UNIT I- OVERVIEW OF ELECTRICAL DRIVES

1. **What is meant by electrical drives?**
   Systems employed for motion control are called drives and they employ any of the prime movers such as diesel or petrol engines, gas or steam turbines, hydraulic motors and electric motors for supplying mathematical energy for motion control. Drives employing electric motion are called electric drives.

2. **Specify the functions of power modulator.**
   Power modulator performs one or more of the following four functions.
   Modulates flow of power form the source to the motor in such a manner that motor is imparted speed-torque characteristics required by the load. During transient operations, such as starting, braking and speed reversal, it restricts source and motor currents within permissible values; excessive current drawn from source may overload it or may cause a voltage dip.

3. **Mention the different types of drives.**
   1)Group drive 2)Individual drive
   3)Multimotor drive

4. **List the different types of electrical drives.**
   1)dc drives 2)ac drives

5. **What are the advantages of electric drives?**
   1)They have flexible control characteristics. the steady state and dynamic characteristics of electrical drives can be shaped to satisfy load requirements.
   2) Drives can be provided with automatic fault detection systems, programmable logic controllers and computers can be employed to automatically ctrl the drive operations in a desired sequence.
   3) They are available in which range of torque, speed and power.
   4) It can operate in all the four quadrants of speed-torque plane. Electric braking gives smooth deceleration and increases life of the equipment compared to other forms of braking.
   Control gear required for speed control, starting and braking is usually simple and easy to operate.

6. **What are the functions performed by electric drives?**
   Various functions performed by electric drives include the following.
   a. Driving fans, ventilators, compressors and pumps etc.
   b. Lifting goods by hoists and cranes
   c. Imparting motion to conveyors in factories, mines and warehouses and
   d. Running excavators and escalators, electric locomotives, trains, cars, trolley buses, lifts and drums winders etc.

7. **What are the disadvantages of electric drives?**
   The disadvantages of electric drives.
   a. Electric drives system is tied only up to the electrified area.
   b. The condition arising under the short circuits, leakage from conductors and breakdown of overhead conductor may lead to fatal accidents.
   c. Failure in supply for a few minutes may paralyses the whole system.

8. **What are the advantages of group drive over individual drive?**
   The advantages of group drive over individual drive are

a. Initial cost: Initial cost of group drive is less as compared to that of the individual drive.
b. Sequence of operation : Group drive system is useful because all the operations are stopped simultaneously.
c. Space requirement : Less space is required in group drive as compared to individual drive.
d. Low maintenance cost: It requires little maintenance as compared to individual drive.

9. What the group drive is not used extensively?

Although the initial cost of group drive is less but yet this system is not used extensively because of following disadvantages.

a. Power factor : Group drive has low power factor
b. Efficiency : Group drive system when used and if all the machines are not working together the main motor shall work at very much reduced load.
c. Reliability : In group drive if the main motor fails whole industry will come to stand still.
d. Flexibility : Such arrangement is not possible in group drive i.e., this arrangement is not suitable for the place where flexibility is the prime factor.
e. Speed : Group drive does not provide constant speed.
f. Types of machines : Group drive is not suitable fro driving heavy machines such as cranes, lifts and hoists etc.

10. Write short notes on individual electric drives.

In individual drive, each individual machine is driven by a separate motor. This motor also imparts motion to various other parts of the machine. Examples of such machines are single spindle drilling machines (Universal motor is used) and lathes. In a lathe, the motor rotates the spindle, moves the feed and also with the help of gears, transmits motion to lubricating and cooling pumps. A three phase squirrel cage induction motor is used as the drive. In many such applications the electric motor forms an integral part of the machine.

11. **Mention the different factors for the selection of electric drives**?

1) Steady state operation requirements.
2) Transient operation requirements.
3) Requirements related to the source.
4) Capital and running cost, maintenance needs, life.
5) Space and weight restriction.
6) Environment and location.

12. Mention the parts of electrical drives.

1) Electrical motors and load.
2) Power modulator
3) Sources
4) Control unit
5) Sensing unit

13. Mention the applications of electrical drives

Paper mills Electric traction

Cement mills Steel mills

14. Mention the types of enclosures

Screen projected type Drip proof type, Totally enclosed type, Flame proof type

15. **Mention the different types of classes of duty**
    Continuous duty, Discontinuous , Short time, Intermittent

16. **What is critical speed?**
    It is the speed that separates continuous conduction from discontinuous conduction mode.

