Unit-I (Design of field system and Armature)

Part A Questions

1) What are the major considerations to evolve a good design of Electrical machines ?

a) Cost b) Durability c) Compliance with performance criteria as laid down as specifications.

2) What are the factors those limit the design of a machine ?

a) Saturation b) Temperature rise c) Insulation d) Efficiency e) Mechanical parts f) Commutation g) power factor.

3) What are the fundamental requirements of high Conductivity materials ?

a) Highest possible conductivity, b) Least possible temperature coefficient of Resistance c) Adequate mechanical strength d) Rollability and Drawability e) Good weldability and Solderablity.

4) Where Conductors of high resistance are used ?

Conductors of high resistance are used, where it is actually desired to dissipate electrical energy as heat.

ie) in starting and regulating devices for motors etc.

5) What are the fundamental requirements of insulating materials?

a) High dielectric strength b) High Resistivity c) Low dielectric hysteresis d) Good thermal Conductivity e) High degree of thermal ability.

6) Which insulating materials are used in modern electric machines?

Mica, Micafolium, Fibrous glass, Asbestos, polyamides, Wood, Silicones, Synthetic resin,

7) Name the types of Magnetic materials?

Based on Relative permeability

a) Ferro magnetic material
b) Para magnetic material
c) Dia magnetic material

Based on hysterisis loop

a) Soft magnetic material
b) Hard magnetic material

8) What do you mean by ageing?

Ageing is the term to denote the ~~deter~~ deterioration of magnetic performance in service, caused by increase in Coercive force and Hysteresis loss which inturn cause cummulative over heating and subsequent breakdown

9) What is CRGO steel? What are it uses?

CRGO → Cold Rolled Grain oriented Steel

It is manufactured by a series of cold reductions and intermediated annealings. This cold reduced material has strong directional magnetic properties, and the rolling direction being the direction of highest permeability. This direction is also the direction of lowest hysteresis loss.

This type of material is suitable for use in transformers and large turbo alternators.

10) What is magnetic circuit?

The magnetic circuit is the path of magnetic flux. The mmf of the circuit creates flux in the path against the reluctance of the path.

11) Write the ohm's law for magnetic circuit?

The equation relating mmf, flux and reluctance of a magnetic circuit can be called ohm's law of Magnetic circuit.

12) What is Magnetization curve?

The magnetization curve is a graph showing the relation between the magnetic field intensity (H) and the flux density, (B) of the magnetic circuit.

This curve is used to estimate the mmf required for flux path in the magnetic material.

13) Write any two similarities between magnetic and electric circuits

i) In electric circuit, the emf circulates current in a closed path. Similarly in a magnetic circuit, the mmf creates flux in a closed path

ii) In electric circuit, the flow of current is opposed by resistance of the circuit. Similarly as a magnetic circuit, the creation of flux is opposed by reluctance of the circuit.

14) Write any two essential differences between magnetic and electric circuits.

i) When the current flows in electric circuit the energy is spent continously, whereas in magnetic circuit, the energy is needed only to create the flux but not to maintain it.

ii) Current actually flows in the electric circuit, whereas the flux does not flow in a magnetic circuit, but it is only assumed to flow.

15) What are the factors which modify the reluctance of air gap?

The reluctance of airgap is modified by slots, radial ventillating ducts and nonuniform air gaps.

16) Define gap contraction factor for slots

$$K_{gs} = \frac{\text{Reluctance of airgap in machines with slotted Armature}}{\text{Reluctance of airgap in machines with Smooth Armature.}}$$

$$k_{gs} = \frac{Y_s}{Y_s'} = \frac{Y_s}{Y_s - k_{cs} w_s}$$

where $Y_s \rightarrow$ Slot pitch

$k_{cs} \rightarrow$ Carter's Coefficient for Slots. Its depends on the ratio $\frac{\text{Slot opening (or Slot width)}}{\text{airgap length.}}$

17) Define gap Contraction factor for ducts?

$k_{gd} = \frac{\text{Reluctance of airgap in machine with Ducts}}{\text{Reluctance of airgap in machines without Ducts}}$

$$k_{gd} = \frac{L}{L'} = \frac{L}{L - k_{cd} n_d w_d}$$

where $L \rightarrow$ length of the core

$k_{cd} \rightarrow$ Carter's Coefficient for ducts. Its depends on the ratio $\frac{\text{Duct width}}{\text{air gap length.}}$

$n_d \rightarrow$ number of ducts

$w_d \rightarrow$ width of the Ducts.

