DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

EE3303 ELECTRICAL MACHINES 1

TWO MARKS QUESTIONS WITH ANSWERS

UNIT-I E L E C T R O M E C H A N I C A L E N E R G Y

UNIT –I: ELECTROMECHANICAL ENERGY CONVERSION

1. **State the principle of electromechanical energy conversion?(NOV/DEC 2022)**
   The mechanical energy is converted into electrical energy which takes place through either by magnetic field or electric field.

2. **What does speed voltage mean?**
   It is that voltage generated in that coil, when there exists a relative motion between coil and magnetic field.

3. **What** is the significance of co-energy?
   When electrical energy is fed to coil not the whole energy is stored as magnetic energy The co energy gives a measure of other energy conversion which takes place in coil otherthan magnetic energy storage.

4. **Give example for single and multiple excited systems?(N/DEC**
   Single excited system-reluctance motor, single phase transformer, relay coil
   Multiply excited system-alternator, electro mechanical transducer

5. **Why do all practical energy conversion devices make use of the magnetic field as a coupling medium rather than electric field?**
   When compared to electric field energy can be easily stored and retrieved form a magnetic system with reduced losses comparatively. Hence most all practical energy conversion devices make use of magnetic medium as coupling.

6. **State necessary condition for production of steady torque by the interaction of stator and rotor field in electric machines?**
   1.The stator and rotor fields should not have any relative velocity or speed between each other
   2.Airgap between stator and rotor should be minimum
   3.Reluctance of iron path should be negligible
   4.Mutual flux linkages should exist between stator and rotor windings

7. **Write the application of single and doubly fed magnetic systems?**
   Singly excited systems are employed for motion through a limited distance or rotation through a prescribed angle Whereas multiply excited systems are used where continues energy conversion take place and in ease of transducer where one coil when energized the care of setting up of flux and the other coil when energized produces a proportional signal either electrical or mechanical

8. **Explain the following with respect to rotating electrical machines (i) Pole pitch & (ii)Chording angle**
   Pole pitch is that centre to centre distance between any two consecutive poles in a rotating machine, measured in slots per poles
   Chording angle is that angle by which the coil span is short of full pitched in electrical degrees.

9. **Why energy stored in a magnetic material always occur in air gap**
   In iron core or steel core the saturation and aging effects form hindrance to storage Built in air

gap as reluctance as well permeability is constant, the energy storage takes place linearly without any complexity Hence energy is stored in air gap in a magnetic medium.

10. What is the necessity to determine the energy density in the design of rotating machines?

Energy density $wf=B^2/2\mu$

11. Write the energy balance equation for motor?

Mechanical energy o/p-=electrical energy i/p-increase in field energy Ff dx=idλ-dWf

12. How the energy stored in magnetic field?

When the moving part of any physical system is held fixed, and then the entire electrical energy input gets stored in the magnetic field.

13. Give any four examples if single excited magnetic system.

(i) Electromagnetic Relay
(ii) Reluctance relay
(iii)MI instruments
(iv)Hysteresis motor.
(v)

14. Write the applications of singly excited and doubly excited magnetic system.

Singly excited magnetic system – EM Relays, Reluctance motor, MI instruments, Hysteresis motor.
Double excited magnetic system – Alternator, Synchronous motor, loud speakers, tachometers, DC machines.

15. State the necessary conditions for the production of steady torque the interaction of stator and rotor fields in an electric machine.

(i) The two fields must have the same number of poles
(ii) The two fields shall be relatively stationary.

16. Write the equation which relates rotor speed in electrical and mechanical radians per second?

$$\omega e = \left(\frac{P}{2}\right) \omega m$$

ωe =speed in electrical radians per sec
ωm =speed in mechanical radians per sec
p=no of poles

17. Relate co energy density and magnetic flux density?

Co energy density=wf=∫0λ (I, x) di wf=1/2BH

18. Define field energy and co energy

<u>Field Energy</u>

Field energy is defined as a convenience for computing force with flux linkages held constant.
F = dw/dx with flux linkages held constant.

<u>Co-energy</u>

Co-energy is defined as a convenience for computing force with current held constant

F = -dw/dx with flux linkages held constant
F = dw'/dx with currents held constant.
Where W= energy, W' = co energy.

19. Enumerate advantages of electric energy over other forms of energy?

I. It can be raised or lowered to reach remotest point of use
II. Used for lighting
III. Motors used for mechanical loads
IV. Used for domestic purposes
V. Used for heating
VI. Used for Air Conditioning
VII. Used for Vehicles

20. Define leakage flux.

Flux linking one coil passes partially through core and competes rest through air, does not link the coil on moving is called Leakage flux.

21. Does the leakage flux take part in energy conversion?

The leakage flux does not interact with the current of the other member. So it does not produce mechanical torque or force. Hence the leakage flux does not take part in energy conversion process.

22. Define Basic energy conversion process.

The basic energy conversion process is the one involving the coupling field and its action and reaction on electric and mechanical systems.

23. Draw the block diagram of Electro Mechanical systems.

Electrical systems ⟷ Coupling field ⟷ Mechanical systems.

24. How the loss mechanisms are represented in Electric and Mechanical Systems?

The loss mechanism is represented externally as resistance in electric terminal and mechanical damper in mechanical terminal.

25. How to represent force and torque from energy equations for a linear systems in a singly excited systems?

$F_{fld} = \lambda^2/2L(x)^2(dL(x)/dx)$
$T_{fld} = \lambda^2/2L(\theta)^2(dL(\theta)/d\theta)$

26. How to represent force and torque from Coenergy equations for a linear systems in a Multiply excited systems?

$F_{fld} = i_1^2/2dL_{11}(x)/dx+i_2^2/2dL_{22}(x)/dx+i_1i_2dL_{12}(x)/dx$,
$T_{fld} = i_1^2/2dL_{11}(\theta)/d\theta + i_2^2/2dL_{22}(\theta)/d\theta + i_1i_2dL_{12}(\theta)/d\theta$

27. Write the energy balance equation for motor?

Mechanical energy o/p-=electrical energy i/p-increase in field energy $F_f\,dx = id\lambda - dW_f$

28. What is the basic feature of an electromagnetic energy conversion device?

They contain air gaps in their magnetic circuits in their moving parts.

29. Why does the energy storage in a magnetic material occur mainly in the air gap?

The reluctance of the air gap is much larger than the magnetic material. Hence the predominant energy is stored occurs the air gap and the properties of the air gap are determined by the dimension of the air gap.

30. What is the energy conversion medium in a singly-excited magnetic field system?
The magnetic circuits have air gap between stationary and moving members in which considerable energy is stored in the magnetic field. This field acts as the energy conversion medium and its energy is the reservoir between electric and mechanical system.

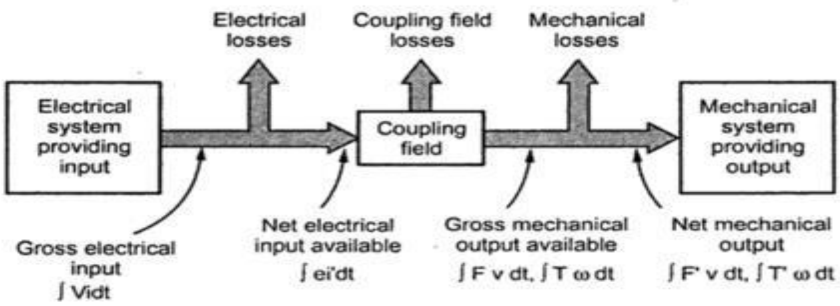
31. Write the relationship between m.m.f and current, inductance and number of turns, self-inductance and mutual inductance.
The inductance can be written in terms

$$\left.\begin{aligned} M_{12} &= \frac{\lambda_{12}}{i_2} \quad \text{H} \\ M_{21} &= \frac{\lambda_{21}}{i_1} \quad \text{H} \end{aligned}\right\}$$

32. Why the relationship between current & coil flux linkages of electromechanical energy conversion devices are linear?
When armature is held open then almost entire mmf is required to drive the flux through air gap and hence magnetic saturation may not occur. So the relationship between current and coil flux linkages of electromechanical energy conversion devices are linear.

