

ELECTRICAL DRIVES AND CONTROLS

UNIT: I

INTRODUCTION

1. Define Drives

A particular system employed for motion control is called drive. Eg. Transportation systems, fans, etc.

2. Define electric Drives

A system employed for motion control by using electric motor as a prime mover is called electric drive.

3. Write all basic elements of electric drives

Electric drives consist of following basic elements.

- a. source
- b. power modulator
- c. motor
- d. sensing device
- e. controlling device

4. Write the functions of power modulators.

- a. It modulates the power flow from source to load through motor.
- b. It converts D.C in to A.C or A.C in to D.C according to the needs.

5. What are the types of electric drives

It consist of three types such as

- a. Individual drive
- b. Group drive
- c. Multi motor drive

6. Define individual drive.

A single motor is used to drive a single load is called individual drive.

7. Define group drive.

A single motor is drive a several machines is called group drive.

8. Define multimotor drive.

In this type of drive system separate motors are used for operating different parts of the same load is called multimotor drive.

9. What is heating curve?

The curve is drawn between temperature rise Vs time, when drive is loaded called heating curve.

10. Mention the different types of classes of duty.

- a. Continuous duty
- b. Short time duty
- c. Intermittent duty
- d. Intermittent duty with starting
- e. Intermittent duty with starting & braking

11. 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
- d. Need of cost
- e. Life period
- f. Reliability
- g. Location and environment

12. What are the applications of electrical drives?

- a. Paper mills
- b. Electric traction
- c. Cement mills
- d. Steel mills

13. What are the types of enclosures?

- a. Screen protected type
- b. Drip proof type
- c. Totally enclosed type
- d. Flame proof type

14. What is meant by overload current capacity of motor.

It is generally greater than the full load current capacity of the motor. During the short time period, the motor can withstand by applying overload.

15. Define continuous rating of a motor.

Continuous rating of a motor is denotes operation at constant load of sufficient duration. Centrifugal pumps, fans, compressors and conveyors are some examples of equipment which run continuously with constant load.

16. Compare AC and DC drives.

DC drives:

- a. The power circuit and control circuit is simple and in expensive
- b. It require frequent maintenance
- c. Power/weight ratio is small

DC drives:

- a. The power circuit and control circuit are expensive
- b. It require less maintenance
- c. Power/weight ratio is large

17. What is meant by intermittent duty?

There are certain loads which require motors to be run for a certain period of time and them switched off for a small period. This type duty is called intermittent duty.

18. 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

19. 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.

20. What are the advantages of the group drive?

- a. A single large motor can be used instead of a number of a small motors.
- b. The rating of the single large motor may be approximately reduced.

UNIT-II

DRIVE MOTOR CHARACTERISTICS

1. What is meant by braking?
Stopping of motor by producing load torque opposite to the torque produced by the electric motors.
2. Write the types of braking used for DC motors
 - a. Dynamic or rheostatic braking
 - b. Plugging or reverse voltage braking
 - c. Regenerative braking.
3. What is meant by dynamic braking?
In this method the armature of shunt motor is disconnected from the supply and is connected across a variable resistance R. The braking torque is controlled by the resistance R.
4. What is meant by plugging in DC motor?
In this method, connections of the armature terminals are reversed so that motor tends to run in the opposite direction therefore the braking torque is produced.
5. What is meant by regenerative braking in DC motor?
In regenerative braking , generated energy is supplied to the source.
6. What is mechanical characteristics of a motor?
Speed torque characteristics of a motor is called mechanical characteristics of motor.
7. Why motor characteristics is important?
To select the electric motor for a particular application it is necessary to know the characteristics of electric motors. Only the performance of DC motor can be judged from its characteristics curve.
8. State the different modes of operation of three phase induction motor.
 - a. Motoring mode
 - b. Braking mode
 - c. Generating mode
9. Give the application of DC motors
 - a. DC shunt motor- Over head cranes
 - b. DC series motor-Traction
 - c. DC compound motor-Pressing machine
10. What are the operating characteristics of DC series motor?
 - a. High starting torque
 - b. Low speed at high loads and dangerously high speed at low loads.
11. What are the operating characteristics of DC shunt motor?
 - a. Medium starting torque
 - b. Approximately constant speed.
12. What is the relation between speed and flux of a dc motor?
The speed of a dc motor is inversely proportional to field flux.
$$N \propto 1/\Phi$$
13. Name the types of braking used in shunt motors.
 - a. Dynamic braking
 - b. Plugging
 - c. Regenerative braking.
14. How will you change the direction of rotation of a DC shunt motor?
DC motor speed can be changed by reversing the armature terminals or field terminals.