18) Define total gap Contraction factor?

$k_g = \frac{\text{Reluctance of airgap in machines with Slotted Armature and Ducts}}{\text{Reluctance of airgap in machines with Smooth Armature and without Ducts.}}$

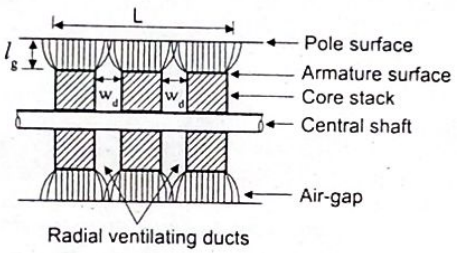
$$k_g = k_{gs} \times k_{gd}$$

$$= \frac{Y_s}{Y_s'} \times \frac{L}{L'}$$

$$k_g = \frac{Y_s}{Y_s - k_{cs} w_s} \times \frac{L}{L - k_{cd} n_d w_d}$$

19) What are ventilating ducts?

The radial ventilating ducts are small gap of width (w_d) in between the stacks of armature core.



They are provided for better cooling of the core, when the length of core is greater than 100 mm. (or) 0.1 metre.

20) What is real and apparent flux density? (or) Distinguish between real and apparent flux densities?

The real flux density is due to the actual flux through a tooth. The apparent flux density is due to total flux that has to be pass through the tooth. Since some of the flux passes through slot, the real flux

density is always less than the apparent (or) total flux density

$$B_{app} = \frac{\text{Total flux in a slot pitch}}{\text{Tooth area}}$$

$$B_{real} = \frac{\text{Actual flux in a tooth}}{\text{Tooth area}}.$$

21) List the methods used for estimating the mmf for teeth?

i) Graphical method ii) Three ordinate method (Simpson's rule) iii) $B_t(1/3)$ method.

22) What are the problems encountered in estimating the mmf for teeth?

i) The flux density in different section of a tooth is not uniform

ii) The slot provides another parallel path for the flux, shunting the tooth.

23) What is Carter's Coefficient? What is the usefulness in the design of dc machine?

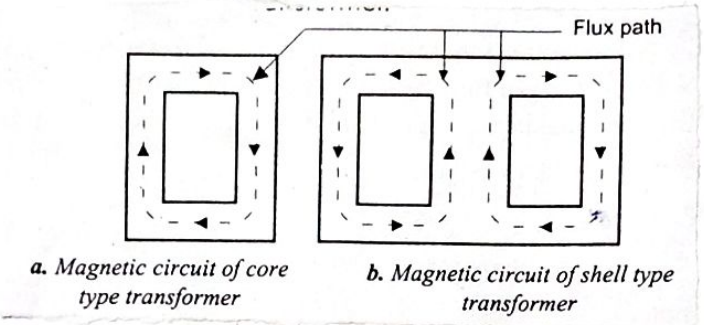
The Carter's Coefficient is a parameter that can be used to estimate the effective slot pitch in case of armature with open (or) semi enclosed slots.

The carter's coefficient is also used to estimate

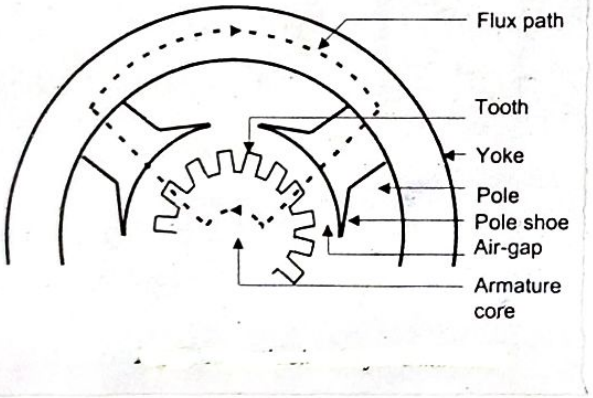
the effective length of armature, when ducts are employed.

In electrical machine design, the carter's coefficient is used to estimate the air gap expansion (or) contraction factor for slots and ducts.

