UNIT 1   DRIVE CHARACTERISTICS

1. What is meant by electrical drives?

Systems employed for motion control are called drives and they employ any of the primemovers such as diesel or petrol engines, gas or steam turbines, hydraulic motors and electric motors for supplying electric motion mathematical energy for motion control. Drives employing are called electric drives.

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

3. 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.
   7) Reliability.

4. What are the advantages of electric drives?
   - They have flexible control characteristics. Characteristics The steady state and dynamic of electrical drives can be shaped to satisfy load requirements.
   - 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.
   - They are available in which range of torque, speed and power.
   - It can operate in all the four quadrants of speedtorque 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.

5. What are the functions performed by electric drives?

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

**6. What are the disadvantages of electric drives?**

The disadvantages of electric drives are
a. Electric drives system is tied only up to the electrified area.
b. The condition arising under the short circuits, leakage from conduct breakdown
c. Failure overhead conductor may lead to fatal accidents.

7. What are the methods of operation of electric drives?
   - Steady state
   - acceleration including starting
   - deceleration including starting

8. Draw the electric drive system.

Fig. An electric-drive system
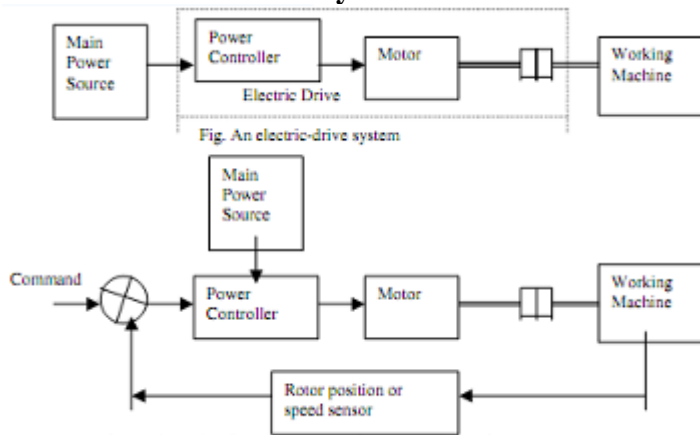
9. What are the advantages of group drive over individual drive?

The advantages of group drive over individual drives

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 simultaneously.

c. Space requirement : individual

d. Low drive. maintenance Less space is required in group drive as compared to cost: drive. It requires little maintenance as compared to individual

10. Write short not es on individual electric drives.

In individual drive, each individual machine is driven by a separate motor. This motor also imparts motion to machines are single spindle drilling machine various other parts of the machine. Ex single spindle drilling machine (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. .

UNIT II CONVERTER / CHOPPER FED DC DRIVES

1. **Give some applications of D.C. drives.**
   The applications of D.C. drives are,
   > a. Rolling mills b. Paper mills c. Mine winders d. Hoists e. Machine tools f. Traction g. Printing presses h. Excavators i. Textile mil l j. Cranes.

2. **How the D.C. motor is affected at the time of starting?**
   A D.C. motor is started with full supply voltage across its terminals, a very high current will flow, which may damage the motor due to heavy sparking at commuter and heating starting

3. **What is called continuous and discontinuous conduction?**
   A dc motor is fed from a phase controlled converter the current in the armature may flow indiscrete pulses in called continuous conduction. A dc motor is fed from a phase controlled converter the current in the armature may flow continuously with an average value superimposed on by a ripple is called discontinuous conduction.

4. **What are the three intervals present in discontinuous conduction mode of single phase half and fully controlled rectifier?**
   The three intervals present in half controlled rectifier are,
   a.Duty interval
   b.Free, wheeling interval
   c.Zero current interval.
   The two intervals present in fully controlled rectifier are
   a.Duty interval
   b.Zero current interval

5. **What is armature voltage control?**
   The speed is directly proportional to the voltage applied across the armature. As the supply voltage is normally constant, the voltage across the armature can be controlled by adding a variable resistance in series with the armature

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

7. **What are the advantages of chopper fed dc drives?**
   DC chopper device has the advantages of high efficiency, flexibility in control, light weight, small size, quick response and regeneration down to very low speed

8. **What are the advantages of rectifier fed dc drives?**
   The main advantages of the SPWM rectifier system are to drive a D.C motor with constant and variation load torque, low harmonic distortion in A.C supply side

9. **Why self-commutated devices are preferred over thyristors for chopper circuits?**
   Self-commutated devices such as power MOSFETs power transistors, IGBTs, GTOs and IGCTs are preferred over thyristors for building choppers because they can be commutated by as low power control signal and don't need commutation circuit.