UNIT II- ELECTRICAL MOTORS

1. **How will you change the direction of rotation of a d.c motor?**
   Either the direction of the main field or the direction of current through the armature conductors is to be reserved.
2. Name the type of induction motor which produces high starting torque.
   Slip ring induction motor
3. **Define armature reaction in dc machines?**
   The interaction between the main flux and armature flux cause disturbance called as armature reaction.
4. **Why commutator is employed in d.c.machines?**
   Conduct electricity between rotating armature and fixed brushes, convert alternating emf into unidirectional emf(mechanical rectifier).
5. **What is back emf in d.c motors**
   As the motor armature rotates, the system of conductor come across alternate North and South Pole magnetic fields causing an emf induced in the conductors. The direction of the emf induced in the conductors. The direction of the emf induced is in the direction opposite to the current .As this emf always opposes the flow of current in motor operation it is called back emf.
6. **Under what condition the mechanical power developed in a dc motor will be maximum?**
   Condition for mechanical power developed to be maximum is Eb = Ua /2 or I a= Ua / 2Ra
7. **To what polarity the interpoles excited in dc motors?**
   For motor operation the polarity of the interpoles must be that of the previous main pole along the direction of rotation.
8. **Why DC motors are not operated to develop maximum power in practice?**
   The current obtained will be much higher than the rated current. The efficiency of operation will be below 50%.
9. **Why are carbon brushes preferred for dc machines?**
   The high contact resistance carbon brushes help the current in the coil undergoing commutation to attain its full value in the reverse direction at the end of commutation. The carbon brushes also lubricate and give less wear and tear on commutator surface.
10. Name the two methods of improving commutation.
    (i) Emf commutation.
    (ii)Resistance commutation
11. **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.
12. **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.
13. **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.
14. **Why almost all large size Synchronous machines are constructed with rotating field system type?**

The following are the principal advantages of the rotating field system type construction of Synchronous machines: The relatively small amount of power, about 2%, required for field system via slip-rings and brushes. For the same air gap dimensions, which is normally decided by the kVA rating, more space is available in the stator part of the machine for providing more insulation to the system of conductors, especially for machines rated for 11kV or above. Insulation to stationary system of conductors is not subjected to mechanical stresses due to centrifugal action. Stationary system of conductors can easily be braced to prevent deformation. It is easy to provide cooling arrangement for a stationary system of conductors. Firm stationary connection between external circuit and system of conductors enable he machine to handle large amount of volt-ampere as high as 500MVA.

15. What are the advantages of salient pole type construction used for Synchronous machines?

Advantages of salient-pole type construction are:

- They allow better ventilation
- The pole faces are so shaped that the radial air gap length increases from the pole center to the pole tips so that the flux distribution in the air-gap is sinusoidal in shape which will help the machine to generate sinusoidal emf
- Due to the variable reluctance the machine develops additional reluctance power which is independent of excitation

16. How does electrical degree differ from mechanical degree?

Mechanical degree is the unit for accounting the angle between two points based on their mechanical or physical placement. 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 magnetic field. 180 electrical degrees is accounted as the angle between adjacent North and South poles.

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

The number of poles P, the electrical machine has, as given by the following equation

18. Define winding factor.

The winding factor Kd is defined as the ratio of phasor addition of emf induced in all the coils belonging to each phase winding to their arithmetic addition.

19. What do you mean by synchronous reactance?

Synchronous reactance X s= (Xl + Xa) The value of leakage reactance Xl is constant for a machine based on its construction. Xa depends on saturating condition of the machine. It is the addition of Xa , which represent the armature reaction effect between two synchronously acting magnetic fields that makes the total reactance Xa to be called syncheornous reactance.

20. How synchronous impedance is calculated from OCC and SCC?

Synchronous impedance is calculated from OCC and SCC as |Zs| = E0/Isc(for same If) A compromised value of Zs is normally estimated by taking the ratio of (E0/Isc) at normal field current Ifn. A normal field current Ifn is one which gives rated voltage Ur on open circuit. |Zs| = Ur/Iscn

21. How does the shaft torque differ from the torque developed in 3-phase Induction motor?

The mechanical power developed P_d causes the rotor to rotate at a speed Nr due to the torque Td developed in the rotor. Therefore, equation for P_r can be written as $P_d = (1-r)T_d / 60$ The remaining power, after the mechanical losses W_m are met with, available in the shaft as mechanical power output $P_o = P_d – W_m$ .The mechanical power output Po, which is less than Pd is available in the shaft running at a speed of Nr and with a shaft torque T. Therefore the shaft torque (T) is slightly less than the torque developed Td, P_d _ ___ 1rT / 60 $W_m = P_d – P_o$ _ _>_ 1r($T_d – T$)] / 60

22. What are the informations obtained from no-load test in a 3-phase I M?

(i) No –load input current per phase,Io
(ii) No load powerfactor and hence no load phase angle
(iii) Iron and mechanical losses together
(iv) elements of equivalent circuit shunt branch

23. What are the informations obtained from blocked rotor test in a 3-phase I M?

(i)Blocked rotor input current per phase at normal voltage

(ii) Blocked rotor power factor and hence phase angle

(iii) Total resistance and leakage reactance per phase of the motor as refered to the stator

24. What is circle diagram of an I M?

When an I M operates on constant voltage and constant frequency source,the loci of stator current phasor is found to fall on a circle.This circle diagram is used to predict the performance of the machine at different loading conditions as well as mode of operation.