33. What are the causes for irrecoverable energy loss when the flux in the magnetic circuit undergoes a cycle?
When a magnetic coil undergoes a cycle $\Phi_1 \rightarrow \Phi_2 \rightarrow \Phi_1$. It undergoes a cycle of magnetization and demagnetization. The hysteresis and eddy current effects are dominant under such condition.

34. Draw an energy flow diagram of an electromechanical energy conversion device when it acts as a motor.



35. Show the generalized expression for emf generated in an AC machine.
$E_{ph} = 4.44\, K_c K_d f\, \phi\, T_{ph}$ volts
E_{ph} = Phase voltage in volts
K_c = pitch factor or coil span factor
K_d = distribution factor
f = frequency in Hz
ϕ = flux per pole in Wb
T_{ph} = number of turns per phase

36. Short advantages of short pitched coil?
Hormonics are reduced in induced voltage
Saving of copper
End connections are shorter

37. What is the significance of winding factor?

Winding factor gives the net reduction in EMF induced due to short pitched coil wound in distributed type

Winding factor $k_w = k_p k_d$

k_p= pitch factor

k_d= distribution factor

$k_p = \cos(\alpha/2)$

$k_d = \sin(m\beta/2)/m\sin(\beta/2)$

38. Define Pole pitch.

The pole pitch is defined as peripheral distance between center of two adjacent poles in dc machine. This distance is measured in term of armature slots or armature conductor come between two adjacent pole centers.

$$\boxed{\begin{aligned}\text{Pole pitch} &= 180^\circ \text{ electrical}\\ &= \text{Slots per pole (no. of slots/P)} = n\end{aligned}}$$

39. Define the pitch factor.

The factor by which induced emf gets reduced due to short pitching is called pitch factor or coil span factor denoted by Kc.

$$\therefore \qquad K_c = \frac{E_R \text{ when coil is short pitched}}{E_R \text{ when coil is full pitched}} = \frac{2E\cos\left(\frac{\alpha}{2}\right)}{2E}$$

$$\therefore \qquad \boxed{K_c = \cos\left(\frac{\alpha}{2}\right)}$$

where α = Angle of short pitch

40. Define the distribution factor.

It is expressed as ratio of the phasor sum of the emfs induced in all the coils distributed in a number of slots under one pole to the arithmetic sum of the emfs induced.

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

m = Slots per pole per phase

β = Slot angle = $\frac{180^\circ}{n}$ and n = Slots per pole

41. Define the synchronous speed.

The speed at which Ac machines generate a voltage at the rated frequency of 50 Hz is called synchronous speed

$$\boxed{N_s = \frac{120f}{P} \text{ r.p.m.}}$$

N_s = synchronous speed ; f= frequency; P =number of poles

42. Tell the advantages of using short pitched winding in a synchronous machine.

- The length required for the end connections of coils is less i.e. inactive length of winding is less. So less copper is required. Hence economical.
- Short pitching eliminates high frequency harmonics which distort the sinusoidal nature of e.m.f. Hence waveform of an induced e.m.f. is more sinusoidal due to short pitching.

- As high frequency harmonics get eliminated, eddy current and hysteresis losses which depend on frequency also get minimized. This increases the efficiency

43. Derive the relation between co energy and the phase angle between the rotor and stator fluxes of the rotating machines?

F_1, f_2 are the rotor and stator flux peak values respectively

$F_r^2 = f_1^2 + f_2^2 + 2f_1f_2\cos\alpha$

Co energy= $\frac{\pi\mu_0 Dl}{4g}\{f_1^2 + f_2^2 + 2f_1f_2\cos\alpha\}$

UNIT-II: DC GENERATORS

1. **What is prime mover?**
The basic source of mechanical power which drives the armature of the generator is called prime mover.

2. **What is the principle of generator?**
When the armature conductor cuts the magnetic flux EMF is induced in the conductor.

3. **What are the essential parts of a d.c generator?**
Magnetic frame or yoke 2. Poles 3. Armature 4. Commutator, pole shoes, armature windings, interpoles 5. Brushes, bearings and shaft.

4. **What are the types of armature winding?**
1. Lap winding, A=P, 2.Wave winding, A=2.

5. Compare lap winding and wave winding.

Lap winding	Wave winding
The number of parallel path is equal to the number of poles i.e., A = P.	The number of parallel paths is always equal to 2 i.e., A = 2.
Lap windings are used for low voltage and high current machines	Wave windings are used for high voltage and low current machines

6. **How are armatures windings are classified based on placement of coil inside the armature slots?**
Single and double layer winding.

7. **Outline the purpose of yoke in a DC machine.**
   - It acts as a protective cover for the whole machine and provides mechanical support for the poles.
   - It carries the magnetic field flux produced by the poles.

8. **Classify types of DC generators**.
   - Separately excited d.c. generator
   - Self excited d.c. generator- Series generator , Shunt generator ,Compound generator

9. **What is meant by self excited and separately excited dc generator?**
   a. Self-excited generator are those whose field magnets are energized by the current produced by the generator themselves

b. Separately excited generator are those whose field magnets are energized from an independent external source of dc current

10. How can one differentiate between long shunt compound generator and short shunt compound generator?

In a short shunt compound generator the shunt field circuit is shorter i.e. across the armature terminals. In a long shunt compound generator the shunt field circuit is connected across the load terminals.

11. Give the materials used in machine manufacturing?

There are three main materials used in m/c manufacturing they are steel to conduct magnetic flux copper to conduct electric current insulation.

12. Why the armature core in d.c machines is constructed with laminated steel sheets instead of solid steel sheets?

Lamination highly reduces the eddy current loss and steel sheets provide low reluctance path to magnetic field.

13. Why commutator is employed in d.c.machines?

Conduct electricity between rotating armature and fixed brushes, convert alternating EMF into unidirectional EMF (mechanical rectifier).

14. What is the function of carbon brush used in dc generators?

The function of the carbon brush is to collect current from commutator and supply to external load circuit and to load.

15. Distinguish between shunt and series field coil construction?

Shunt field coils are wound with wires of small section and have more no of turns.
Series field coils are wound with wires of larger cross section and have less no of turns.

16. What is core loss? What is its significance in electric machines?

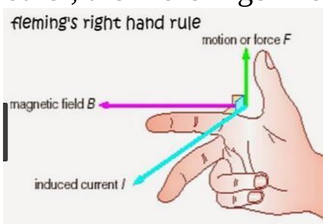
When a magnetic material undergoes cyclic magnetization, two kinds of power losses occur on it. Hysteresis and eddy current losses are called as core loss. It is important in determining heating, temperature rise, rating & efficiency of transformers, machines & other A.C run magnetic devices.

17. What is eddy current loss?

When a magnetic core carries a time varying flux, voltages are induced in all possible path enclosing flux. Resulting is the production of circulating flux in core. These circulating current do no useful work are known as eddy current and have power loss known as eddy current loss.

