, Y = 100 \sin 314t$.

10. (i) show that the torque developed in doubly excited magnetic system is equal to the rate of increase of field energy with respect to displacement at constant current.

(ii) The λ- I characteristics of singly excited electromagnet is given by $i = 121 \lambda^2 x^2$ for $0 < i < 4$ A and $0 < x < 10$Cm. If the air gap is 5Cm and a current of 3A is flowing in the coil, Calculate (a) Field Energy (b) Co- energy (c) Mechanical Force on the moving part.

UNIT-IV: DC GENERATORS
PART:A

1. What is the difference between Lap winding and Wave Winding of a DC Machine armature.

2. List the factors involved in the voltage build up of a shunt generator.

3. Why the external characteristics of a DC shunt generator is more drooping than that of a separately excited generator?

4. What are the requirements of the excitation systems?

5. Why fractional pitched winding is preferred over full pitched winding?

6. Define Commutation and Commutation period.

7. Define Winding factor.

8. Draw a schematic diagram indicating flow of energy in the conversion of Mechanical Energy to Electrical form.
9. What is armature reaction in DC generators? What are its effects?
10. Write the EMF equation of DC generator explaining all terms.
11. Mention the uses of DC generators.
12. Give few applications of Ward-Leonard systems.
13. Draw the External Characteristics of a |Shunt generator.
14. What are the Characteristics of DC generators?
15. What are the different types of DC generators?
16. How the generators are classified based on method of excitation?
17. State the application of various types of generators.
18. Define back pitch and front pitch.
19. Define winding pitch and commutator pitch.
20. Why the air gap between the pole pieces and the armature is kept very small?

PART :B

1. Derive an expression for the emf of DC generator.
2. A 6-pole DC generator has 150 slots. Each slots has 8 conductors and each conductor has resistance of 0.01Ω.The armature terminal current is 15 A. Calculate the current per conductor and the drop in armature for Lap and Wave winding connections.
3. Write notes on the following:
(i) Self and separately excited DC generators
(ii) Commutation.
4. Obtain the condition for maximum efficiency of the DC generator.
5. A 400V DC shunt generator has a full load current of 200 A. The resistance of the armature and field windings are 0.06 Ω and 100 Ω respectively. The stray losses are 2000 W.Find the Kw output of prime mover when it is delivering full load and find the load for which the efficiency of the generator is maximum.
6. Explain the different methods of excitation and characteristics of a DC generators with suitable diagrams.
7. Two DC shunt generators are connected in parallel to supply a load of 5000 A. Each machine has an armature resistance of 0.03 Ω and field resistance of 60 Ω but the emf of one machine is 600V and that of the other machine is 640 V. What power does each machine supply?
8. (i) Explain armature reaction and commutation in detail.
(ii) Draw the OCC Characteristics and External Characteristics of DC generator.
9. A 100 kW DC hunt 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
10. Draw the performance characteristics of different types of DC generators and explain them.

UNIT-V: DC MOTORS
PART:A
1. Why the Starters necessary for starting DC motors?
2. Why is belt drive not suitable for DC series motor.
3. What is the significance of back emf in a DC motor?
4. Why DC series motor called variable speed motor?
5. List the merits and demerits of Swinburne's test.
6. What are the methods of speed control in DC motor?
7. Mention the application of various DC motor.
8. Give few applications of Ward-Leonard systems.
9. Draw the characteristics of DC compound motor.

10. State the voltage equation of DC motor.
11. State Fleming's left hand rule?
12. How to reverse the direction of rotation of dc motor?
13. What is Back emf?
14. Draw the circuit model of various types of motors.
15. Define Speed regulation of dc motor.
16. Write the torque equation of a DC motor.
17. Draw the Speed-Current and torque-current Characteristics of a DC series motor.
18. State the function of NO Volt coil of the starter.
19. When you will say the motor is running at base speed?
20. State the advantages and disadvantages of Flux control method?

PART:B

1. Explain the different methods of excitation and characteristics of a DC motors with suitable diagrams.

2. Explain the various methods of controlling the speed of a DC shunt motor and bring out their merits and demerits. Also, state the situations where each method is suitable.

3. (i) Derive from the fundamental, emf and torque equations and explain the characteristics of Dc shunt motor.

(ii) What are the merits and demerits of Hopkinson's test?

4. (i) Discuss in detail about shunt armature speed control of dc shunt motor.

(ii) A 500V dc shunt motor running at 700 rpm takes an armature current of 50A.Its effective armature resistance is 0.4Ω. What resistance must be placed in series with the armature to reduce the speed to 600 rpm, the torque remaining constant?

5. (i) What are the various starting methods of DC motor? Explain any one method.

(ii) Explain in detail the various method of speed control in DC motor?

6. With neat circuit diagram explain the conduction of Swinburne's test.

7. 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, Calculate 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.

8. A 250 V dc shunt motor runs at 1000 rpm on no load and takes 5A.The armature and shunt field resistance are 0.2Ω and 250Ω respectively. Calculate the speed when loaded and taking a current of 50A.Due to armature reaction the field weakens by 3%

9. (i)Draw and explain the characteristics of compound motor

(ii)Explain the factor affecting the speed of a DC motor.

10. (i) Explain the important ratings of a DC motor.

(ii) A 250V DC shunt motor has R f =150Ω and R a =0.6Ω.The motor operates on no-load with a full field flux at its base speed of 1000 rpm with Ia=50A.If the machine drives a load requiring a torque of 100 Nm, Calculate armature current and speed of motor. If the motor is required to develop 12 kW at 1200 rpm. What is the required value of the external series resistance in the field circuit? Assume linear magnetization. Neglect saturation and armature reaction.

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