Maria College Of Engineering And Technology,Attoor
Department of Electrical and Electronics Engineering
Electrical Drives and Control
Third Semester Mechanical Engineering
2 marks (Questions & Answers)

UNIT – I
INTRODUCTION

1. **Define Drive and Electric Drive.**

   Drive: A combination of prime mover, transmission equipment and mechanical working load is called a drive

   Electric drive: An Electric Drive can be defined as an electromechanical device for converting electrical energy to mechanical energy to impart motion to different machines and mechanisms for various kinds of process control.

2. **List out some examples of prime movers.**

   I.C Engines, Steam engine, Turbine or electric motors.

3. **List out some advantages of electric drives.**

   i. **Availability of electric drives over a wide range of power a few watts to mega watts.**
   ii. **Ability to provide a wide range of torques over wide range of speeds.**
   iii. **Electric motors are available in a variety of design in order to make them compatible to any type of load.**

4. **Give some examples of Electric Drives.**

   i. **Driving fans, ventilators, compressors and pumps.**
   ii. **Lifting goods by hoists and cranes.**
   iii. **Imparting motion to conveyors in factories, mines and warehouses**
   iv. **Running excavators & escalators, electric locomotives trains, cars trolley buses, lifts & drum winders etc.**

5. **What are the types of electric drives?**

   Group electric drives (Shaft drive),Individual Drives,
   Multi motor electric drives.

6. **Classify electric drives based on the means of control.**

Manual, Semiautomatic, Automatic.

7. What is a Group Electric Drive (Shaft Drive)?

- **This drive consists of single motor, which drives one or more line shafts supported on bearings.**
- **The line shaft may be fitted with either pulleys & belts or gears, by means of which a group of machines or mechanisms may be operated.**

8. What are the advantages and disadvantages of Group drive (Shaft drive)?

Advantages:

- **A single large motor can be used instead of a number of small motors.**
- **The rating of the single motor may be appropriately reduced taking into account the diversity factor of loads.**

Disadvantages:

- **There is no flexibility, Addition of an extra machine to the main shaft is difficult.**
- **The efficiency of the drive is low, because of the losses occurring in several transmitting mechanisms.**
- **The complete drive system requires shutdown if the motor, requires servicing or repair.**
- **The system is not very safe to operate**
- **The noise level at the work spot is very high.**

10. What is an individual electric drive? Give some examples.

In this drive, each individual machine is driven by a separate motor. This motor also imparts motion to various other parts of the machine.

Single spindle drilling machine, Lathe machines etc.

10. What is a multi motor electric drive? Give some examples.

In this drive, there are several drives, each of which serves to activate on of the working parts of the driven mechanisms.

Metal cutting machine tools, paper making machines, rolling mills, traction drive, Traveling cranes etc.,

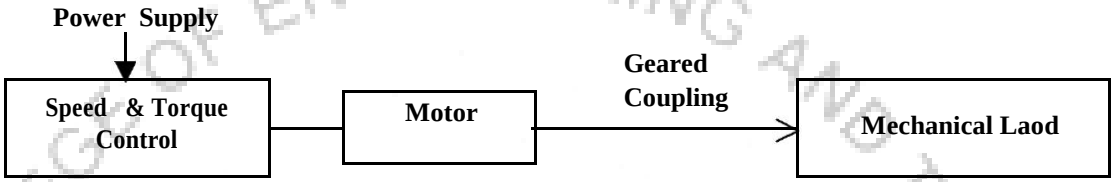
11. Write about manual control, semiautomatic control & Automatic control?

Manual control: The electric drives with manual control can be as simple as a room fan, incorporating on switch and a resistance for setting the required speed.

Semiautomatic control: This control consists of a manual device for giving a certain command (Starting, braking, reversing, change of speed etc.,) and an automatic device that in response to command, operates the drive in accordance with a preset sequence or order.

Automatic control: The electric drives with automatic control have a control gear, without manual devices

12. What are the Typical elements of an Electric Drive?



13. What is a load diagram? What are its types? What are required to draw a load diagram?

A load diagram is the diagram which shows graphically the variation of torque acting on the electric drive. The motor of the electric drive has to overcome the load torque expressed as a function of time.

Types:

- **One for the static or steady state process**
- **Other for the dynamic process, when the dynamic components of torque are induced by the inertia of the motor & load.**

(Instantaneous speed, acceleration, Torque & power) as a function of time are required to draw…..