10. What are the types of control strategies in dc chopper?

- Time ratio control.
- Current limit control

11. What is known as half-controlled rectifier and fully controlled rectifier?

The rectifiers that provide control of dc voltage in either direction and therefore, allow motor control in quadrants I and IV. They are known as fully-controlled rectifiers. The rectifiers that allow dc voltage control only in one direction and motor control in quadrant I only. They are known as half-controlled rectifiers.

12. Mention the methods of armature voltage controlled dc motor?

When the supplied voltage is ac, Ward-Leonard schemes Transformer with taps and un controlled rectifier bridge Static Ward-Leonard scheme or controlled rectifiers When the supply is dc: Chopper control.

UNIT III INDUCTION MOTOR DRIVES

1. **What are the different methods of speed control of IM?**
   Stator voltage control
   Supply freq. control
   Rotor resistance control
   Slip power recovery control.

2. **What is meant by stator voltage control? Mention the application of stator voltage control**.
   The speed of the IM can be changed by changing the stator voltage because the torque is proportional to the square of the voltage. This method is suitable for applications where torque demand reduced with speed, which points towards its suitability for fan and pump drives.

3. **What are the three regions in the speed-torque characteristics in the IM?**
   - Motoring region (0<=s<=1)
   - Generating region(s<0)
   - Plugging region (1<=s<=2) where s is the slip.

4. **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.

5. **What is meant by V/F control ?**
   When the frequency to maintain is reduced the i/p voltage must be reduced proportionally so as constant flux otherwise the core will get saturated resulting in excessive iron loss and magnetizing current. This type of IM motor.

6. **What are the advantages of V/F control?**
   - Smooth speed control
   - Small i/p current and improved power factor at low freq. start
   - Higher starting torque for low case resistance

7. **How is the speed control by variation of slip frequency obtained?**
   Speed control by variation of slip frequency is obtained by the following ways.
   a. Stator voltage control using a three-phase voltage controller.
   b. Rotor resistance control using a chopper controlled resistance in the rotor circuit.
   c. Using a converter cascade in the rotor circuit to recover slip energy.
   d. Using a cyclo converter in the rotor circuit.

8. **Mention the effects of variable voltage supply in a cage induction motor.**
   When a cage induction motor is fed from a variable voltage for speed control the following observations may be made.
   a. The torque curve beyond the maximum torque point has a negative shape. A stable operating point in this region is not possible for constant torque load.
   b. The voltage controlled must be capable of withstanding high starting currents. The range of speed control is rather limited.
   c. The motor power factor is poor.

9. **What are the disadvantages of square wave inverter in induction motor drive?**

Square wave inverters have commutation problems at very low frequencies, as the D.C. link voltage available at these frequencies cannot charge the commutating capacitors sufficiently enough to commutate the thrusters. Those puts a limit on the lower frequency of operation. To extend the frequency towards zero, special charging circuits must be used.

10. What are the effects of harmonics in VSI fed induction motor drive?

The motor receives square wave voltages. These voltage components. The has harmonic harmonics of the stator current cause additional losses and heating. Harmonics are also responsible These for torque pulsations. The reaction of the fifth and seventh harmonics with the fundamental gives rise to the seventh harmonic pulsations in the torque developed. For a given induction motor fed from a square wave inverter the harmonic content in the current tends to remain constant independent of input the rang e 42 of operating frequencies of the inverter.

11. What are the advantages and disadvantages of rotor resistance control?

Advantage of rotor resistance control is that motor torque capability remains unaltered even at low speeds. Only other method which has this advantage is variable frequency control. However, cost of frequency control. rotor resistance control is very low compared to variable Major disadvantage is low efficiency due to additional losses in resistors connected in the rotor circuit

12. Why the static scherbius drive has a poor power factor?

Drive input power is difference between motor input power and the power fed back. Reactive input power is the sum of motor and inverter reactive power. Therefore, drive has a poor power factor throughout the range of its options.

13. Give the four modes of operation of a Scherbius drive

The f our modes of operation of static Scherbius drive are,
1. Sub synchronous motoring.
2. Sub synchronous regeneration
3. Super synchronous motoring
4. Super synchronous regeneration

UNIT IV SYNCHRONOUS MOTOR DRIVES

1. Give the use of synchronous motors.

   Synchronous motors were mainly used in constant speed applications. The development of semiconductor variable frequency sources, such as inverters and cycloconverters, has allowed their use in draft fane, main line traction, servo drives, etc

2. How are the stator and rotor of the synchronous motor supplied?

   The stator of the synchronous motor is supplied from a thyristor power converter capable of providing a variable frequency supply. The rotor, depending upon the situation, may be constructed with slip rings, where it conforms to a conventional rotor. It is supplied with D.C. through slip rings. Sometimes rotor may also be free from sliding contacts (slip rings), in which case the rotor is fed from a rectifier rotating with rotor.