18. How will you find the direction of EMF using Fleming's right hand rule?

The thumb, forefinger & middle finger of right hand are held so that these fingers are mutually perpendicular to each other, then forefinger-field thumb-motion middle current.



19. Write down the EMF equation for d.c.generator?

$E = (\Phi NZ/60)(P/A)$ V.

Where, Φ = Flux per pole in Weber

Z = Total number of armature conductors   N = Speed of armature in rpm

P = Number of poles   A = Number of parallel paths

20. Under What circumstances does a dc shunt generator fails to generate?

Absence of residual flux, initial flux setup by field may be opposite in direction to residual flux, shunt field circuit resistance may be higher than its critical field resistance; load circuit resistance may be less than its critical load resistance.

21. Define critical field resistance of dc shunt generator?

Critical field resistance is defined as the resistance of the field circuit which will cause the shunt generator just to build up its EMF at a specified field.

22. Why is the EMF not zero when the field current is reduced to zero in dc generator?

Even after the field current is reduced to zero, the machine is left out with some flux as residue so EMF is available due to residual flux.

23. On what occasion dc generator may not have residual flux?

The generator may be put for its operation after its construction, in previous operation; the generator would have been fully demagnetized.

24. What are the conditions to be fulfilled by for a dc shunt generator to build back EMF?

The generator should have residual flux, the field winding should be connected in such a manner that the flux setup by field in same direction as residual flux, the field resistance should be less than critical field resistance, load circuit resistance should be above critical resistance.

25. Define armature reaction in dc machines?

The effect of the mmf set up by the armature current on the distribution of mmf under main pole of a DC machine is called armature reaction.The effects are Demagnetization and cross magnetization.

26. What are two unwanted effects of armature reactions?

Cross magnetizing effect & demagnetizing effect.

27. Name the three things required for the generation of EMF.

Presence of armature conductors

Presence of magnetic field

Relative motion between conductor and magnetic field

28. What is pole pitch?

The periphery of the armature is divided for a number of poles of the generator. The center to center distance between two adjacent poles is called pole pitch. It is also equal to the number of armature slots or armature conductors per pole.

29. How can the voltage in a DC generator be increased?

Increasing the main field flux and the speed of the armature can increase the voltage in a DC generator.

30. What are the conditions to be fulfilled for a shunt generator to build up voltage?

a. There must be some residual magnetism in the field poles.
b. The shunt field resistance should be less than critical resistance.
c. The field coils should be connected with the armature in such a way that current flowing through them should increase the EMF induced by the residual magnetism.

31. Infer the conditions under which a DC shunt generator fails to excite.

- Absence of residual flux
- Initial flux set up by field may be opposite in direction to residual flux
- Shunt field circuit resistance may be higher than its critical field resistance.
- Direction of rotation may be wrong
- There may be disconnection in the field winding

32. What do you mean by the residual flux in DC generator?

The magnetic flux retained in the poles of the machine even without field supply is called the residual flux.

33. Why does curving the pole faces in a DC machines contributes to a smoother DC output voltage from it?

To achieve good air gap flux distribution the pole faces are curved, which improves the commutation and contributes to a smoother DC output voltage.

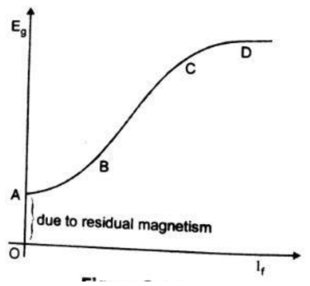
34. Summarize the characteristics of DC generator.

Open Circuit Characteristic (O.C.C.) (E_0/I_f)
Internal Or Total Characteristic (E/I_a)
External Characteristic (V/I_L)

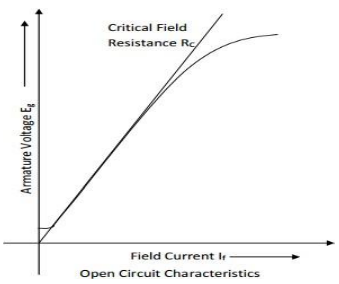
35. What are open circuit characteristics of DC shunt generator?

It is the relation between the field current and the EMF induced in the armature.

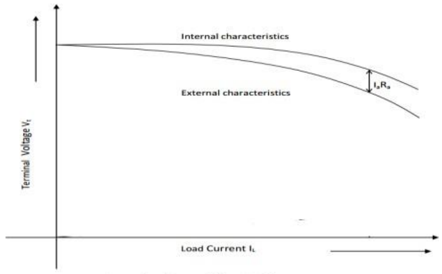
36. Illustrate the open circuit characteristics of self-excited DC generator.



37. Draw various characteristics of DC shunt generator.

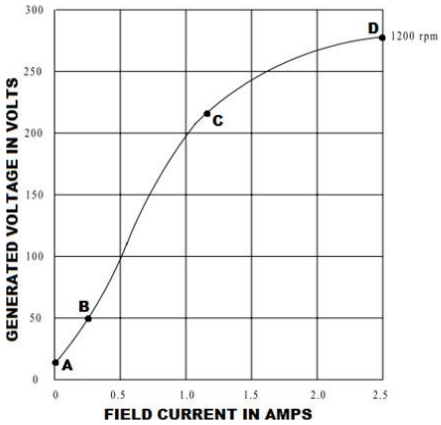


Open Circuit Characteristics



Internal and External Characteristics

38. Draw and explain the magnetizing characteristics of DC shunt generator.



When current passed through the magnetic material then its molecules are arranged in definite order. Up to a certain value (Point B) of field current the maximum molecules are arranged. In this stage the flux established in the pole increased directly with the field current and the generated voltage is also increased. Point B to point C is showing the magnetization curve is almost a straight line. Above a certain point (point C in this curve) the non-magnetized molecules become very fewer and it became very difficult to further increase in pole flux. This point is called saturation point. Point C is also known as the knee of the magnetization curve. A small increase in magnetism requires very large field current above the saturation point (point C to point D).

39. Identify the reason why external characteristic curve DC shunt generator is more drooping than that of a separately excited generator.

For a shunt generator, with increase in load current, the ohmic drop increases and the terminal voltage drops which makes the characteristic to droop down. On the other hand, the terminal voltage is not reduced to a large extent as the field current is kept constant in a separately excited DC generator and thereby maintaining a constant emf generated.

40. Define the term 'critical speed' in dc shunt generator.

Critical speed is defined as the speed at which the generator is to be driven to cause self-excited generator to build up its EMF for the given field circuit resistance.

41. How the critical field resistance of a dc shunt generator is estimated from its OCC?

Critical field resistance can be obtained from OCC by drawing a straight line passing through the origin and tangent to the initial straight line portion of OCC. The slope of this line gives the value of critical field resistance for the given speed at which OCC is obtained.

42. Differentiate between geometric neutral axis (GNA) and magnetic neutral axis (MNA).

GNA is the axis which is situated geometrically or physically in the mid way between adjacent main poles. MNA is the axis which passes through the zero crossing of the resultant magnetic field waveform in the air gap.

43. In which part of the dc machine is the compensating winding situated?

In the slots provided in the main pole phases.

44. What are the various types of commutation?

Linear commutation and Sinusoidal commutation.

45. Name the two methods of improving commutation.
EMF commutation and Resistance commutation.

46. What is reactance EMF in dc machine?
The self induced EMF in the coil undergoing commutation which opposes the reversal of current is known as reactance EMF.

47. Define the term commutation in dc machines.
The changes that take place in winding elements during the period of short circuit by a brush is called commutation.

48. How and why the compensating winding in dc machine excited?
As the compensation required is proportional to the armature current the compensating winding is excited by the armature current.