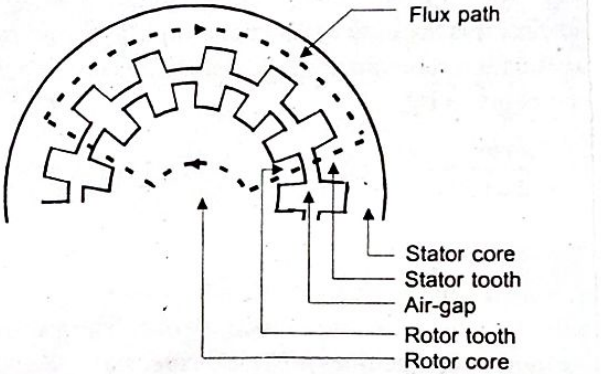
24) Draw the magnetic circuit of transformer, DC machine, Induction motor and Salient pole Synchronous Machine?



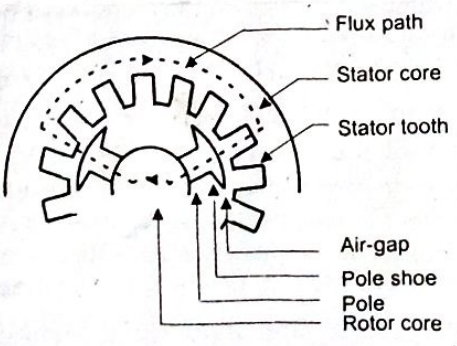
Magnetic circuit of transformer



Magnetic circuit of DC Machine



Magnetic circuit of Induction Motor



Magnetic circuit of Synchronous machine

Unit-II (Transformer)

Part A Questions

1, What are the advantages of three phase transformer over Single phase transformer ?

i) A 3 phase transformer is lighter, occupies lesser space, cheaper and more efficient than a bank of Single phase transformer.

ii) The installation and operational costs are Smaller for 3 ϕ units.

2. Distinguish between Shell type and Core type transformers.

	Core type	Shell type
1,	Core is Surrounded by the winding	winding is Surrounded by the core
2,	Construction is Simple	Construction is difficult.
3,	Low Mechanical Strength	Hight mechanical Strength
4)	Better heat dissipation from windings	Heat is not easily dissipated from windings

3. Difference b/w distribution and power transformer?

	Distribution transformer	Power transformer
i)	power rating $\leq$ 200 kVA	power rating > 200 kVA
ii)	Used for Distribution purposes.	Used for transmission purposes.
iii)	Energy efficiency is good	power efficiency is good
iv)	Regulation is low	Regulation is high.

4. Why the area of yoke is taken larger that of a core for transformer?

The area of yoke is taken larger than core, because it reduces the flux density in the yoke and which turn reduces the magnetising current and iron loss for the yoke.

5. Why stepped cores are used in transformer?

If the number of steps increased in the transformer core construction, results in diameter of circumscribing circle over the core will be less. This results in length of mean turn of the winding is minimum. Hence there is a savings in copper and reduction in copper loss.

6. Why circular coils are preferred for transformers?

The excessive leakage fluxes produced during short circuit and overloads develop severe mechanical stress on the coil. In circular coil these forces are radial and there is no tendency to change its shape. But on rectangular coils, these forces are perpendicular to the conductors and tends to deform the coil in circular form.

7. List out the Advantages and Disadvantages of Stepped core?

Advantages

For same area of cross section, the stepped cores will have lesser diameter of circumscribing circle than square cores. This results in reduction in length of mean turn of the winding with consequent reduction in both cost of copper and copper loss.

Disadvantages

With large number of steps a large number of different sizes of laminations have to used. This results in higher labour chargers for shearing and assembling different types of laminations.

8, What are the advantages and Disadvantages of using higher flux density in the core?

Advantages

i) Reduction in area of cross section of yoke and core for same output

ii) Reduction in mean length of LV and HV turns, resulting in Saving of Copper, reduced overall cost and weight of transformer.

Disadvantages

i) Increased magnetising current and iron loss.

ii) Saturation of magnetic material

iii) Lower efficiency, because of higher no load loss.

9. State different losses in a transformer?

The losses in a transformer are of two types, namely

i) Core losses or iron losses.