25. What are the advantages and disadvantages of circle diagram method of predetermining the performance of 3 –phase I M?

The prediction can be carried out when any of the following information is available The input line current., the input power factor, The active power input, The reactive power input, The apparent power input, The output power , The slip of operation, The torque developed, The equivalent rotor current per phase, Maximum output power, Maximum torque developed. The only disadvantage is, being a geometrical solution, errors made during measurements will affect the accuracy of the result.

26. What are the advantages and disadvantages of direct load test for 3 –phase I M?

Advantages Direct measurement of input and output parameters yield accurate Results Aside from the usual performance other performances like mechanical Vibration, noise etc can be studied. By operating the motor at full load for a continuous period, the final steady temperature can be measured. Disadvantages Testing involves large amount of power and the input energy and the entire energy delivered is wasted Loading arrangement cannot be provided for motors of large power rating

27. State the characteristic features of synchronous motor.

a. the motor is not inherently self-starting

b. The speed of operation is always in synchronous with the supply frequency irrespective of load conditions

c. The motor is capable of operating at any power factor.

28. In what way synchronous motor is different from other motors?

All dc and ac motors work on the same principle. Synchronous motor operates due to magnetic locking taking place between stator and rotor magnetic fields.

29. Name any two methods of starting synchronous motors

- By an extra 3 phase cage induction motor
- By providing damper winding in pole phases
- By operating the pilot excitor as a dc motor

30. What is the effect on speed if the load is increased on a 3 phase synchronous motor?

The speed of operation remains constant from no load to maximum load in the motor operating at constant frequency bus bars.

31. Why a synchronous motor is a constant speed motor?

Synchronous motor work on the principle of force developed due to the magnetic attraction established between the rotating magnetic field and the main pole feed. Since the speed of rotating magnetic field is directly proportional to frequency the motor operates at constant speed.

32. What is the phasor relation between induced emf and terminal voltage of a 3 phase Synchronous motor?

The rotating magnetic field is initially established by the prime source of supply V. The main field then causes an emf e to get induced in the 3 phase winding. Hence when the machine operates as a synchronous motor the emf phasor always lags the terminal voltage phasor by the load/torque.

33. What are V and inverted V curves of synchronous motor? The variation of magnitude of line current with respect to the field current is called V curve . The variation of power factor with respect to the field current is called inverted V curve.

34. What happens when the field current of a synchronous motor is increased beyond the normal value at constant

input? Increase in emf causes the motor to have reactive current in the leading direction. The additional leading reactive current causes the magnitude of line current, accompanied by the decrease in power factor