15. Why the series motors used for traction purpose?

For traction purpose, we requires high starting of DC motor. The DC series motor has high starting torque. That is why, series motor used in traction purpose.

16. What are the classification of load torque?

- a. Active load torque
- b. Passive load torque

17. What are the advantages of squirrel cage induction motor over DC motor?

- a. Simple construction
- b. Less maintenance
- c. Low cost
- d. High efficiency

18. What are the components of load torque?

- a. Friction torque
- b. Windage torque
- c. Torque required to the useful mechanical work

19. What are the two types of dynamic braking?

- a. DC braking
- b. AC braking

20. Define slip

$$\text{Slip}(s) = (N_s - N_r)/N_s$$

Where

N_r = rotor speed in rpm'

UNIT-III
STARTING METHODS

1. Write the speed equation of DC motor.

The speed equation of the dc motor is given by

$$N = (V - I_a R_a) / \Phi \quad \text{or} \quad E_b / \Phi$$

Where

N=Speed of dc motor

I_a=Armature current

R_a=Armature resistance

Φ=flux

2. Why is starter necessary for a DC motor?

A DC motor is directly switched on, at the time of starting, the motor back emf is zero. Due to this, the armature current is very high. Due to the very high armature current, the motor become damaged. The starting current can be limited by using starter.

3. Name the various types of starters commonly used for starting an induction motor.

- a. DOL starter b. Stator resistance starter c. Star delta starter
- d. Auto transformer starter e. Rotor resistance starter

4. What is the function of a starter in dc motor?

- a. To limit the starting current
- b. To protect the motor against low voltage and over load condition.

5. State the advantages of DOL starter

- a. High starting torque b. Low cost c. Simple operation

6. What are the different types of protection provided in starter used for a three phase induction motor?

- a. No voltage release coil b. Over load release coil

7. Name and mention the function of protective devices that are used to protect the motor.

a. No volt release coil (NVR):

Under low voltage condition, the coil should be deenergise and motor disconnected from the supply.

b. Over load release(OLR):

Under over load condition, the coil should be deenergise and motor disconnected from the supply.

8. Name the different types of starters used in DC motors

- a. Two point starter b. Three point starter c. four point starter

9. What are the methods of starting in three phase squirrel induction motor?

- a. DOL starter b. Stator resistance starter c. Star delta starter
- d. Auto transformer starter

10. What are the advantages and disadvantages of auto transformer starter?

Advantages:

- a. Reduced line current b. Smooth starting

Disadvantages:

- a. Cost is high b. It is used for large motors only.

11. What is the objective of rotor resistance starter?

- a. To limit the starting current b. To control the starting torque c. To vary the motor speed.

12. What type of starter is used for slip ring induction motor?

Rotor resistance starter

13. Name the type of induction motor which produces high starting torque.

Slip ring induction motor

14. 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.

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

Three point starter:

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

Four point starter:

- a. 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.

16. What are the effect of increasing rotor resistance on starting current and starting torque?

Addition of external resistance to the rotor circuit gives two advantages

- a. Reduces the starting current.
- b. It improves the starting torque.

17. 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)

18. 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.

19. 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.

20.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.

UNIT-IV

CONVENTIONAL AND SOLID STATE SPEED CONTROL OF DC DRIVES

1. What are the applications of DC motors?

- a. Electric traction c. Machine tools
- b. Steel mills d. textile mills

2. What are the advantages of dc drives?

- a. Low cost b. Reliability c. Simple control

3. What are methods of speed control of DC motors?

- a. Armature control b. Flux control c. Voltage control

4. What is meant by armature resistance control?

A resistance is connected in series with armature. By varying the controller resistance R , the potential drop across the armature is varied. Therefore, the motor speed also varied.

