UNIT I
INTRODUCTION

1.Define Drive and Electric 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, Semi automatic, 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.

9. 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. What are the types Drive systems?

Electric Drives Mechanical Drives Electromechanical Drives Hydraulic drives.

12. 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.

13. 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.

14. 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.

15. 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.

16. 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 contro

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

Centrifugal pumps, fans, conveyors & compressors.

18. 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.

19. 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 (Psh) that is much higher than P, if the temperature rise is the consideration.

20. 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.

UNIT – II
DRIVE 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.Compare electrical and mechanical braking .

Brakes require frequent maintenance very little maintenance not smooth can be applied to hold the system at any position cannot produce holding torque.

6.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.

7.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.

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9.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.

10.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.

11.Compare electrical and mechanical braking.

Brakes require frequent maintenance very little maintenance not smooth can be applied to hold the system at any position cannot produce holding torque.

12.Differentiate cumulative and differential compound motors.

- Cumulative The orientation of the series flux aids the shunt flux
- Differential Series flux opposes shunt flux

13.What do you mean by Rheostatic braking?

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

14.What is back emf in d.c. Motor?

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 conductor is in opposite to current. As this emf always opposes the flow of current in motor operation it is called as back emf.

15.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.

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.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.

6.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 lead 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.

7.How reduced voltage starting of Induction motor is achieved?
D.O.L Starter (Direct Online Starter) Star-Delta Starter Auto Transformer Starter Reactance or Resistance starter.

8.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.

9.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.

10.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.

11.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.

12.Why starts are used for DC motors?

In DC motors starters are used to limit the starting current within about 2 to 3 times the rated current by adding resistance in series with the armature circuit. Other than this starting resistances starters are variable fitted with protective devices like no –voltage protection and over-load protection.

13.Why stator resistance rarely used?

Due to addition of resistance in the stator side cause the voltage available to the motor X times the normal voltage i.e. The starting current drawn by the motor as well as the current drawn from the supply get reduced by X times where as the starting torque developed gets reduced by X2 times.

14.What are the effects of increasing rotor resistance in the rotor circuit of a 3-phase induction motor as starting?

Due to addition of resistance in rotor circuit by the stator not only reduces the staring current, in addition to that the starting torque developed than those given by DOL starting.

15.What are the advantages of Electronic starter?

The moving parts and contacts get completely eliminated.
- The arcing problem gets eliminated.
- Minimum maintenance is required as there are no moving parts.
- The operation is reliable
- Starting time also gets reduced.

UNIT – IV
CONVENTIONAL AND SOLID STATE SPEED CONTROL OF D.C.DRIVES

1.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 .

2.Give the Limitation of field control .

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

3.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.

4.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.

5. What are the advantages of field control method?

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

6. 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.

7. 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

8. State the advantages of dc chopper drive.

- Dc chopper drive s has the advantages of
- High efficiency
- Flexibility in control
- Light weight
- Small size

- Quick response.

9. Why chopper based DC drives give better performance than rectifier controlled drives.

- Less harmonic
- Low ripple content
- High efficiency

10.Name the solid state controllers used for the speed control of DC shunt motor and series motor,

1. Phase controlled rectifier fed DC drives
2. Chopper fed DC drives

11. Give application of Ward-Leonard system of speed control

It is used for elevators, hoist control and for main drive in steel mills where motor of ratings 750KW to 3750KW are required.

12.What is the principle of the field control method of speed control of DC shunt motors?

The speed of the DC motor can be controlled by varying the field flux. This method of speed control can be used for increasing the speed of motor above its rated speed, because the speed of the motor is inversely proportional to the field flux.

13. What is the effect of inserting resistance in the field circuit of of DC shunt motor on its speed and torque?

- Speed increases above base speed.
- Torque decreases.

14. What are the two main methods adopted for speed control of DC motors?

- Armature resistance control
- Flux control

15. What are the electrical parameters affecting the speed of the DC motors?

Armature voltage Field current

16. State the types of controlled rectifier Dc drives .

1. Single phase controlled rectifier DC drives (a)Half wave controlled rectifier Dc drives (b)Half controlled rectifier DC drives (c)Full controlled rectifier DC drives

2. Thee phase controlled rectifier fed DC drives

17.How can speed be controlled in a DC shunt motor?
The DC shunt motor speed controlled by
(a) Armature voltage control (below rated speed)

(b)Flux control method (above rated speed)

18. List the advantages of DC six pulse converter compared with three pulse converter

- Current should be continuous
- Requires less filter circuits
- It gives two quadrant operation

19.What factors limit the maximum speed of field control Dc motor?

Field flux Armature voltage

20. State control strategies of choppers .

Time ratio control Current limit control

21. 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 motors.

22. What is static Ward – Leonard drive?

Controlled rectifiers are used to get variable dc voltage from an ac source of fixed voltage. Controlled rectifiers fed dc drives are known as “static Ward – Leonard drive”.

23. What is meant by voltage control in induction motor? and where it is applicable?

In Induction motor speed can be controlled by varying the stator voltage. This can be done by using transformer. This method is called voltage control. This is suitable only for controlling the speed below rated value.

24. What is meant by armature control?

The armature having controller resistance in series during the speed control by varying the controller resistance R, the potential drop across the armature is varied. Hence the speed of the motor also varied. This method of speed control is applicable for speed less than no load speed.

25. What is meant by flux control (or) field control method?

By varying the field flux the speed can be controlled is called flux control. This method can be used for increasing the speed of the motor is inversely proportional to the field flux.

26. In which type of control the field current and armature current control?

i).For armature control method (or) voltage control method the field current is kept constant
ii).For field control (or) flux control the armature current kept constant

27. What is Slip-Power recovery system?

The slip power can be recovered to the supply source can be used to supply an additional motor which is mechanically coupled to the main motor. This type of drive is known as slip-power recovery system.

UNIT – V

CONVENTIONAL AND SOLID STATE SPEED CONTROL OF A.C. DRIVES

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 MWs.

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 interval 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 Va 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. What is voltage commutation?

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

11. 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.

12. 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.

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

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

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

1. Phase control
2. Integral cycle control

15. Mention the two slip-power recovery schemes.

1. Static Scherbius scheme
2. Static Kramer drive scheme.

16. 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.

17. 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.

18. Give the special features of static scherbius scheme.

- The scheme has applications in large power fan and pump drives which requires speed control in narrow 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.

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

Since a static Kramer system possesses no line commutated inverter, it causes bless reactive power and smaller harmonic contents of current than a static scherbius.

20. 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 limitations of cyclo converter method of speed control?

1. It requires more semiconductor devices like thyristors, MOSFETs compared with inverters
2. Harmonic contents more with low power factor.

22. What are the classifications of PWM technique?

1. Single pulse width modulation
2. Multiple pulse PWM modulation
3. Sinusoidal Pulse PWM

23. Why do we go for PWM inverter control?

The output from inverter is square with some harmonic contents so we have to remove or reducing the harmonic contents by using some voltage control technique called PWM.

24. Compare static Kramer and scherbius system.

Kramer: The system consists or SRIM,diode bridge rectifier and line commutated inverter The slip power can flow in one direction This is applicable for below synchronous speed operation.
Scherbius: This system consists of SRIM,two SCR bridge (or) cyclo converter The slip power can flow in both direction Applicable for both below and above synchronous speed operation.

25. What is meant by ac voltage controller?

AC voltage controller is nothing but, which is used to converters fixed ac voltage into variable ac voltage without changing supply frequency.