14. What are the types Drive systems?

Electric Drives	**Mechanical Drives**
Electromechanical Drives	**Hydraulic drives.**

15. Give an expression for the losses occurring in a machine.

The losses occurring in a machine is given by

$$W = W_c + x^2 W_v$$

Where Wc = Constant losses

Wv = Variable losses at full load

X = load on the motor expressed as a function of rated load.

16. What are the assumptions made while performing heating & cooling calculation of an electric motor?

i. **The machine is considered to be a homogeneous body having a uniform temperature gradient. All the points at which heat generated have the same temperature. All the points at which heat is dissipated are also at same temperature.**

ii. **Heat dissipation taking place is proportional to the difference of temperature of the body and surrounding medium. No heat is radiated.**

iii. **The rate of dissipation of heat is constant at all temperatures.**

17. What are the factors that influence the choice of electrical drives?

1. **Shaft power & speed**
2. **Power range**
3. **Starting torque**
4. **Maintenance**
5. **Total purchase cost**
6. **Influence on power supply**
7. **Availability**
8. **Nature of electric supply**
9. **Types of drive**
10. **Service cost**
11. **Speed range**
12. **Efficiency**
13. **Influence on the supply network**
14. **Special competence**
15. **Cost of energy losses**
16. **Environment**
17. **Accessibility**
18. **Nature of load**
19. **Electrical Characteristics**
20. **Service capacity & rating**

18. Indicate the importance of power rating & heating of electric drives.

Power rating: Correct selection of power rating of electric motor is of economic interest as it is associated with capital cost and running cost of drives.

Heating: For proper selection of power rating the most important consideration is the heating effect of load. In this connection various forms of loading or duty cycles have to be considered.

19. How heating occurs in motor drives?

The heating of motor due to losses occurring inside the motor while converting the electrical power into mechanical power and these losses occur in steel core, motor winding & bearing friction.

20. What are the classes of duties

1. **Continuous duty**
2. **Short time duty operation of motor** } **Main classes of duties**
3. **Intermittent periodic duty**
4. **Intermittent periodic duty with starting**
5. **Intermittent periodic duty with starting & braking**
6. **Continuous duty with intermittent periodic loading**
7. **Continuous duty with starting & braking**
8. **Continuous duty with periodic load changes**

21. How will you classify electric drives based on the method of speed control?

1. **Reversible &non reversible in controlled constant speed**
2. **Reversible and non reversible step speed control**
3. **Reversible and non reversible smooth speed control**
4. **Constant predetermined position control**
5. **Variable position control**
6. **Composite control.**

22. List out some applications for which continuous duty is required.

Centrifugal pumps, fans, conveyors & compressors

23. Why the losses at starting is not a factor of consideration in a continuous duty motor?

While selecting a motor for this type of duty it is not necessary to give importance to the heating caused by losses at starting even though they are more than the losses at rated load. This is because the motor does not require frequent starting it is started only once in its duty cycle and the losses during starting do not have much influence on heating.

24. What is meant by "short time rating of motor"?

Any electric motor that is rated for a power rating P for continuous operation can be loaded for a short time duty (P_{sh}) that is much higher than P, if the temperature rise is the consideration.

25. What is meant by "load equalization"?

In the method of "load Equalization" intentionally the motor inertia is increased by adding a flywheel on the motor shaft, if the motor is not to be reversed. For effectiveness of the flywheel, the motor should have a prominent drooping characteristic so that on load there is a considerable speed drop.

26. How a motor rating is determined in a continuous duty and variable load ?

1. **Method of Average losses**
2. **Method of equivalent power**
3. **Method of equivalent current**

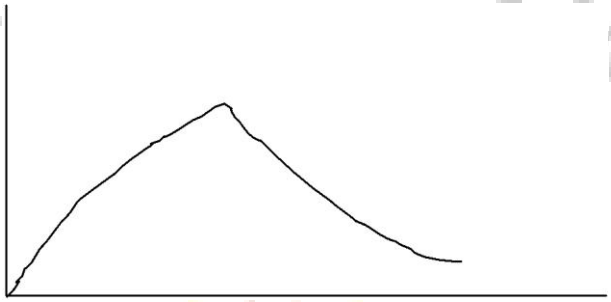
4. **Method of equivalent Torque**

27. Define heating time constant & Cooling time constant?

The time required to heat the machine parts to 63.3% of its final temperature rise is called as heating time constant.