35. **Distinguish between synchronous phase modifier and synchronous condenser** A synchronous motor used to change the power factor or power factor in the supply lines is called synchronous phase modifier. A synchronous motor operated at no load with over excitation condition to draw large leading reactive current and power is called a synchronous condenser.
36. **How the synchronous motor can be used as s synchronous condenser?** Synchronous motor is operated on over excitation so as to draw leading reactive current and power from the supply lines. This compensates the lagging current and power requirement of the load making the system power factor to become unity. The motor does the job of capacitors and hence called as syn chronous condenser.
37. **What type of single phase induction motor would you use for the following applications?**
    i) Ceiling fan (ii) Wet grinder Ceiling fan – capacitor start and run motor Wet grinder – capacitor start motor
38. **After servicing a single phase fan it was found to run in reverse direction. What could be the reason?**
    The connection to the starting/ auxiliary winding would have reversed.
39. **What will be the direction of rotation of a shaded pole single phase induction motor?**
    The motor rotates in the direction specified by the unshaded to shaded region in the pole phase
40. **In what respect does a 1-phase Induction motor differ from a 3-phase Induction motor?**
    Construction wise a plain 1-phase Induction motor is more or less similar to a 3-phase squirrel-cage Induction motor except that its stator is provided with only 1-phase winding.
41. **What are the inherent characteristics of plain 1-phase Induction motor**
    A plain 1-phase Induction motor is not used in practice due to the following inherent characteristics
    A plain 1-phase Induction motor does not have any starting torque. However, if the rotor is initially given a starting torque, by some means, the motor can pick up its speed in a direction at which the initial torque is given and deliver the required output.
42. **Name the two different theories with which principle of 1-phase induction motors are explained.**
    The two different theories are
    Double revolving field theory
    Cross field theory
43. **State double revolving field theory.**
    Double revolving theory, formulated by Ferrari, states that a single pulsating synchronous speed proportional to the frequency of the pulsating field.
44. **Name any four types of 1-phase induction motors.**
    Based on the method of starting arrangement provided, the 1-phase Induction motors are classified as follows (i) Split-phase motor (ii) Capacitor start motor (iii) Capacitor start and run motor (iv) Shaded pole motor (v) Repulsion start Induction run motor
45. **State the principle of 3 phase IM?**
    While starting, rotor conductors are stationary and they cut the revolving magnetic field and so an emf is induced in them by electromagnetic induction. This induced emf produces a current if the circuit is closed. This current opposes the cause by Lenz's law and hence the rotor starts revolving in the same direction as that of the magnetic field
46. **Induction motor can run at synchronous speed? True or false? Explain.**
    No, if the speed of induction motor is Ns then the relative speed between the rotating flux and the rotor will be zero and so no torque is produced
47. **An induction motor is generally analogous to?**
    It is analogous to a winding rotating transformer with its secondary circuit closed'.
48. **What would happen if a 3 phase induction motor is switched on with one phase disconnected?**
    The motor is likely to burn.

49. What happens if the air gap flux density in an induction motor increases?

The increase in air gap flux increases iron loss and hence efficiency decreases.

50. State the advantages of skewing?

It reduces humming and hence quite running of motor is achieved. It reduces magnetic locking of the stator and rotor.

51. State the condition at which the starting torque developed in a slip-ring induction motor is maximum.

When R2=X2

52. What are the effects of increasing rotor resistance on starting current and starting torque?

The additional external resistance reduces the rotor current and hence the current drawn from the supply. It improves the starting torque developed by improving the power factor in high proportion to the decrease in rotor current.

53. What is slip of an induction motor?

The slip speed expressed as the ratio of synchronous speed is defined as slip.

Percentage slip S=Ns-N/Ns*100

54. How the magnitude of rotor emf is related to the slip in an I M?

Rotor circuit emf per phase E2r=SE2

55. How the frequency of rotor emf is related to the slip in an I M?

Frequency of rotor emf/current fr=Sfs

56. What is the normal value of slip of an I M operating at full load?

3 - 5%

57. Why is not possible for the rotor speed of an I M to be equal to the speed of its rotating magnetic field?

The machine will not be able to develop any mechanical torque to run as a motor.

58. What are the principal advantages of rotating field type construction?

Relatively small amount of power required for field system can easily supplied to rotating system using slip rings and brushes, more space is available in the stator part of the machine to provide more insulation, it is easy to provide cooling system, stationary system of conductors can easily be braced to prevent deformation.

59. What is hunting how can it be prevented? When a sync motor is used for driving a fluctuating load, the rotor starts oscillating about its new position of equilibrium corresponding to the new load. This is called hunting or phase swinging. To prevent hunting dampers are damping grids are employed.

60. what are different torques of a sync motor?

1. Starting torque
2. Running torque
3. Pull-in torque
4. Pull-out torque

61. Define step angle?

It is defined as angle through which the stepper motor shaft rotates for each command pulse. It is denoted as β,

i)β=[(Ns-Nr)/ Ns.Nr]x360o

Where Ns = no. of stator poles or stator teeth

Nr = no. of rotor poles or rotor teeth

ii) β = 3600/mNr

Where m= no. of stator poles

62. What are different types of stepper motor?

1. Variable reluctance (VR) motor
2. Permanent magnet (PM) stepper motor
3. Hybrid stepper motor

63. What is the advantage in using stepper motor?

1. it can drive open loop without feedback
2. it requires little or no maintenance.

64. Give the applications of stepper motor?

1. Robotics
2. Computer peripherals
3. Facsimile machine
4. Aerospace

65. What are the adv. of reluctance m/c?

1. Motor speed is constant
2. Simple construction

66. Why are centrifugal switches provided on many 1-phase Induction motors?

Centrifugal switches are provided on many 1-phase Induction motors to disconnect the starting / auxiliary winding from the supply when the motor reaches about 70% of its synchronous speed.

67. What are the effects of increasing rotor resistance on starting current and starting torque?

The additional external resistance reduces the rotor current and hence the current drawn from the supply.