49. How is the interpole winding in dc machine excited?
Interpole winding is connected in series with the armature circuit and is excited by the armature current.

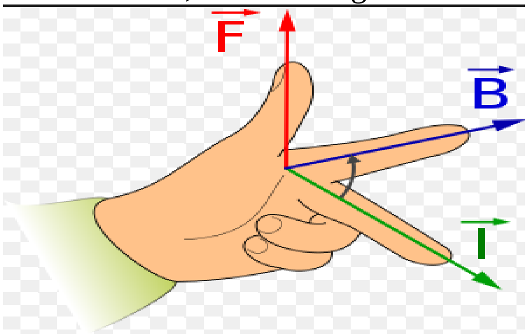
50. To what polarity are the interpoles excited in dc generators?
The polarity of the interpoles must be that of the next main pole along the direction of rotation in the case of generator.

51. Specify the role of interpoles in DC machines.
Interpoles are designed in DC motors to overcome the effects of the armature reactance andthe self-induction of the machine.

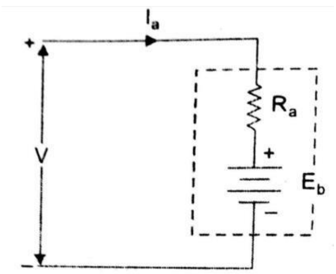
UNIT III: DC MOTORS

1. **What is the basic principle of operation of DC motor?**
   When a current carrying conductor is placed in a magnetic field, a mechanical force is exerted on the conductor which develops the torque.

2. **How will you find the direction of force produced using Fleming's left hand rule?**
   The thumb, forefinger & middle finger of left hand are held so that these fingers are mutually perpendicular to each other, then forefinger-field thumb-motion middle current.



3. **Illustrate the circuit of the DC shunt motor.**



4. **How does D.C. motor differ from D.C. generator in construction?**
   Generators are normally placed in closed room and accessed by skilled operators only. Therefore on ventilation point of view they may be constructed with large opening in the frame. Motors have to be installed right in the place of use which may have dust, dampness, inflammable gases, chemicals….etc. to protect the motors against these elements, the motor frames are made either partially closed or totally closed or flame proof.

5. **How will you change the direction of rotation of d.c.motor?**
   Either the field direction or direction of current through armature conductor is reversed.

6. **State one advantage and disadvantage in the application of each of the three basic types of DC motors**.
   <u>Shunt Motor:</u>
   Advantage: Substantially constant speed i-e low speed regulation
   Disadvantage: Cannot be used for constant speed application
   <u>Series Motor:</u>
   Advantage: High torque low speed (at start) and low torque at high speed. This is typical requirement for traction type of load
   Disadvantage: Accidental no load can cause the motor to run at dangerously high speed.
   <u>Compound Motor:</u>
   Advantage: Negligible speed regulation for cumulatively compound motor. Disadvantage: Higher cost.

7. **What is back emf? Outline the significance of back emf.**
   When the motor armature rotates , the conductor also rotates and cut the flux.In accordance with laws of electromagnetic induction, an emf is induced in them in opposition to the applied voltage. It is referred to as counter emf or back emf.
   Significance
   Back emf acts like a governor.i.e it makes the motor self-regulating, so that it draws as much current as just required .

8. **Write the voltage and power equation of a dc motor.**
   $V=E_b+ I_aR_a$ - voltage equation
   V- applied voltage in volts; E_b- back emf in volts ; I_a - armature current in amps ; R_a - armature resistance in ohms.
   $VI_a= E_bI_a +I_a^2R_a$ – power equation
   VI_a - Electrical power supplied to armature; $I_a^2R_a$ -power loss in the armature
   E_bI_a - power developed by the motor armature.

9. **Define differential and cumulative compound motor.**
    - A compound wound dc motor is said to be cumulatively compounded when the shunt field flux produced by the shunt winding assists or enhances the effect of main field flux, produced by the series winding.
    - A compound wound dc motor is said to be differentially compounded when the shunt field flux produced by the shunt winding opposes the effect of main field flux, produced by the series winding.

10. **When is a four point DC starter required in DC motors?**
    A four point DC starter is required for dc motor under field control.

11. **If speed is decreased in a dc motor, what happens to the back EMF decreases and armature current?**
    If speed is decreased in a dc motor, the back EMF decreases and armature current increases.

12. **How does a series motor develop high starting torque?**
    A dc series motor is always started with some load. Therefore the motor armature current increases. Due to this, series motor develops high starting torque.

13. **What are the losses in dc motor?**
    1.Copper losses
    2.Iron losses
    3.Mechanical losses

14. **What is the function of no-voltage release coil in D.C. motor starter?**
    As long as the supply voltage is on healthy condition the current through the NVR coil produce enough magnetic force of attraction and retain the starter handle in ON position against spring force. When the supply voltage fails or becomes lower than a prescribed value then electromagnet may not have enough force to retain so handle will come back to OFF position due to spring force automatically.

15. **Enumerate the factors on which speed of a d.c.motor depends?**
    N= (V-IaRa)/Φ so speed depends on air gap flux, resistance of armature, voltage applied to armature.

16. **Write down the equation for back EMF of DC motor.**

$$E_b = P\ \Phi\ Z\ N\ P\ /\ 60\ A,\ [\text{Volts}]$$

17. **Write down the equation for torque developed in DC motor.**

$$T_d = \Phi\ I_a\ Z\ P\ /\ 2\pi\ A\ ,\ [\text{N-m}]$$

$$T_d\ \alpha\ \Phi\ I_a$$

18. **Why DC motors are not operated to develop maximum power in practice?**
    The current obtained will be much higher that the rated current
    The efficiency of operation will be below 50 %

19. **Under what condition the mechanical power developed in a DC motor will be maximum?**
    Condition for mechanical power developed to be maximum is

$$E_b = V_a /2 \text{ or } I_{\mathbf{a}}= V_a / 2R_a$$

20. Why shaft torque is always less than that developed inside the armature in a DC motor?

Mechanical power developed inside the armature is $P_d = E_b I_a = 2\pi N T_d / 60$

Mechanical power output available on the shaft is

i. $P_o = 2\pi NT / 60$
ii. $P_d - P_o = W_i + W_m$

Therefore shaft torque T is less than torque developed in the armature T_d to meet the iron loss W_i and mechanical loss W_m.

21. Explain how the back EMF of a motor causes the development of mechanical power?

Net electrical power into motor armature is $P_{mot} = E_b I_a$

$\Phi\ \omega_m\ Z\ P\ I_a / 2\ \pi\ A$

$\omega_m\ \{\Phi\ Z\ P\ I_a / 2\ \pi\ A) = \omega_m\ T = P_{mech}$

So it is power absorbed by E_b that gets converted to mechanical form.

22. Why a differentially compound motor is not used in practice?

As the motor is loaded, the series winding reduces the flux produced by the shunt winding and so its N-T characteristic curves are upwards. Under accidental overload, flux / pole tend to zero and motor speed can increase to dangerous values. Hence they are not used in practice.

23. What do you mean by constant torque operation and constant HP operation of speed control in DC shunt motor?

Constant torque operation of speed control is i) Armature control method ii)constant HP method is Field control method.