This losses consist of hysteresis and eddy current losses and occur in the transformer core due to the alternating flux.

ii) Copper losses

This losses occur in both the primary and secondary windings due to their ohmic Resistance

10. Define window space factor ?

It is defined as the ratio of copper area in the window to the total area of the window

Window space factor, (K_w) = Copper area in the window, (A_c) / Total area in the window, (A_w)

$$K_w = \frac{A_c}{A_w}$$

11, What is meant by stacking factor ?

It is defined as the ratio of net iron area to the gross iron area. The value is usually taken as 0.9.

Stacking factor (S_f) = Net iron area (without Insulation) / Gross iron area (with Insulation)

$$S_f = \frac{A_i}{A_{gi}}$$

12, Why transformer oil used as cooling medium ?

When transformer oil is used as a coolant the heat dissipation by convection is 10 times more than the convection due to air. Hence the transformer oil is used as coolant.

13. How does heat dissipation occurs in a transformer ?

i) Conduction
ii) Convection - 6.5 $w/m^2 {}^\circ C$
iii) Radiation - 6 $w/m^2 {}^\circ C$

Unit - III (DC Machines)

PART A Question with Answers

1. Give the main parts of a DC machine?

i) Yoke ii) Field poles, iii) Armature iv) Armature winding v) Commutator, vi) Brushes and bearings vii) Inter poles.

2. State total electrical and magnetic loading?

Total electrical loading is defined as the total ampere conductors around the armature

$$\text{Total Electrical loading} = I_z \cdot Z$$

Total magnetic loading is defined as the total flux around the armature periphery at the airgap

$$\text{Total magnetic loading} = P\phi$$

3) Define Specific electrical and magnetic loading?

Specific electrical loading is defined as the ratio of Total armature ampere conductors to the ~~Armat~~ Armature periphery at air gap.

$$\text{Specific electrical loading (ac)} = \frac{I_z \cdot Z}{\pi D}$$

Specific magnetic loading is defined as the ratio of total flux around the airgap to the Area of flux path at the air gap.

Specific Magnetic loading $B_{av} = \frac{P\phi}{\pi DL}$

4, What are the Main dimensions of a DC Machine ?.

Diameter of the Armature (D), Length of the Armature (L) are the main dimensions of a DC machine.

5. Name the factors influencing the choice of Specific of electric loading

i) Temperature rise ii) Size of machine
iii) Speed of machine iv) Armature Reaction
v) Voltage vi) Commutation

6, Name the factors influencing the choice of Specific of Magnetic loading

i) Flux density in teeth.
ii) Frequency of flux reversals.
iii) Size of machine.

7, What are the factors to be considered for the Selection of number of poles in dc machine ?.

i) Frequency ii) weight of iron parts
iii) Length of Commutator, iv) weight of Copper
v) Labours charges vi) Flash over and distortion of field form.

8) List the Advantage and Disadvantages of having higher number of poles ?.

Advantages

i) Weight of iron parts reduces.

ii) Cost of armature and field conductor reduces.

iii) Overall length and diameter of the machine reduces.

iv) Distortion of field form under load ~~condition~~ condition reduces.

Disadvantages

i) Frequency of flux reversal increases.

ii) Labour charge increases.

iii) Possiblity of flash over between brush arms increases.

9) Mention the ~~cruiding~~ guiding factors for the selection of number of poles ?

i) The frequency lies b/w 25 to 50 Hz.

ii) Current/parallel path (I_z) not exceed 200 A

iii) The armature mmf not be large. It should be in the range 5000 to 12,500 AT.

10) List the factors to be considered while selecting D and L from Volume part of DC machine ?

i) Pole proportions

ii) Moment of inertia

iii) Peripheral Speed

iv) Voltage b/w adjacent Commutator Segments.

11, What are the factors to be considered in the design of Commutator of a DC machine?

i) peripheral Speed ii) Voltage b/w adjacent Segments iii) Number of Coils in the armature iv) Number of Brushes.

12, What is peripheral Speed?

The peripheral Speed is the ~~translation~~ translational Speed that may exist at the Surface of the rotor, while it is rotating.

Peripheral Speed $\boxed{V_a = \pi D n}$ m/s

13, Why Square pole is preffered in DC machine?

If the Cross Section of the body is Square, then the length of meanturn of field winding is minimum. Hence to reduce the Copper requirement, a Square Cross Section is preferred for the pole of a DC machine.