It improves the starting torque developed by improving the power factor in high proportion to the decrease in rotor current.

68. What is slip of an induction motor?

The slip speed expressed as the ratio of synchronous speed is defined as slip.

Percentage slip S=Ns-N/Ns*100

69. What are the advantages of slip-ring I M over cage I M?

(i) Rotor circuit is accessible for external connection.

(ii) By adding external resistance to the rotor circuit the starting current is reduced with the added advantage of improving starting torque.

(iv) Additional speed control methods can be employed with the accessibility in the rotor circuit

70. What are the losses occurring in an I M and on what factors do they depend?

Magnetic losses Wi

Electrical losses Wcu

Mechanical losses Wm

For I M operating in normal condition (with constant voltage and frequency) magnetic and mechanical losses remain constant whereas electrical losses vary in square proportion to the current.

71. What care should be taken at the time of construction to reduce eddy current losses in I M?

Make the resistance of the core body as large as possible. This is achieved by laminating the stator core, stacked and rewetted at right angles to the path of eddy current. The laminations are insulated from each other by thin coat of varnish.

72. Why is there not appreciable magnetic losses in the rotor core of Induction motors?

Although the rotor core is also subjected to magnetic flux reversals and since the frequency of flux reversals in the rotor, fr = Sfs, is very small, the iron loss incurred in the rotor core is negligibly small.

73. What is meant by synchronous watt?

With the power input to the motor Pi, after the losses in the stator winding. Wcu1 and stator core, Wi, are met with, the remaining power is transferred to the rotor by the rotating magnetic field as power input to the rotor Pir

Pir = Pi –wau1 - Wi

The power input to the rotor Pir is transferred from the stator to the rotor by rotating magnetic field which rotates at synchronous speed Ns. Torque Td is developed in the rotor as

74. State the characteristic features of synchronous motor.

a. the motor is not inherently self starting

b. The speed of operation is always in synchronous with the supply
Frequency irrespective of load conditions
c. The motor is capable of operating at any power factor.

75. Explain the principle of operation of DC motor.

The DC motor is based on the principle that, when a current carrying conductor is placed in a magnetic field, it experiences a mechanical force.

In DC motor the field windings when passed current produces the necessary magnetic field. The armature carrying current is present in this field and hence experiences force. Since the armature conductors are present on the periphery perpendicular to the force, they experience a turning force or torque. Torque is the product of force and the radius at which the force acts. So overall armature experiences a torque and starts rotating.

76. Give the back emf equation of DC motor.

The back emf equation of DC motor is given by,

$$E_b = \frac{\phi PNZ}{60A} \quad \text{V}$$

where, ϕ is the flux per pole (Wb)
P is the number of poles
N is the speed of the armature in rpm (rotations per minute)
Z is the total number of conductors
A is the number of parallel paths

77. Give the voltage and Torque equation of DC motor.

The voltage equation:

$$V = E_b + I_a R_a \quad \text{V}$$

Torque equation:

$$T = \frac{\phi I_a PZ}{2\pi A} \quad \text{Nm}$$

where, V is applied voltage,
E_b is the back emf (V)
I_a is the armature current (A)
R_a is the armature resistance (Ω)
ϕ is the flux per pole (Wb)
P is the number of poles
Z is the total number of conductors
A is the number of parallel paths.
A=2 for wave winding
A=P for lap winding

78. What are the types of DC motor?

The types of DC motors are,

a) **Shunt motor** – the field winding is connected parallel to the armature winding.
b) **Series motor** – the field winding is connected in series with the armature winding.

c) **Compound motor** – both shunt and series field windings are present. If the shunt field winding is connected across both the armature winding and the series field winding, then it is called long shunt compound motor. If the shunt field winding is connected only across the armature winding, then it is called the short shunt compound motor.

If the shunt field and the series field windings are wound in a such a way that they aid each other (i.e., in same direction), then we say it is cumulatively compounded. If the shunt field and the series field windings are wound in a such a way that they oppose each other (i.e., in opposite direction), then we say, that it is differentially compounded.

79. What are the losses occurring in a transformer.

The losses occurring in a transformer are

a) Core loss – loss occurring in the core of the transformer. This has two components.

- Hysteresis loss – The loss occurring due to the magnetization characteristics of the core.
- Eddy current loss – The loss occurring due to the eddy current produced in the core.

b) Copper loss (I^2R loss) – loss occurring in the windings of the transformer. This has two components.

- Primary copper loss – The loss occurring due to the current flowing through the primary winding.
- Secondary copper loss – The loss occurring due to the current flowing through the secondary winding.