Speed and torque equations of DC motor are = $K_N (V_a - I_a R_a)/\Phi$

$K_N V_a / \Phi$ as armature drop is neglected

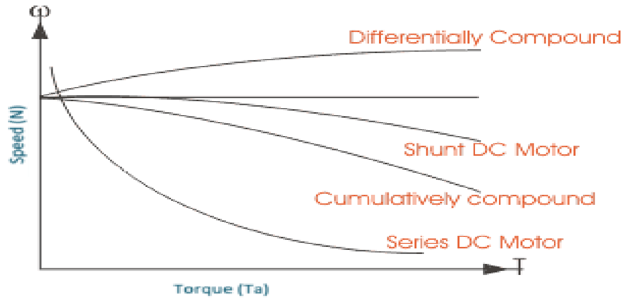
$T = K_T\ \Phi\ I_a$

At load torque $T_L = T_{motor}$ at base speed N_b, apply full voltage to field; so $I_f = I_{f(max)}$.

Adjust armature voltage V_a to rated value. With field remaining fixed for constant torque, I_a should remain fixed at rated value. For speeds above rated value, reduce V_a, the speed reduces as per the first equation, the motor draws rated I_a at constant load torque. The speed cannot be raised above N_b as rated I_a cannot be exceeded unless the torque is allowed to be reduced.

Keeping V_a at rated value if I_f is reduced, the speed would increase but torque would reduce. This indeed is constant Hp drive.

24. Draw the mechanical characteristics of all types of DC motor.



25. Why a DC shunt motor is also called a constant flux motor or constant speed motor?

In a DC shunt motor flux produced by field winding is proportional to field current. Here the input voltage is constant. So field current and flux is also constant. Therefore, dc shunt motor is called constant flux motor or constant speed motor.

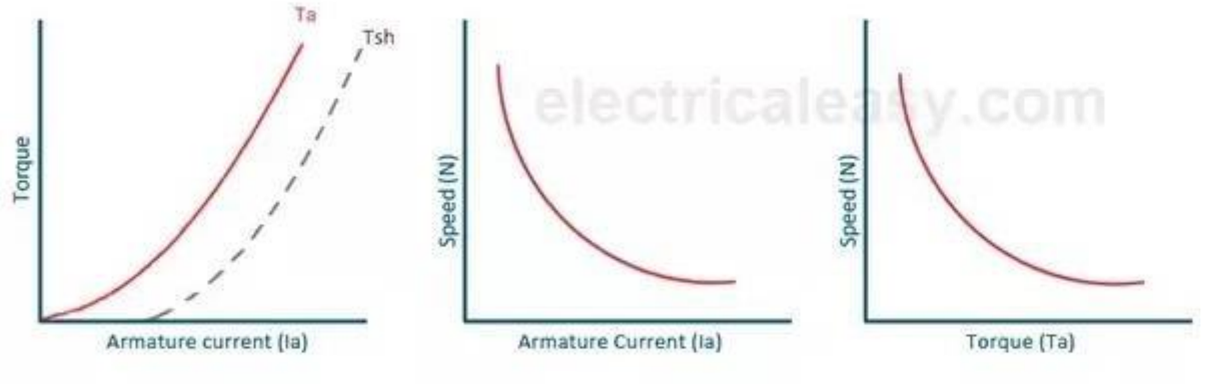
26. Why DC series motor is suitable for traction application?

A DC series motor develops large starting torque as the torque is proportional to the square of armature current .Hence it is suitable for traction application

27. Organize the precaution to be taken during starting of DC series motor and why.

- It should not be started at without any load.
- In dc series motor, flux is directly proportional to armature current. Under no load condition, the armature current is very low and flux also will be less. By using the formula N α 1/ ϕ, the motor speed will be very dangerous very high.

28. Draw the characteristics of DC series motor.



29. What is the necessity of starter in dc motors?

When a dc motor is directly switched on, at the time of starting, the motor back EMF is zero. Due to this, the armature current is very high. Due to the very high current, the motor gets damaged. To reduce the starting current of the motor a starter is used.

30. Why is the starting current high in a DC motor?

The absence of back EMF at the time of starting causes the armature current to shoot up to about 20 times the normal current, if no limiting resistance is included.

31. What is the function of over-load release coil provided in a DC motor starter?

Due to any overload in the motor, if the line current increases above a preset value, the excess magnetic force causes the lifting of an iron piece. As the iron piece makes an upward movement, a contactor fitted along with it causes the two terminals of NVR coil to get short circuited. Hence the electromagnet fitted with NVR coil loses its magnetic force and releases the starter handle from the ON position towards OFF position, thus protecting the motor against over-load.

32. How does 4 point starter differ from 3 point starter?

In 3 point starter, NVR coil is connected in series with the shunt field coil. The exciting current through the NVR coil in 3 point starter is same as the shunt field current of the motor. In 4 point starter, NVR coil along with a high resistance connected across the supply voltage. Thus the exciting current through NVR coil of a 4 point starter is purely proportional to the supply voltage and independent of shunt field current.

33. Enumerate the factors on which the speed of a DC motor depends.

$N = E_b / \Phi = (V_a - I_a R_a) / \Phi$

The speed of dc motor depends on three factors.

a. Flux in the air gap
b. Resistance of the armature circuit
c. Voltage applied to the armature
d.

34. Specify the techniques used to control the speed of DC shunt motor for below and above the rated speed.

Below rated speed - Armature control method

above rated speed - Flux or field control method

35. What are different methods of speed control in D.C shunt motor?

1.Armature control
2.Flux or field control
3.Applied voltage control

36. List the different methods of speed control employed for DC series motor.

a. Field diverter method
b. Regrouping of field coils
c. Tapped field control
d. Armature resistance control
e. Armature voltage control for single motor
f. Series parallel control for multiple identical motors

37. What is the relation between electrical degree and mechanical degree?

Electrical degree θ_e and mechanical degree are related to one another by the number of poles P, the electrical machine has, as given by the following equation. $\theta_e = (P/2)\,\theta_m$

38. State the condition for maximum efficiency.

Constant Losses = Variable Losses

39. Outline the advantages of Swinburnes test.

Advantages

1. This method is economical since power required to test a large machine is very small (i.e.,) no load input power.
2. The efficiency of the machine can be predetermined at any load, since constant losses are known.
3. This method enables us to determine the losses and efficiency without actually loading the machine.

40. Summarize the disadvantages of Swinburne’s test.

- It is not suitable for series motor
- Change in iron loss is not considered at full load from no load.
- As the Swinburne’s test is performed at no load. Commutation on full load cannot be determined

41. Is it possible to conduct Swinburne’s test on DC series motor? Justify.

No. Swinburne’s test cannot be performed on DC series motor, since at no load series motor attains a large speed which may damage the motor itself.

42. List the advantages and disadvantages of regenerative test.

Advantages:

1. Power required for the test is small as compared to full load power of the two machines.
2. Since the machines can be tested under full load conditions for long duration, the performance of the machines regarding commutation and temperature rise can be studied.

Disadvantage:

1. Two identical machines are required.

43. What is the meaning of electrical degree?

Electrical degree is used to account the angle between two points in rotating electrical machines. Since all electrical machines operate with the help of magnetic fields, the electrical degree is accounted with reference to the polarity of magnetic fields. 180 electrical degrees is accounted as the angle between adjacent North and South poles.

44. List out some examples of prime movers.

I.C. Engines, Steam engine, Turbine or Electric Motors.