The time required to cool the machine parts to 36.6% of its final temperature fall is called as cooling time constant.

28. Draw the heating & Cooling curve of an electric motor.



29. What are the various function performed by an electric drive?

1. **Driving fans, ventilators, compressors & pumps etc.,**
2. **Lifting goods by hoists & cranes**
3. **Imparting motion to conveyors in factories, mines & warehouses and**
4. **Running excavators & escalators, electric locomotives, trains, cars, trolley buses and lifts etc.**

30. Write down the heat balance equation.

Heat balance equation is given by

$$Ghd\theta_0 + S\theta_0 \, .dt = p.dt$$

UNIT – II
ELECTRICAL MOTOR CHARACTERISTICS

1. Why a single phase induction motor does not self start?

When a single phase supply is fed to the single phase induction motor. Its stator winding produces a flux which only alternates along one space axis. It is not a synchronously revolving field, as in the case of a 2 or 3phase stator winding, fed from 2 or 3 phase supply.

2. What is meant by plugging?

The plugging operation can be achieved by changing the polarity of the motor there by reversing the direction of rotation of the motor. This can be achieved in ac motors by changing the phase sequence and in dc motors by changing the polarity.

3. Give some applications of DC motor.

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

4. What are the different types of electric braking?

Dynamic or Rheostatic braking,
Counter current or plugging and
Regenerative braking

5. What is the effect of variation of armature voltage on N-T curve and how it can be achieved?

The N-T curve moves towards the right when the voltage is increased. This can be achieved by means of additional resistance in the armature circuit or by using thyristor power converter.

6. Compare electrical and mechanical braking.

Mechanical	Electrical
Brakes require frequent maintenance	very little maintenance
Not smooth	smooth
Can be applied to hold the system at any position	cannot produce holding torque.

7. When does an induction motor behave to run off as a generator?

When the rotor of an induction motor runs faster than the stator field, the slip becomes negative. Regenerative braking occurs and the K.E. of the rotating parts is return back to the supply as electrical energy and thus the machine generates power.

8. Define slip.

$$S = \frac{N_S - N_r}{N_S}$$

Where, N_S = synchronous speed in rpm.
N_r = rotor speed in rpm
S = Slip

10.Define synchronous speed.

It is given by $N_S = 120f / p$ rpm.

Where N_S = synchronous speed, p = no. of stator poles, f = supply frequency in Hz

10. Why a single phase induction motor does not self start?

When a single phase supply is fed to the single phase induction motor. Its stator winding produces a flux which only alternates along one space axis. It is not a synchronously revolving field, as in the case of a 2 or 3phase stator winding, fed from 2 or 3 phase supply.

12. What is meant by regenerative braking?

In the regenerative braking operation, the motor operates as a generator, while it is still connected to the supply here, the motor speed is grater that the synchronous speed. Mechanical energy is converter into electrical energy, part of which is returned to the supply and rest as heat in the winding and bearing.

13. Give some applications of DC motor.

Shunt : driving constant speed, lathes, centrifugal pumps, machine tools, blowers and fans, reciprocating pumps

Series : electric locomotives, rapid transit systems, trolley cars, cranes and hoists, conveyors

Compound : elevators, air compressors, rolling mills, heavy planners.

14. Compare electrical and mechanical braking.

Mechanical	Electrical
Brakes require frequent maintenance	very little maintenance
Not smooth	smooth
Can be applied to hold the system at any position	cannot produce holding torque.

15. Differentiate cumulative and differential compound motors.

Cumulative
The orientation of the series flux aids the shunt flux
differential
series flux opposes shunt flux

16. What is meant by mechanical characteristics?

A curve drawn between the parameters speed and torque.

17. What is meant by electrical characteristics?

A curve drawn between the armature current and armature torque.

18. What is meant by performance characteristics?

The graph drawn between the output power Vs speed , efficiency, current and torque.

19. What do you mean by Rheostatic braking?

In this braking armature is removed and connected across a variable rheostat.

20. Is Induction motor runs with synchronous speed or not.

Induction motor never runs with synchronous speed. It will stop if it tries to achieve synchronous speed.