112. Give the emf equation of the transformer.

The emf induced in the transformer is given by

$$E_1 = 4.44 f N_2 \phi_m \quad \text{V}$$

$$E_2 = 4.44 f N_1 \phi_m \quad \text{V}$$

where, E_1 is the emf induced in the primary winding.

E_2 is the emf induced in the secondary winding.

N_1 is the number of turns in the primary winding.

N_2 is the number of turns in the secondary winding.

ϕ_m is the maximum flux produced.

f is the frequency in Hz.

113. What are the typical uses of auto transformer?

To give small boost to a distribution cable to correct for the voltage drop. As induction motor starter

114. What are slip rings? The slip rings are made of copper alloys and are fixed aroud the shaft insulating it. Through these slip rings and brushes rotor winding can be connected to external circuit.

115. What is the advantage of cage motor?

Since the rotor has low resistance, the copper loss is low and efficiency is very high. On account of simple construction of rotor it is mechanically robust, initial cost is less, maintenance cost is less, simple starting arrangement.

116. When is a synchronous motor said to receive 100% excitation?

When Eb = V, synchronous motor receive 100% excitation.

117. What is a synchronous capacitor?

An over excited synchronous motor, running without any mechanical load, used specifically for power factor correction is known as synchronous capacitor

118. When is a synchronous motor said to be under - excited? What will be the p.f at this condition?

Excitation emf Eb less than supply voltage Eb < V

Lagging power factor.

119. What are the inherent disadvantages of synchronous motor?

i) Higher cost

ii) Necessity of a dc excitation source
iii) Greater initial cost
iv) High maintanence cost

120. Mention four applications of synchronous motor?

Power factor correction
Constant speed, constant load drives
Voltage regulation of transmission lines

121. Enlist the advantages and disadvantages of synchronous motor.

Advantages of Synchronous Motors:

1. The speed is constant and independent of load.
2. These motors usually operate at higher efficiencies.
3. Electro magnetic power varies linearly with the voltage.
4. These motors can be constructed with wider air gaps than induction motors, which make them better mechanically.
5. An Over excited synchronous motor having a leading power factor can be operated in parallel with induction motors.

Disadvantages of Synchronous Motor:

1. It cannot be started under load.
2. It requires dc excitation which must be supplied from external source.
3. It has a tendency to hunt.
4. It cannot be used for variable speed jobs as there is no possiblity of speed Adjustment
5. Collector rings and brushes are required.

122. Define pullout torque in synchronous motor:

The maximum torque which the motor can develop without pulling out of step or synchronism is called the pull out torque.

123. Define pull in torque in synchronous motor:

It pertains to the ability of the machine to pull into synchronism when changing from induction to synchronous motor operation

124. B What is crawling in I.M?

The tendency of the motor to run stably at speeds as low as one seventh of its synchronous speed with a low pitched howling sound is called crawling

125. What are the losses in induction motor?

a)constant losses
b)variable losses.

126. What are the characteristics of double squirrel cage motor, compared to a squirrel cage motor ?

(i) High starting torque
(ii) Excellent running performance

UNIT-III- SPEED CONTROL AND STARTING

127. What are the different speed control methods of squirrel cage induction motors?

a)supply frequency control
b)supply voltage control.
c)controlling number of stator poles.
d)adding rheostats in stator

128. What are the types of starters?

a)stator resistance starter
b)autotransformer starter.
c) star delta starter.
d) rotor resistance starter.
e) direct to line starter

129. How the stator poles can be changed?

a)consequent poles method.
b)multiple stator winding method.
c)pole amplitude modulation method.

130. What is the effect of change in input voltage on starting torque of induction motor?

There is no change in starting torque due to change in input voltage. the motor reacts by drawing more current at lower speeds to keep the same torque

131. What are the definitions associated with stepping motor?

a)holding torque.
b)detent torque
c)step angle.
d)critical torque.
e)limiting torque.
f)slewing rate.

132. What is the function of a no-voltage release coil provided in a dc 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 the ON position against spring force. When the supply voltage fails or becomes lower than a prescribed value the electromagnet may not have enough force and the handle will come back to OFF position due to spring force automatically. Thus a no-voltage or under voltage protections given to the motor

133. Enumerate the factors on which the speed of a dc motor depends.

$N = 1/CE (Ua-IaRm)/\phi$

The speed of dc motor depends on three factors.