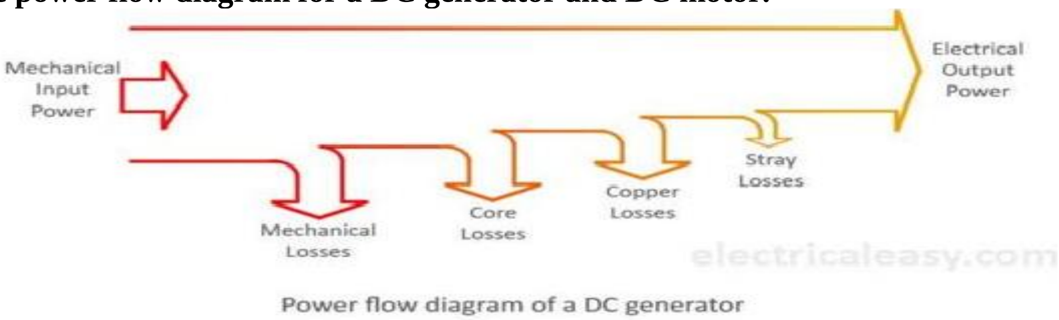
45. Give some applications of DC motor.

a. Shunt : driving constant speed, lathes, centrifugal pumps, machine tools, blowers and fans, reciprocating pumps
b. Series : electric locomotives, rapid transit systems, trolley cars, cranes and hoists, conveyors
c. Compound : elevators, air compressors, rolling mills, heavy planners.

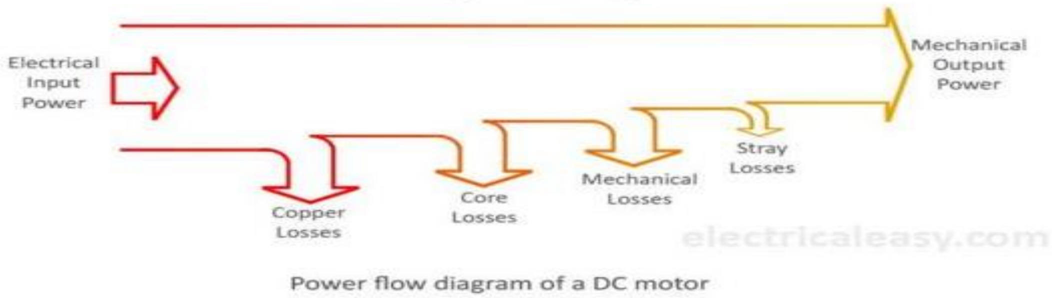
46. Why field control is considered superior than armature control method of DC shunt motor?

The regulating resistance which has to carry only a small current is easily available. b.Power wasted in regulating the resistance is very small and hence this method is more economical.

47. Draw the power flow diagram for a DC generator and DC motor.



Power flow diagram of a DC generator



Power flow diagram of a DC motor

48. Mention the types of braking of dc motor?

1.Regenerative braking
2.Dynamic braking
3.Plugging

49. What is meant by dynamic braking in DC motor?

When an electric motor rotates, the kinetic energy is stored in its rotating mass.During dynamic braking the kinetic energy of the motor is converted into electric energy. This energy is dissipated in resistive element.

UNIT IV:SINGLE PHASE TRANSFORMERS

1. Define a transformer?

A transformer is a static device which changes the alternating voltage from one level to another.

2. What is the turns ratio and transformer ratio of transformer?

Turns ratio = N_2/ N_1

Transformer = $E_2/E_1 = I_1/ I_2 = K$

3. State the principle of operation of a transformer.

Transformer operates on the principle of mutual induction between inductively coupled coils. When AC source is connected to one coil, flux is produced in the core, which links both the coils. As per Faraday's Laws of Electromagnetic Induction, EMF is induced in the secondary coil also. If the external circuit is closed the power is supplied.

4. What are the main parts of a transformer? What type of material is used for the core?

Laminated core and primary and secondary windings are the main parts. The core is built up of thin soft iron or high-grade silicon steel laminations to provide a path of low reluctance to the magnetic flux.

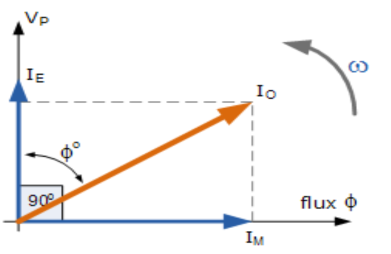
5. What is an ideal transformer?

An ideal transformer is one which does not involve any power losses and also does not have any leakage of magnetic field.

6. List the properties of an ideal transformer.

No winding resistance, no magnetic leakage flux, no copper loss, no core loss

7. Draw the phasor diagram of an ideal transformer.

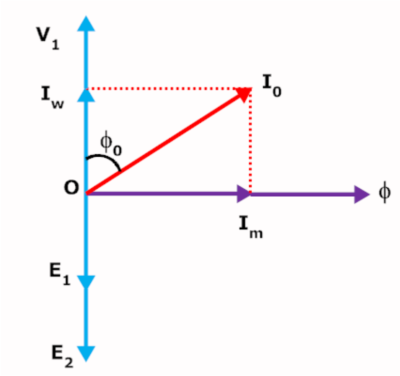


$$I_E = I_O \cos\phi$$

$$I_M = I_O \sin\phi$$

$$I_O = \sqrt{I_M^2 + I_E^2}$$

8. Demonstrate the no load phasor diagram of a transformer.



V1
Iw
I0
ϕ0
O
ϕ
Im
E1
E2

9. List the various components of no load current in a transformer.

- No load current ,I_0 has two components I_w and I_μ.
- I_μ is known as magnetizing component. This component produces mutual flux Φ in the core. I_μ lagging behind V_1 by 90˚.
  $I_\mu = I_0 \sin \Phi_0$
- I_w is known as iron loss or active or working component. It is in phase with the applied voltage V_1. It supplies a very small primary copper loss and iron loss.
  $I_w = I_0 \cos \Phi_0$
  $\cos \Phi_0$ – No load power factor

10. What will happen if the primary of a transformer is connected to a DC supply?

The primary will draw a steady current and hence produce constant flux. Consequently no back EMF will be produced. The primary winding will draw excessive current due to low resistance of the primary. This result in over heating of primary windings and the fuses will blow.

11. List four applications of a transformer. It can raise or lower the voltage or current in an AC circuit.

a. It can act as an impedance transferring device by increasing or decreasing the value of a capacitor, inductor or resistance in an AC circuit.
b. It can isolate two circuits electrically.
c. It can be used to prevent DC from passing one circuit to another.

12. How does flux leakage occur in transformr?

The entire flux set up by one winding during load condition may not be able to reach the other winding to carry on the useful purpose of energy transformation. Some of the fluxes will be present in and around the respective windings only, causing self induced EMF in them. These fluxes are called leakage fluxes.

- Reducing the magnetizing current to the minimum.
- Reducing the reluctance of the iron core to the minimum.
- Reducing the number of primary and secondary turn to the minimum.
- Sectionalizing and interleaving the primary and secondary windings.

14. How do you reduce hysteresis loss in a transformer?

Hysteresis loss can be reduced by selecting suitable core material. Silicon steel is having less Stein Metz hysteresis coefficient.

15. Compare core zshell type transformer .

Basis for Comparison	**Core Type Transformer**	**Shell Type Transformer**
Definition	The winding surround the core.	The core surrounds the winding.
Lamination Shape	The lamination is cut in the form of the L strips.	Laminations are cut in the form of the long strips of E and L.
Cross Section	Cross-section may be square, cruciform and three stepped	The cross section is rectangular in shape.

Copper Required	More	Less
Other Name	Concentric Winding or Cylindrical Winding.	Sandwich or Disc Winding
Limb	Two	Three
Insulation	More	Less
Flux	The flux is equally distributed on the side limbs of the core.	Central limb carry the whole flux and side limbs carries the half of the flux.
Winding	The primary and secondary winding are placed on the side limbs.	Primary and secondary windings are placed on the central limb
Magnetic Circuit	Two	One
Losses	More	Less
Maintenance	Easy	Difficult
Mechanical Strength	Low	High
Output	Less	High
Natural Cooling	Does not Exist	Exist

16. What is the purpose of laminating the core in a transformer?

In order to minimise eddy current loss.