UNIT — III
STARTING METHODS

1. Mention the Starters used to start a DC motor.

Two point Starter
Three point Starter
Four point Starter

2. Mention the Starters used to start an Induction motor.

D.O.L Starter (Direct Online Starter)
Star-Delta Starter
Auto Transformer Starter
Reactance or Resistance starter
Stator Rotor Starter (Rotor Resistance Starter)

3. What are the protective devices in a DC/AC motor Starter.

Over load Release (O.L.R) or No volt coil
Hold on Coil
Thermal Relays
Fuses(Starting /Running)
Over load relay

4. Is it possible to include/ Exclude external resistance in the rotor of a Squirrel cage induction motor?. Justify

No it is not possible to include/ Exclude external resistance in the rotor of a Squirrel cage induction motor because, the rotors bars are permanently short circuited by means of circuiting rings (end rings) at both the ends. i.e. no slip rings to do so.

5. Give the prime purpose of a starter for motors.

when induction motor is switched on to the supply, it takes about 5 to 8 times full load current at starting. This starting current may be of such a magnitude as to cause objectionable voltage drop in the lines. So Starters are necessary

6. Why motor take heavy current at starting?

When 3 phase supply is given to the stator of an induction motor, magnetic field rotating in space at synchronous speed is produced. This magnetic field is cut by the rotor conductors, which are short circuited. This gives to induced current in them.

Since rotor of an induction motor behaves as a short circuited secondary of a transformer whose primary is stator winding, heavy rotor current will require corresponding heavy stator balancing currents. *Thus motor draws heavy current at starting*

7. What are the methods to reduce the magnitude of rotor current (rotor induced current) at starting?.

By increasing the resistance in the rotor circuit

By reducing the magnitude of rotating magnetic field i.e by reducing the applied voltage to the stator windings.

8. What is the objective of rotor resistance starter (stator rotor starter)?

To include resistance in the rotor circuit there by reducing the induced rotor current at starting. This can be implemented only on a slip ring induction motor.

9. Why squirrel cage induction motors are not used for loads requiring high starting torque?

Squirrel cage motors are started only by *reduced voltage starting* methods which leads to the development of low starting torque at starting. This is the reason Why squirrel cage induction motors are not used for loads requiring high starting torque.

10. How reduced voltage starting of Induction motor is achived?.

D.O.L Starter (Direct Online Starter)
Star-Delta Starter
Auto Transformer Starter
Reactance or Resistance starter

11. Give the relation between line voltage and phase voltage in a
(i) Delta connected network (ii) Star connected network

Delta connected network:

$$V_{phase} = V_{line}$$

Star connected network:

$$V_{phase} = V_{line} / \sqrt{3}$$

12. Give some advantages and disadvantages of D.O.L starter.

Advantages:
Highest starting torque
Low cost
Greatest simplicity

Disadvantages:

The inrush current of large motors may cause excessive voltage drop in the weak power system

The torque may be limited to protect certain types of loads.

13. Explain double stage reduction of line current in an Auto transformer starter.

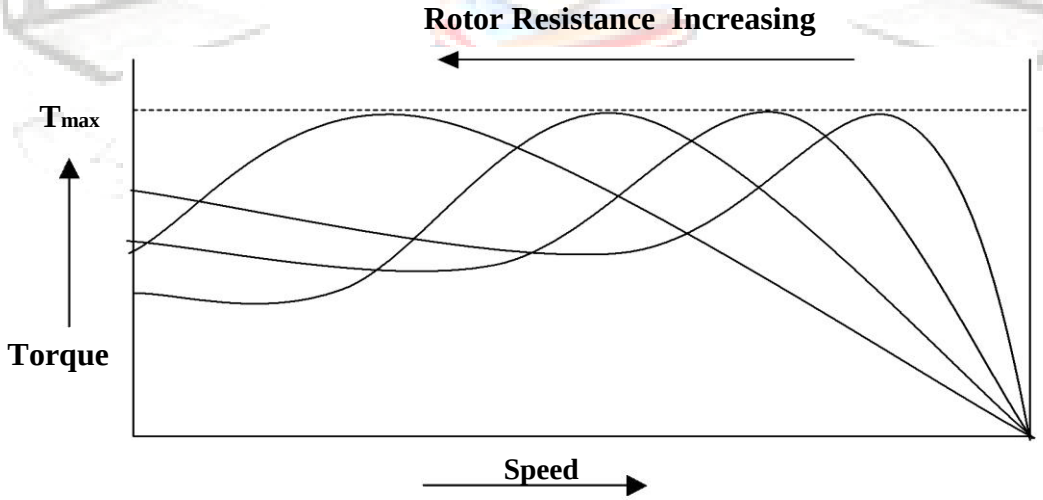
First stage reduction is due to reduced applied voltage