5. What is meant by flux control method?

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 the motor above its rated speed, because the speed of the motor is inversely proportional to the field flux.

6. What are the methods of speed control of DC series motor?

- a. Variable resistance in series with motor.
- b. Flux control method
 - i. Field divertor
 - ii. Armature divertor
 - iii. Tapped field control

7. 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.

8. What is meant by controlled rectifier?

It converts fixed ac voltage in to variable dc output voltage.

9. What is meant by DC drives?

A dc motor speed can be controlled by using power electronic converters. It is called as dc drives.

10. What are the different types of dc drives?

- a. Single phase dc drives b. Three phase dc drives c. Chopper drives

11. What are the two methods of speed control of dc motors?

The DC motor speed controlled by (a) armature voltage control (b) Flux control method.

12. What is chopper?

It convert the fixed dc voltage in to variable dc voltage.

13. What are the different types of chopper?

- a. First quadrant chopper
- b. Second quadrant chopper
- c. Third quadrant chopper
- d. Four quadrant chopper

14. What are the different types of single phase dc drives?

- (i) Single phase half controlled DC drives
- (ii) Single phase full controlled DC drives

15. 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

16. How is chopper used in speed control of dc motor?

DC chopper converts fixed DC voltage into variable DC output voltage. The variable output voltage can be obtained by varying the duty cycle of the chopper. This variable voltage is fed to the motor. Due to this, DC motor speed can be changed.

17. What are the electrical parameters affecting the speed of the DC motor?

- a. Armature voltage
- b. Field current

18. State control strategies of choppers. a. Time ratio control
b. Current limit control

19. Write the applications of DC chopper. a. Electric traction
b. Steel mills
c. Paper mills
d. Machine tools
e. Printing mills

20. 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-V
CONVENTIONAL AND SOLID STATE SPEED CONTROL OF AC DRIVES

1. How the variable frequency is obtained at the output of the inverter?

In the inverter circuit, the output frequency can be varied by varying the on and off time of the devices.

2. List the methods of speed control applicable to 3 phase induction motor.

- a. Rotor resistance control
- b. Cascade control
- c. Slip power recovery scheme.

3. How is speed control achieved by voltage/frequency control in a 3 phase induction motor?

In voltage/frequency control method, motor speed can be varied by varying voltage and frequency

But we can maintain V/F ratio is constant.

4. Write the speed equation of an induction motor.

Speed equation $N = N_s (1 - S)$

Where

$N_s = \text{Synchronous speed} = 120f/p$

$S = \text{SLIP}$

5. State the types of speed control of induction of induction motor.

- a. Stator voltage control
- b. Stator frequency control
- c. Rotor resistance control
- d. Slip power recovery scheme

6. What is meant by stator voltage control?

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

7. What are the applications of AC drives?

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

8. 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.

9. What are the advantages of voltage/frequency control?

- a. Smooth speed control.
- b. High starting torque for low cage resistance.

10. What is meant by stator current control?

The three phase induction motor speed can be controlled by stator current control. The stator current can be varied by using current source inverter.

11. What is meant by slip power recovery system?

The wasting of slip power can be recovered by various schemes for the speed control of slip ring induction motor. This system is called as slip power recovery system.

12. 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.

13. What is meant by sub synchronous speed operation?

The sub synchronous speed operation means, the slip ring induction motor speed can be controlled below synchronous speed. The slip power is fed back to the supply.

14. What is meant by super synchronous speed operation?

The super synchronous speed operation means, the slip ring induction motor speed can be controlled above synchronous speed. The slip power is fed back to the rotor side.

15. 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.

16. 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.

17. 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.

18. What are the two types of static scherbius system?

- a. DC link static scherbius system
- b. Cycloconverter scherbius system.

19. What are the disadvantages of static rotor resistance control/

- a. Slip power is wasted in the rotor circuit resistance.
- b. Efficiency is less.

20. 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.