17. How transformers are classified according to their construction?

1. Core type 2.shell type. In core type, the winding (primary and secondary) surround the core and in shell type, the core surrounds the winding.

18. Explain on the material used for construction?

The core is constructed by sheet steel laminations assembled to provide a continuous magnetic path with minimum of air gap included. The steel used is of high silicon content sometimes heat treated to produce a high permeability and a low hysteresis loss at the usual operating flux densities. The eddy current loss is minimized by laminating the core, the laminations being used from each other by light coat of core plate vanish or by oxide layer on the surface. The thickness of lamination varies from 0.35mm for a frequency of 50Hz and 0.5mm for a frequency of 25Hz..

19. Why do we use iron core in a transformer?

Transformer action demands only the existence of alternating flux linking the two windings. No doubt such action will be obtained if an air core is used. But it will be obtained much more effectively if an iron core is used. It is because the flux is then substantially confined to a definite path (i-e iron path) having a much more permeability than air.

20. What determines the thickness of the lamination or stampings?

1.Frequency 2.Iron loss

21. How does change in frequency affect the operation of a given transformer?

With a change in frequency, iron and copper loss, regulation, efficiency & heating varies so the operation of transformer is highly affected.

22. Give the EMF equation of a transformer and define each term?

EMF induced in primary coil E1= $4.44f\Phi mN_1$ volt

EMF induced in secondary Coil E2 =$4.44\ f\Phi mN_2$.

f ---------- freq of AC input

Φ --------maximum value of flux in the core

N_1, N_2 Number of primary & secondary turns.

23. A 1100/400 V, 50 Hz single phase transformer has 100 turns on the secondary winding. Calculate the number of turns on its primary.

We know that V1 / V2 = k = N2 / N1

Substituting in above equation 400/1100 = 100/N1

N1 = 100/400 x 1100= 275 turns.

24. Does transformer draw any current when the secondary is open? Why?

Yes, it (primary) will draw the current from the main supply in order to magnetize the core and to supply for iron and copper losses on no load. There will not be any current in the secondary since secondary is open.

25. Define voltage regulation of a transformer?

When a transformer is loaded with a constant primary voltage, the secondary voltage decreases for lagging PF load, and increases for leading PF load because of its internal resistance and leakage reactance. The change in secondary terminal voltage from no load to full load expressed as a percentage of no load or full load voltage is termed as regulation.

%regulation =E2-V2/E2 *100

V2>E2 for leading p.f load

V2<E2 for lagging p.f load

26. Define all day efficiency of a transformer?

It is computed on the basis of energy consumed during a certain period, usually a day of 24 hrs. All day efficiency=output in kWh/input in kWh for 24 hrs.

27. Why transformers are rated in kVA?

Copper loss of a transformer depends on current & iron loss on voltage. Hence total losses depend on Volt-Ampere and not on PF. That is why the rating of transformers is in kVA and not in kW.

28. What are the typical uses of auto transformer?

1. To give small boost to a distribution cable to correct for the voltage drop.

2. as induction motor starter.

29. What are the applications of step-up & step-down transformer?

Step-up transformers are used in generating stations. Normally the generated voltage will be either 11kV. This voltage (11kV) is stepped up to 110kV or 220kV or 400Kv and transmitted through transmission lines (simply called as sending end voltage). Step-down transformers are used in receiving stations. The voltage are stepped down to 11kV or 22kV are stepped down to 3phase 400V by means of a distribution transformer and made available at consumer premises. The transformers used at generating stations are called power transformers.

30. What is the angle by which no-load current will lag the ideal applied voltage?

In an ideal transformer, there are no copper & core loss i.e. loss free core. The no load current is only magnetizing current therefore the no load current lags behind by angle 90. However the winding possess resistance and leakage reactance and therefore the no load current lags the applied voltage slightly less than 90^0.

31. List the arrangement of stepped core arrangement in a transformer?

To reduce the space effectively

To obtain reduced length of mean turn of the winding

To reduce I^2 R loss.

32. Why are breathers used in transformers?

Breathers are used to entrap the atmospheric moisture and thereby not allowing it to pass on to the transformer oil. Also to permit the oil inside the tank to expand and contract as its temperature increases and decreases.

33. What is the function of transformer oil in a transformer?

It provides good insulation & Cooling.

34. Can the voltage regulation goes negative? If so under what condition?

Yes, if the load has leading PF.

35. Distinguish power transformers & distribution transformers?

Power transformers have very high rating in the order of MVA. They are used in generating and receiving stations. Sophisticated controls are required. Voltage ranges will be very high. Distribution transformers are used in receiving side. Voltage levels will be medium. Power ranging will be small in order of kVA. Complicated controls are not needed.

36. Name the factors on which hysteresis loss depends?

1. Frequency 2. Volume of the core 3. Maximum flux density

37. Why the open circuit test on a transformer is conducted at rated voltage?

The open circuit on a transformer is conducted at a rated voltage because core loss depends upon the voltage. This open circuit test gives only core loss or iron loss of the transformer.

38. What is the purpose of providing Taps in transformer and where these are provided?

In order to attain the required voltage, taps are provided, normally at high voltages side(low current).

39. What are the necessary tests to determine the equivalent circuit of the transformer?

Open circuit test

Short circuit test

40. Define efficiency of the transformer?

Transformer efficiency η= (output power/input power) x 100

41. Full load copper loss in a transformer is 1600W. What will be the loss at half load?

If n is the ratio of actual load to full load then copper loss = x^2 (F.L copper loss)

$P_{cu} = (0.5)^2 . 1600=400W$.

42. List the advantage of stepped core arrangement in a transformer?

1. To reduce the space effectively

2. To obtain reduce length of mean turn of the winding

3. To reduce I^2R loss.

43. When will a Bucholz relay operate in a transformer?

Bucholz rely is a protective device in a transformer. If the temperature of the coil exceeds its limit, Bucholz relay operates and gives an alarm.

44. The efficiency of a transformer is always higher than that of rotating electrical machines. Why?

In rotating machines, there are mechanical losses (frictional and windage losses) due to the rotating parts. As there is no rotating part in a transformer, efficiency of transformer is always higher than rotating electric machines.

45. Where and under what circumstances is a unit ratio Transformer used?

In transformers the power to the secondary winding comes from the primary winding via magnetic field. There is no conductive connection between primary and secondary. Therefore, even if a change in voltage level is not required, still it is advisable to obtain power through unit ratio transformer as it provides electrical isolation. It is mandatory for all medical equipments.

46. What is Sumpner's Test?

Back to Back Test. Two identical transformers required to conducting open circuit test and short circuit test simultaneously.

47. Why does short circuit test on a transformer give the copper loss only?

Because the voltage is less iron losses are less

48. What are the advantages and disadvantages of load test of a Transformer?

a. Accurate determination of performance
b. Thermal performance
c. Capacity of variable load beyond certain capacity
d. Loads with different power factor
e. Entire energy consumed during the test is wasted

49. What do you mean by no-load current of a transformer?

It is the input drawn by a transformer from the supply mains when its secondary windings are kept opened (or) no-load is connected to secondary.

50. What are the functions of no-load current in a transformer?

No-load current produces flux and supplies iron loss and copper loss on no-load.

51. State the conditions under which OC and SC tests are conducted in a transformer.

a. Since no load current, I_0 is very small, pressure coils of the wattmeter and the voltmeter should be connected such that the current taken by them should not flow through the current coil of the wattmeter. The transformer should be energized with rated voltage when conducting OC test.
b. For conducting SC test, the secondary winding should be short-circuited and a very low voltage should be given for the circulation of full-load current.