Second stage reduction is due to reduced number of turns

14. Compare the Induction motor starters

Description of Starter	% of line voltage applied	Starting current (I_s)compared with		Starting torque (Ts)compared with	
		D.O.L current(I_{dol})	Full load current(I)	D.O.L Torque(T_{dol})	Full load torque(T)
D.O.L Starter	100%	$I_s = I_{dol}$	$I_s = 6I$	$T_s = T_{dol}$	$T_s = 6T$
Star Delta starter	57.7%	$I_s = (1/\sqrt{3})^2 I_{dol}$	$I_s = 2I$	$T_s = (1/\sqrt{3})^2 T_{dol}$	$T_s = 2/3T$
Auto transformer starter	80%	$I_s = (0.8)^2 I_{dol}$	$I_s = 3.84\ I$	$T_s = (0.8)^2 T_{dol}$	$T_s = 1.28\ T$
	60%	$I_s = (0.6)^2 I_{dol}$	$I_s = 2.16\ I$	$T_s = (0.6)^2 T_{dol}$	$T_s = 0.72\ T$
	40%	$I_s = (0.4)^2 I_{dol}$	$I_s = 0.96\ I$	$T_s = (0.4)^2 T_{dol}$	$T_s = 0.32\ T$
Reactance-resistance starter	64%	$I_s = (0.64)^2 I_{dol}$	$I_s = 2.5\ I$	$T_s = (0.425)^2 T_{dol}$	$T_s = 0.35T$

15. Draw the Speed-Torque characteristics of an Induction motor with various values of Rotor Resistance.



UNIT – IV
CONVENTIONAL SPEED CONTROL

1. **Give the expression for speed for a DC motor.**

Speed $N = \frac{k(V - I_a R_a)}{\phi}$

where V = Terminal Voltage in volts
Ia = Armature current in Amps
Ra = Armature resistance in ohms ϕ= flux per pole.

2. **What are the ways of speed control in dc motors?**

Field control - by varying the flux per pole. -for above rated speed
Armature control- by varying the terminal voltage -for below rated speed

3. **Give the Limitation of field control**

   a. **Speed lower than the rated speed cannot be obtained.**
   b. **It can cope with constant kW drives only.**
   c. **This control is not suitable to application needing speed reversal.**

4. **Compensating winding can be used to increase the speed range in field control method**

5. **What are the 3 ways of field control in DC series motor?**

∗ **Field diverter control**
∗ **Armature diverter control**
∗ **Motor diverter control**
∗ **Field coil taps control**
∗ **Series-parallel control**

6. **What are the main applications of Ward-Leonard system?**

∗ **It is used for colliery winders.**

* **Electric excavators**
* **In elevators**
* **Main drives in steel mills and blooming and paper mills.**

7. What are the merits and demerits of rheostatic control method?

* **Impossible to keep the speed constant on rapidly changing loads.**
* **A large amount of power is wasted in the controller resistance.**
* **Loss of power is directly proportional to the reduction in speed. Hence efficiency is decreased.**
* **Maximum power developed is diminished in the same ratio as speed.**
* **It needs expensive arrangements for dissipation of heat produced in the controller resistance.**
* **It gives speed below normal, not above.**

8. What are the advantages of field control method?

* **More economical, more efficient and convenient.**
* **It can give speeds above normal speed.**

9. Compare the values of speed and torque in case of motors when in parallel and in series.

* **The speed is one fourth the speed of the motor when in parallel.**
* **The torque is four times that produced by the motor when in parallel.**

10. Mention the speed control method employed in electric traction.

Series-parallel speed control.

11. What is the effect of inserting resistance in the field circuit of a dc shunt motor on its speed and torque?

For a constant supply voltage, flux will decrease, speed will increase and torque will increase.

12. While controlling the speed of a dc shunt motor what should be done to achieve a constant torque drive?

Applied voltage should be maintained constant so as to maintain field strength

UNIT – V
SOLID STATE SPEED CONTROL

1. What is a controlled rectifier?

A **controlled rectifier is a device which is used for converting controlled dc power from a control voltage ac supply.**

2. What is firing angle?

The control of dc voltage is achieved by firing the thyristor at an adjustable angle with respect to the applied voltage. This angle is known as firing angle.