· Flux in the air gap
· Resistance of the armature circuit
· Voltage applied to the armature

134. List the different methods of speed control employed for dc series motor· Field diverter method

· Regrouping of field coild\s
· Tapped field control
· Armature resistance control
· Armature voltage control for single motor
· Series parallel control for multiple identical motors

135. Name the different methods of electrical breaking of dc motors.

(i) Dynamic braking
(ii) Regenerating braking
(iii) Counter current braking or plugging

136. List the drawbacks of armature resistance control?

In armature resistance control, speed is varied by wasting power in external resistors that are connected in series with armature. Since it is an inefficient method of speed control, it was used in intermittent load application where the duration of low speed operation forms only a small proportion of total running time.

137. Mention the methods of armature voltage control dc motor?

When the supply voltage is ac
i) Ward-Leonard schemes
ii) Transformer with taps and uncontrolled rectifier bridge
iii) Static Ward-Leonard scheme (or) controlled rectifiers
When the supply is dc
Chopper control

138. What are the disadvantages of conventional ward-Leonard schemes?

- Higher initial cost due to use of two additional machines.
- Large weight and size.
- Needs more floor space and proper foundation.
- Required frequent maintenance.
- Higher noise and higher loss.

139. Mention the drawbacks of rectifier fed dc drives?

- Distortion of supply
- Low power factor
- Ripple in motor current

140. What are the different methods of speed control of induction motors?

- Stator voltage control
- Supply frequency control
- Rotor resistance control
- Slip power recovery control

141. What is meant by stator voltage control?

The speed of the induction motor can be changed by changing the stator voltage. Because the torque is proportional to square of the voltage.

142. Mention the applications of stator voltage control?

The stator voltage control method is suitable for applications where torque demand reduced with speed, which points towards its suitability for

1. Fan ii) Pump drives

143. What are the advantages of stator voltage control method?

- The control circuitry is simple
- Compact size
- Quick response time
- There is considerable savings in energy and thus it is economical method as compared to other methods of speed control.

144. What are the advantages and disadvantages of star delta starter?

Advantages: a. This method of starting is simple, cheap, effective b. The reduced voltage is not variable.

Disadvantages:

a. The reduction in voltage is fixed and starting torque is also low. b. This method is unsuitable for line voltage exceeding 3000V.

143. Write the difference between three point and four point starter

Three point starter:

The NVR coil is connected in series with the shunt field winding. b. The exiting current through the NVR coil in three point starter is same as shunt field of the motor.

Four point starter:

The NVR coil along with a high resistance is connected across the supply voltage. b. The exciting current through NVR coil of a four point starter is directly proportional to the supply voltage and independent on shunt field current.

145. What is the advantage of a four point starter over a three point starter used for dc motors?

The main advantage of the four point starter is the dc motor used for field control(above the normal speed)

146. Is it possible to include external resistance in the rotor of a squirrel cage induction motor?

External resistance can not be connected in the rotor of the squirrel cage induction motor because the rotor out cage is already short circuited by end rings.

147. Explain the rotor resistance starter allows fast start with heating of induction motor.

In slip ring induction motor is normally started with rotor resistance starter. Here we can apply full voltage to the stator winding. Due to this, motor start with fast as well as heating of the motor.

148. Why, large current is drawn by three phase induction motor at the time of starting?

When 3 phase induction motor is switched on at normal supply voltage, heavy current will flow through the motor because at the time of starting, there is no back emf. An induction motor, when directly switched on, takes 5 to 7 times its full load current and develops only 1.5 to 2.5 times full load torque .This will affect the operation of other electrical equipments connected to the same line. Due to this, starters are used for the three phase induction motors

149. What is meant by Ward Leonard control system?

The speed of the DC motor is controlled by armature and field control method. The armature control can be achieved by varying the field of the DC generator. The flux control method can be achieved by varying the field of the controlled DC motor.

150. Name the solid state controllers used for the speed control of dc shunt motor and series motor.

a. Phase controlled rectifier fed DC drives b.Chopper fed dc drives

151. Define firing angle.

The firing angle is defined as the angle between zero crossing of the input voltage and the instant the thyristor is fired. The firing angle is denoted as α.

UNIT IV- DC DRIVES

152. What is meant by electrical drives?

Systems employed for motion control are called "DRIVES" and drives employ any of the prime movers such as, diesel or petrol engines, gas or steam turbines, hydraulic motors and electric motors for supplying mechanical energy for motion control. Drives employing electric motion known as "Electric Drives".

153. Define an electric drive.

The combination of an electric motor, the energy transmitting shaft and the controlling devices for controlling the performance of the motor is called an electric drive

154. Name the factors governing the selection of a motor for a particular purpose.

1. Mechanical output required
2. Electrical input required
3. Environment
4. Cost
5. Electrical characteristics,
6. Mechanical characteristics,
7. Size and rating

155. State the merits and de merits of electrical braking.

Merits : 1 less maintenance 2 no dirt 3regenerative braking possible Demerits: 1 motor should have suitable braking characteristics . 2 no holding torque 3 during failure of supply mechanical braking needed

156. Mention the application of electric drives?

- Paper mills
- Electric traction
- Cement mills
- Steel mills.