52. What is the purpose of conducting OC test on a transformer?

To find shunt branch elements of the equivalent circuit (R_o & X_o)
To find iron loss at rated voltage.

53. What is the purpose of conducting SC test on a transformer?

To find total resistance, impedance and hence reactance referred to a particular side.
To find full load copper loss.

54. Why OC test is generally performed on LV side of a transformer?

The test voltage required, the rated voltage is less on LV side. This will also permit to use voltmeter and wattmeter of lower voltage range.

55. Why SC test is generally performed on HV side of a transformer?

The rated current is less on HV side. This will also permit to use ammeter and wattmeter of lower current range.

56. What are the advantages of OC and SC tests of a transformer over the load test?

The performance of a transformer can be calculated on the basics of its equivalent(or circuit which contains R_0, X_0, R_{01} and X_{01} R_{02} and X_{02} referred to secondary) These constants or parameters can be easily determined by the OC and SC tests. These tests are very economical and convenient because they furnish the required information without actually loading the transformer.

57. Why wattmeter in OC test of transformer reads iron loss and that in the SC test reads copper loss on full load?

In OC test, the no load current in the transformer is quite small compared to full load current, so copper loss due to the small no load current can be neglected. Hence, the wattmeter reading can be taken as equal to core losses in transformer.

In SC test the applied voltage is short circuit voltage in the transformer and hence it is quite small compared to rated voltage, so core loss due to the small applied voltage can be neglected. Hence the wattmeter reading can be taken as equal to copper losses in transformer

58. What is the condition for obtaining maximum efficiency of a transformer?

The efficiency will be maximum when the variable losses are equal to the constant (iron) losses.

59. Give the expression for load current at maximum efficiency.

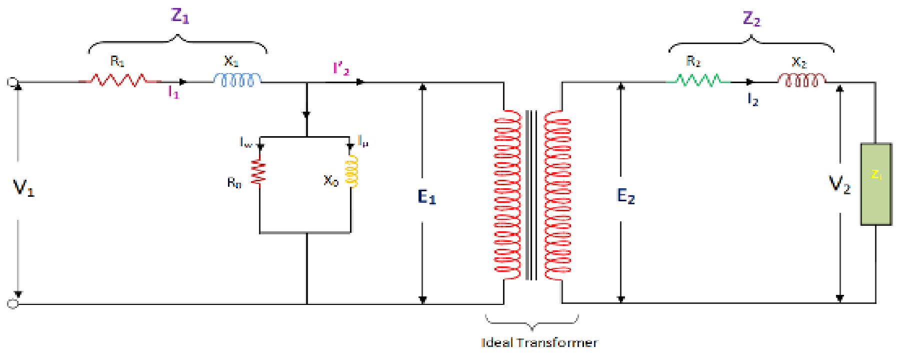
$$I_2 = \sqrt{\frac{P_i}{R_{02}}}$$

I_2 = load current; P_i= iron loss; R_{02}= equivalent resistance referred to secondary

60. What do you understand by all-day efficiency?

The ordinary or commercial efficiency of a transformer is given by the ratio between output (in Watts) and the input (in Watts) but the performance of a distribution transformer is determined by the all-day efficiency. It is defined as the total energy output (kWH) in 24 hrs a day to the total energy input in kWH for the same 24 hours of the day.

61. Draw the equivalent circuit of single-phase transformer.



62. Why the iron losses in a transformer are independent of the load current?

The hysteresis and eddy current losses depend upon the maximum flux density in the core and the frequency. Since from no-load to full-load the flux linking with the core and the supply frequency remains constant, these losses remain constant, i.e., iron loss is independent of load current.

63. What is the angle by which no-load current will lag the ideal applied voltage?

In an ideal transformer, there are no copper loss and no core loss,(i.e. loss free core). The no load current is only magnetizing current. Therefore the no-load current lags behind by an angle of 90˚. However the windings possess resistance and leakage reactance and therefore the no-load current lags the applied voltage slightly less than 90˚.

64. What is the purpose of providing 'taps' in transformer and where these are provided?

In order to attain the required voltage, 'taps' are provided. Normally it will be provided at low voltage side.

x

65. Give the condition to be satisfied for parallel operation of transformer

The conditions for the successful operation of transformers as follows.

1. The line voltage ratio of two transformers must be equal.
2. The per unit impedance of each transformer should be equal and they should have same ratio of equivalent leakage reactance to the equal resistance(X/R).
3. The transformers should have same secondary winding polarity.
4. The Transformers should have same phase sequence (Three phase transformer)
5. The transformers should have the zero relative phase replacement between the secondary line voltages.(Three phase transformers)

66. What is inrush current in a transformer?

When a transformer is first energized, a transient current up to 10 to 15 times larger than the rated transformer current can flow for a few cycles of the input waveform.This is called inrush current.

UNIT-5:AUTO TRANSFORMER AND THREE PHASE TRANSFORMER

1.A transformer rated at a primary voltage 4,800 volts and a secondary voltage of 240 volts what is the turn's ratio?

$N_1/N_2=4800/240=20:1$

2. Give the expression for hysteresis loss and eddy current loss?

Hysteresis loss in transformer:

Wh= ηBmax1.6fV (watts)

where, η = Steinmetz hysteresis constant ; f- frequency in Hz ; Bmax- maximum flux density in Wb/m2 ; V = volume of the core in m3

Eddy current loss in transformer:

We= Ke (Bmax)2 f2 t2 V2 (watts)

Ke- Eddy current coefficient ; t- thickness of lamination in meters

3.What is fringing effect?

It is seen that the useful flux passing across the air gap tends to buldge outwords, there by increasing the effective area of the air gap and reducing the flux density in the gap is called fringing effect.

4.What is mean by stacking factor?

Magnetic cores are made up of thin, lightly insulated laminations to reduce the eddy current loss. As a result, the net cross sectional area of the core occupied by the magnetic material is less than its gross cross section; their ratio being is called the stacking factor. The stacking value is normally less than one .its value vary from 0.5 to 0.95 .the stacking factor value is also reaches to one as the lamination thickness increases.

5.Why all day efficiency is lower than commercial efficiency?

Distribution transformers will not supply the rated load for the whole day. Hence all day efficiency is lower than commercial efficiency.

6.List the merits of an autotransformer.

Continuously varying voltage can be obtained.
Requires less copper and is more efficient.
Voltage regulation is superior.

7.List the advantages of auto transformer over two winding transformer.

- Reduction in the weight and size,
- reduction in the no load (iron losses) and on load losses (copper losses),
- higher efficiency
- lower cost
- better voltage regulation

8.What are the various losses in a transformer?

i) Magnetic losses / Iron losses – Constant losses

ii) Electric losses / Copper losses – Variable losses

9.Why are iron losses considered as constant losses in transformer?

Iron losses depend on supply frequency and flux density in the core. For all normal operations, the frequency of flux reversals which is same as supply frequency is constant and the value of flux density more or less remains constant. Hence iron losses remain constant under all load conditions. i-e from no-load to full-load.

10.Why all day efficiency is lower than commercial efficiency?

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iv) Electric losses / Copper losses – Variable losses

14.Why are iron losses considered as constant losses in transformer?

Iron losses depend on supply frequency and flux density in the core. For all normal operations, the frequency of flux reversals which is same as supply frequency is constant and the value of flux density more or less remains constant. Hence iron losses remain constant under all load conditions. i-e from no-load to full-load.

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