3. Give some applications of phase control converters.

Phase control converters are used in the speed control of fractional kW dc motors as well as in large motors employed in variable speed reversing drives for rolling mills. with motors ratings as large as several MW's.

4. What is the main purpose of free wheeling diode?

Free wheeling diode is connected across the motor terminal to allow for the dissipation of energy stored in motor inductance and to provide for continuity of motor current when the thyristors are blocked.

5. What is a full converter?

A **full converter is a tow quadrant converter in which the voltage polarity of the output can reverse, but the current remains unidirectional because of unidirectional thyristors.**

6. What is natural or line commutation?

The commutation which occurs without any action of external force is called natural or line commutation.

7. What is forced commutation?

The commutation process which takes place by the action of an external force is called forced commutation.

8. What is a chopper?

A **chopper is essentially an electronic switch that turns on the fixed-voltage dc source for a short time intervals and applies the source potential to motor terminals**

in series of pulses.

9. **What are the two main difficulties of variable frequency system?**

Control of V_a requires variation of chopper frequency over a wide range. Filter design for variable frequency operation is difficult.At low voltage, a large value of t_{off} makes the motor current discontinuous.

10. Classify commutation.

* **Voltage commutation**
* **Current commutation.**

11. What is voltage commutation?

A charged capacitor momentarily reverse-bias the conducting thyristor to turn it off. This is known as voltage commutation.

12. What is current commutation?

A current pulse is forced in the reverse direction through the conducting thyristor. As the net current becomes zero, the thyristor is turned OFF. This is known as current commutation.

13. What is load commutation?

The load current flowing through the thyristor either becomes zero (as in natural or line commutation employed in converters) or is transferred to another device from the conducting thyristor. This is known as load commutation.

14. What are the different means of controlling induction motor?

* **Stator voltage control.**
* **Frequency control**
* **Pole changing control.**
* **Slip power recovery control.**

15. What are the two ways of controlling the RMS value of stator voltage?

* **Phase control**
* **Integral cycle control**

16. Mention the two slip-power recovery schemes.

* **Static scherbius scheme**
* **Static Kramer drive scheme.**

17. Give the basic difference between the two slip-power recovery schemes.

The slip is returned to the supply network in scherbius scheme and in Kramer scheme, it is used to drive an auxiliary motor which is mechanically coupled to the induction motor shaft.

18. Write short notes on inverter rectifier.

The dc source could be converted to ac form by an inverter, transformed to a suitable voltage and then rectified to dc form. Because of two stage of conversion, the setup is bulky, costly and less efficient.

19. Give the special features of static scherbius scheme.

* **The scheme has applications in large power fan and pump drives which requires speed control in anrrow range only.**
* **If max. slip is denoted by S_{max}, then power rating of diode, inverter and transformer can be just S_{max} times motor power rating resulting in a low cost drive.**
* **This drive provides a constant torque control.**

20. What are the advantages of static Kramer system,, over static scherbius system?

* **Since a static Kramer system possesses no line commutated inverter, it causes less reactive power and smaller harmonic contents of current than a static scherbius.**
* **What is electrical power supply system?**
* **The generation, transmission and distribution system of electrical power is called electrical power supply system.**

21. What are the 4 main parts of distribution system?

* **Feeders,**
* **Distributors and**
* **Service mains.**

22. What are feeders?

Feeders are conductors which connect the stations (in some cases generating stations) to the areas to be fed by those stations.

23. What are the advantages of high voltage dc system over high voltage ac system?

* **It requires only tow conductors for transmission and it is also possible to transmit the power through only one conductor by using earth as returning conductor, hence much copper is saved.**

* **No inductance, capacitance, phase displacement and surge problem.**

* **There is no skin effect in dc, cross section of line conductor is fully utilized.**

24. What do you mean by the term earthing?

The term "earthing" means connecting the non-current carrying parts of electrical equipment to the neutral point of the supply system to the general mass of earth in such a manner that at all time an immediate discharge of electrical energy takes place without danger.

25. What are the different methods of providing neutral earthing?

* **Solid earthing**
* **Resistance earthing**
* **Reactance earthing**
* **Arc suppression coil or Peterson coil earthing.**