14) Mention the factors governing the choice of number of armature Slots in a DC machine

i) Slot width, ii) Flux pulsation iii) Cost and iv) Commutation.

15, Define Copper Space factor of a coil ?

It is defined as the ratio of Conductor area to the Area of Cross Section of the coil

$$\text{Copper Space factor} = \frac{\text{Conductor Area}}{\text{Area of Cross Section of the Coil}}$$

16 Define field form factor (k_f) ?

$$\text{Field form factor } k_f = \frac{B_{av}}{B_g} = \frac{\text{pole arc}}{\text{pole pitch}}$$

Where B_{av} → Specific magnetic loading (or) Average flux density

B_g → maximum flux density

$$\text{Pole pitch } (\tau) = \frac{\pi D}{P}$$

17) What is meant by Unbalanced Magnetic Pull ?

Unbalanced magnetic pull is the radial force acting on the rotor due to non uniform air gap around the armature periphery.

Unit-IV (Design of Induction Motor)

Part A Questions

1, List construction difference between Slip ring and Squirrel cage Induction motor?

Slip ring (wound rotor)	Squirrel cage
i) Rotor Consists of three phase winding	Rotor Consists of bars which are shorted at the ends with the help of end rings
ii) ~~No~~ Slip rings and brushes are present.	No slip rings and brushes.
iii) Resistance can be added externally	External Resistance cannot be added.
iv) Rotor resistance Starter can be used	It is not possible to use rotor Resistance Starter.

2. What is the function of end ring in the rotor of a Cage Induction Motor?

In squirrel cage rotors, the copper bars are placed in the slots. These bars are short circuited at each end with the help of conductor copper ring called end ring.

The end ring provides good mechanical strength.

3. What type of slots are preffered in Induction motor?

Open type or semi closed slots are preferred for Induction motor. It results in less airgap Contraction factor giving a small value of magnetising current, low tooth pulsation loss and much quieter operation.

4. What are the factors to be considered for choosing the specific magnetic loading?

The choice of specific magnetic loading depends on

i) Power factor

ii) Iron loss

iii) Overload Capacity

5. What are the factors to be considered for choosing the specific electric loading?

The choice of specific electric loading depends on

i) Copper loss and temperature rise

ii) Voltage

iii) Overload capacity.

6, How do you select $\frac{L}{\tau}$ ratio for design of Induction motor?

i) For minimum cost, $\frac{L}{\tau} = 1.5$ to 2

ii) For Good power factor, $\frac{L}{\tau} = 1$ to 1.25

iii) For good efficiency, $\frac{L}{\tau} = 1.5$

iv) For Good overall design, $\frac{L}{\tau} = 1$

v) For Best power factor, $\tau = \sqrt{0.18L}$

7, What are the factors to be considered for selecting the number of stator slots in a Induction motor?

i) Tooth pulsation loss ii) leakage reactance iii) Magnetising current iv) Iron loss and cost.

8, List the factors to be considered for estimating the air gap length of Induction motor?

i) Power factor ii) unbalanced magnetic pull iii) Overload Capacity iv) Cooling v) pulsation loss and Noise.

9, What are the advantages and disadvantages of large airgap length in Induction motor?

Advantage

A large airgap length results in higher overload capacity, better cooling, reduction in noise and reduction in unbalanced magnetic pull

Disadvantage

Large air gap length results in high value of Magnetising current.

10, Why the air gap of an Induction motor is made as small as possible?

The mmf and the magnetizing current are

primarily decided by length of airgap. If airgap is small, then mmf and magnetizing current will be less, which inturn increases the value of power factor. Hence by keeping small air gap, high power factor can be achieved.

11. Write the empirical formula for length of airgap of an Induction motor

$$l_g = 0.2 + 2\sqrt{DL} \quad , \text{ mm}$$

where D → Inner diameter of stator in m

L → length of the stator in m.

12. List the undesirable effects produced by certain combination of rotor and stator slots?

i) Crawling (motor runs at 1/7th of Synchronous Speed).

ii) Cogging (motor refuse to start.)

iii) Noise and Vibration.