157. Define four-quadrant operation?

A motor operate in two modes, motoring and braking. In motoring, it converts electrical energy into mechanical energy, which supports its motion. In braking it works as a generator converting mechanical energy into electrical energy and thus, opposes the motion. Motor can provide motoring and braking operations for both forward and reverse directions.

158. Mention the applications of AC drives?

AC drives are used in a number of applications such as fans, blowers, mill run-out tables, cranes, conveyors, traction etc.

159. What are the main factors influencing to select the electric drives for particular applications?

Any motor select as a electric drive for particular application it should depend on the following factors a. steady state operation b. Transient operation c. Related with source

160. 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

161. 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	$T_s = (0.425)^2 T_{dol}$	$T_s = 0.35T$

162. 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.

163. 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

164. 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.

165. 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.

166. Mention the two slip-power recovery schemes.

* Static scherbius scheme
* Static Kramer drive scheme.

167. 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.

d. Need of cost e. Life period f. Reliability g. Location and environment

168. Define heating time constant.

Heating time constant is defined as the time taken by the machine to attain 0.632 of its final steady temperature rise. The heating time constant of the machine is the index of the time taken by the machine to attain its final steady temperature rise

169. Write the best choice of electric motors for the following application: a)Pump load, b)Elevator

a) Pump load- single phase or three phase cage induction motor b) Elevator –DC series motor, Slip ring induction motor.

170. Give the application of DC motors

a. DC shunt motor- Over head cranes b. DC series motor-Traction c. DC compound motor-Pressing machine

171. What is the relation between speed and flux of a dc motor?

The speed of a dc motor is inversely proportional to field flux. $N \alpha 1/\Phi$

UNIT V- AC DRIVES

178. What is meant by Slip power recovery Scheme?

This slip power can be returned to the supply source and can be used to supply an additional motor which is mechanically coupled to the main motor. This type of drive is known as a slip power recovery system and improves the overall efficiency of the system.

179. What are the various methods of speed control of 3 phase induction motor?

(i) stator voltage control
(ii) stator frequency control
(iii) V/f method
(iv) pole changing method

180. What are the features of variable frequency control?

- Speed control and braking operation are available from zero speed to above base speed.
- Drop in speed from no load to full load is small.
- Copper losses are low. Hence efficiency and power factor are high as the operation is restricted between synchronous speed and maximum torque point at all frequencies.
- During transient (starting, braking and speed reversal) operation can be carried out at the maximum torque with reduced current giving good dynamic response.

181. What is meant by frequency control of induction motor?

The speed of the induction motor can be controlled by changing the supply frequency, because the speed is directly proportional to supply frequency. This method of speed control is called frequency control.

182. What is meant by V/F control?

When the frequency is reduced, the input voltage must be reduced proportionally so as to maintain constant flux. Otherwise the core will get saturated resulting in excessive iron loss and magnetizing current. This type of induction motor behavior is similar to the working of dc series motor.

183. 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.

184. What is meant by dynamic braking?

Dynamic braking of electric motor 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.

185. 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.

186. What are the steps to be taken for the successful selection of electric drive? what are factors affecting the selection of a suitable motor as a drive for a purpose?

Electrical characteristics
Mechanical features
Size of motors
Cost
Types of motors available
Starting and running characteristics

187. 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.

188. What are the advantages of slip power recovery system? a. The slip power can be recovered and fed back to the supply. b. The over all efficiency also improved.

189. What is meant by static scherbius drive? The slip ring induction motor speed can be controlled both below and above synchronous speed, static scherbius drive system is used.

190. What is meant by Kramer system? The Kramer system is only applicable for sub synchronous speed operation

because the slip power is fed back to the supply.

191. **What is the function of conventional Kramer system?** In conventional Kramer system, the slip Power is converted in to dc by rotary converter. The dc voltage is fed to dc motor. The dc motor is coupled with slip ring induction motor. The speed of the slip ring induction motor can be controlled by varying the field regulator of the dc motor.
192. **What are the disadvantages of static rotor resistance control/** a. Slip power is wasted in the rotor circuit resistance. b. Efficiency is less.
193. **State one major advantage and disadvantage of slip power recovery scheme based wound rotor induction motor drive.** Advantage: The slip power can be recovered and fed back to the supply due to this overall efficiency is increased. Disadvantage: Power factor of the system is low.