1) What is back e.m.f in a D.C. Motor? State its expression.

Armature starts rotating, the main flux gets cut by the armature winding and an e.m.f gets induced in the armature. This e.m.f opposes the applied d.c voltage and is called back e.m.f denoted as Eb.

\[ E_b = \frac{PNZ}{60A} \]

- \( P \) = Flux per pole
- \( N \) = Number of poles
- \( Z \) = Total armature conductors
- \( A \) = Number of parallel paths

2) Write the voltage equation of D.C. Motor

\[ V = E_b + I_a R_a \]

The back e.m.f is always less than supply voltage \( (E_b < V) \). But \( R_a \) is very small hence under normal running conditions, the difference between back e.m.f and supply voltage is very small.

4) What are the important characteristics of a d.c. motor?
- Torque – Armature current characteristics
- Speed – Armature current characteristics
- Speed – Torque Characteristics

5) Why series motor is never started on No load?

Under light load or no load as flux is very small, the motor tries to run at dangerously high speed which may damage the motor mechanically. This can be seen from the speed – armature current and the speed- torque characteristics that on low armature current and low torque condition motor shows a tendency to rotate with dangerously high speed.
6) List some application of d.c. shunt motor?
Blowers and fans
Centrifugal and reciprocating pumps
Lathe machine
Machine tools
Milling machines
Drilling machines

7) List some application of d.c. series motor?
Cranes
Hoists, Elevators
Trolleys
Conveyors
Electric Locomotives

8) List some application of d.c. compound motors?
Rolling mills
Punches
Shears
Heavy Planers
Elevators

9) What is synchronous speed?

The speed depends on the supply frequency (f) and the number of poles for which stator winding is wound (P). It is called synchronous speed denoted as \( N_s \) and given by

\[ N_s = \frac{120f}{P} \text{ in r.p.m} \]

10) What is rotor conductor and end ring?

The rotor core is cylindrical and slotted on its periphery. The rotor consists of uninsulated copper or aluminum bars called rotor conductors. The bars are placed in the slots. These bars are permanently shorted at each end with the help of conducting copper ring called end ring.
11) Compare Slip ring and squirrel cage motor

**Slip Ring Rotor**
**Squirrel cage Rotor**

Rotor consists of a three phase winding similar to the stator winding  
Rotor consists of bars which are shorted at the ends with the help of end rings

Construction is complex  
Construction is very simple

Resistance can be added externally  
As Permanently shorted, external resistance cannot be added

High starting torque can be added  
Moderate starting torque which cannot be controlled

Speed control by rotor resistance is possible  
Speed control by rotor resistance is not possible

Slip rings and brushes are presented to add external resistance  
Slip rings and brushes are absent

Rotor copper losses are high hence efficiency is less  
Rotor copper losses are less hence have higher efficiency

12). What is slip?

The difference between the synchronous speed (Ns) and actual speed (N) of the rotor is known as slip speed. The percentage of slip is given by

\[ \% \text{ slip } s = \left( \frac{N_s - N}{N_s} \right) \times 100 \]

13) Induction motor as a transformer?

Transformer is a device in which two windings are magnetically coupled and when one winding is excited by a.c. supply of certain frequency, the e.m.f gets induced in the second winding having same frequency as that of supply given given to the first winding. The winding of which supply is given is called primary winding while winding in which e.m.f gets induced is called secondary winding.
14) What is transformation ratio?

\[ K = \frac{E_2}{E_1} \quad \text{(or)} \quad k = \frac{N_2}{N_1} \]

Where \( E_1 \) = Stator e.m.f per phase in volts

\( E_2 \) = Rotor induced e.m.f per phase in volts at start when motor is at standstill.

15). what are the types of Single phase induction motors?
Split phase induction motor
Capacitor start induction motor
Capacitor start capacitor run induction motor
Shaded pole induction motor

16) What are the types of electric braking in D.C. Motors?
Rheostatic or dynamic braking
Plugging
Regenerative braking

17) What is meant by Rheostat or dynamic braking?

Dynamic braking of electric motors occurs when the energy stored in the rotating mass is dissipated in an electrical resistance. This requires the motor to operate as a generator to convert this stored energy into electrical.

18) What is meant by Plugging?

It is one method of braking of induction motor. when phase sequence of supply of the motor running at a speed is reversed, by interchanging connections of any two phases of stator with respect to supply terminals, operation shifts from motoring to plugging region.

19) What is meant by Regenerative Braking?

Regenerative braking occurs when the motor speed exceeds the synchronous speed. In this case, the induction motor would runs as the induction machine is converting the mechanical power into electrical power, which is delivered back to the electrical system. This method of braking is known as regenerative braking.
20) What are the types of electric braking in induction Motors?
Rheostatic or dynamic braking
Plugging
Regenerative braking
D.C.Dynamic braking

21) What are the three regions in the speed –torque characteristics of induction motor?
   I. Motoring region (0< s<1)
   II. Generating region(s<0)
   III. Plugging region (1<s<2)

22) List the advantage of squirrel cage I.M?
    Cheaper
    Light in weight
    Rugged in construction
    More efficient
    Require less maintenance
    Can be operated in dirty and explosive environments
BIG QUESTION

1). Draw and explain the torque –speed characteristics for the DC motors.

2). What is meant by braking. Explain in details.

3). Draw and explain the speed- torque characteristics curve of 3-phase induction motor.

4) Explain single-phase induction motors speed torque curve in details.

5). What are the braking methods available for induction motors and explain in details.

6) Breaking problems