13. Define dispersion coefficient?

It is defined as the ratio of Magnetizing current to ideal short circuit current.

$$\text{Dispersion Coefficient } (\sigma) = \frac{I_m}{I_{sc}}$$

where $I_{sc} = \frac{E_{sph}}{X_{sph}}$

E_{sph} → Stator voltage / phase

X_{sph} → Total leakage Reactance reffered to Stator

14, Name the different types of leakage fluxes in 3 ϕ Induction motor ?

i) Slot leakage flux

ii) Zig-Zag leakage flux

iii) Overhang leakage flux

iv) Differential leakage flux.

Unit - V (Design of Synchronous Machines

Part A Questions

1) Compare Salient pole rotor and non salient pole rotor

Salient pole	non Salient pole (Cylindrical)
i) Has projected poles	No projecting poles.
ii) Needs damper winding	Doesn't need damper windings.
iii) Large diameter and Short axial length	Small diameter and long axial length
iv) Used for low speed alternators	Used for high speed alternators

2) Define Short circuit ratio ?

Short circuit ratio is defined as the ratio of field current required to produce rated voltage on open circuit to field current required to circulate rated current at short circuit.

It is also the reciprocal of Synchronous Reactance

$$SCR = \frac{1}{X_s}$$

3, What are the effects of SCR on machine performance?

i) Voltage Regulation, ii) Stability

iii) Short circuit current iv) Parallel operation
v) Self excitation.

4, How does the value of SCR affects the design of alternator?

For high stability and low voltage regulation, the value of SCR should be high, which requires large air gap.

When the length of airgap is large, the mmf requirement will be high. So the field system will be large. Hence the machine will be costlier.

5, What is the limiting factor for the diameter of Synchronous machine?

The limiting factor for the diameter of Synchronous machine is the peripheral speed

For Cylindrical m/c, V_a is 175 m/sec

For Salient pole m/c, V_a is 80 m/sec.

6. What is runaway Speed?

The runaway Speed is defined as the Speed at which the prime mover would have, if it is Suddenly unloaded.

7. List the factors which influence on selecting Specific electric loadings?

i) Copper loss and temperature rise ii) Voltage

iii) Synchronous reactance iv) Stray load loss.

8) What are the factors that influence the choice of specific magnetic loading in a synchronous machine?

i) iron loss ii) Voltage iii) Short circuit current iv) Stability v) parallel operation.

9) State the factors that must be considered in choosing air gap length of an synchronous machine?

i) Regulation ii) Stability limit iii) Cooling System iv) Tooth pulsation loss v) unbalanced magnetic pull.

10) Write the expression for length of airgap in Salient pole and cylindrical pole rotor in ~~Syn~~ Synchronous machine?

Salient pole machine $l_g = \frac{AT_a \times SCR \times k_f}{B_{av} \times k_g \times 10^6}$

cylindrical rotor machine $l_g = \frac{0.5 \times SCR \times ac \times \tau \times k_f}{B_{av} \times k_g \times 10^6}$

11) List the advantage of large air gap in Synchronous machine?

i) Low voltage Regulation ii) Reduction in Armature Reaction, iii) High Stability iv) Better cooling and v) Less noise.

12) What is the use of damper winding in Synchronous machine ?

In Synchronous Generator

i) Suppress the negative Sequence field

ii) Damp out the oscillation during hunting.

In Synchronous Motor

i) Start the motor

ii) Develop damping power when the machine starts hunting.

13) What are the advantages of Short pitched Coils ?

i) It saves the copper

ii) It gives more Sinusoidal waveform by reducing the harmonic Component.

iii) Due to elimination of high frequency harmonics eddy current loss and hysterisis losses are reduced.

14) Define pitch factor and Distribution factor ?

Pitch factor (K_f) = $\frac{\text{emf induced in Short pitch coil}}{\text{emf induced in Full pitch Coil}}$

$$K_f = \cos\left(\frac{\alpha}{2}\right)$$

Distribution factor (K_d) = $\frac{\text{emf induced in distributed wdg}}{\text{emf induced in Concentrated wdg.}}$

$$K_d = \frac{\sin\left(\frac{m\beta}{2}\right)}{m \sin\left(\frac{\beta}{2}\right)}$$

Where

$m \rightarrow$ slots / pole / phase

$\beta \rightarrow$ slot angle $= \frac{180^\circ}{n}$

$\alpha \rightarrow$ angle by which the coils are short pitched.

$n \rightarrow$ slots / pole.