3. What is the difference between an induction motor and synchronous motor?

   An induction motor operates at lagging power factor and hence the converter supplying the same must invariable is a force commutated one. A synchronous motor, on the other hand, can be operated at any power factor by controlling the field current.

4. List out the commonly used synchronous motors.
   Commonly used synchronous motors are,
   a. Wound field synchronous motors.
   b. Permanent magnet synchronous motors
   c. Synchronous reluctance synchronous motors.
   d. Hysteresis motors.

5. Mention the main difference between the wound field and permanent magnet motors.

   When a wound filed motor is started as an induction motor, D.C. field is kept off. In case of a permanent magnet motor, the field cannot be 'turned off' .

6. Give the advantages and applications of PMSM.

   The advantages of PMSM are, a. High efficiency b. High power factor c. Low sensitivity to supply voltage variations. The application of PMSM is that it is preferred of industrial applications with large duty cycle such as pumps, fans and compressors.

7. Give the uses of a hysteresis synchronous motor.

   Small hysteresis motors are extensively used in tape recorders, office equipment and fans. Because of the low starting current, it finds application in high inertia application such as gyrocompasses and small centrifuges.

8. Mention the two modes employed in variable frequency control

   Variable frequency control may employ and of the two modes. a. True synchronous mode b. Self-controlled mode

9. Which synchronous machine is said to be self controlled?

   A machine is said to be self controlled if it gets its variable frequency from an inverter whose thrusters are freed in a sequence, using the information of rotor position or stator voltages. In the former a rotor position sensor is employed which measures the rotor position with respect to the stator and sends pulses to the thyristors. Thus frequency of the inverter output is decided by the rotor speed.

10. What is Commutator Less Motor (CLM)?

        The self controlled motor has properties of a D.C. Motors both under steady state and dynamic conditions and therefore is called commutator less motor(CLM). These machines have better stability behaviours. They do not fall out of step and do not have oscillatory behaviours, as in normal synchronous motors.

11. Give the application of self controlled synchronous motor.

        A self controlled synchronous motor is a substitute for a D.C. motor drive and finds application where a D.C. motor is objectionable due to its mechanical commutator, which limits the speed range and power output.

12. List out the advantages of load commutation over forced commutation.

        Load commutation has a number of advantages over forced commutation
- It does not require commutation circuits
- Frequency of operation can be higher
- It can operate at power levels beyond the capability of forced commutation.

13. Give some application of load commutated inverter fed synchronous motor drive.

        Some prominent applications of load commutated inverter fed synchronous motor drive are high speed and high power drives for compressors, blowers, conveyers, steel rolling mills, main-line traction and aircraft test facilities.

14. How the machine operation is performed in self-controlled mode?

        For machine operation in the self-controlled mode, rotating filed speed should be the same as rotor speed. This condition is realised by making frequency of voltage induced in the armature. Firing pulses are therefore generated either by comparison of motor terminal voltages or by rotor position sensors.

15. What is meant by margin angle of commutation?

        The difference between the lead angle of firing and the overlap angle is called the margin angle of commutation. If this angle of the thyristor, commutation failure occurs. Safe commutation is assured if this angle has a minimum value equal to the turn off angle f the thyristor.

16. What are the disadvantages of VSI fed synchronous motor drive?

        VSI synchronous motor drives might impose fewer problems both on machine as well as on the system design. A normal VSI with 180° conduction of thyristors required forced commutation and load commutation is not possible.

17. How is PWM inverter supplied in VSI fed synchronous motor?

        When a PWM inverter is used, two cases may arise the inverter may be fed from a constant D.C. source in which case regeneration is straight forward. The D.C. supply to the inverter may be obtained from a diode rectifier. In this case an additional phase controlled converter is required on the line side.

UNIT V DESIGN OF CONTROLLER FOR DRIVES

1. What is a closed loop control system?
   A closed loop system is mainly used to maintain constant speed operation. It is a system in which the output has control over the input.

2. What are the advantages of closed loop system?
   a. System protection.
   b. Greater accuracy
   c. Improved dynamic response
   d. Reduced effects of disturbances such as loading.

3. What are the basic blocks of a closed loop system of a dc motor?
   The system consists of a dc motor, power converter, feedback path, comparator and speed controller.

4. What are the two types of feedback in dc drive?
   i. Current feedback
   ii. Speed feedback

5. What is speed feedback?
   The motor speed can be sensed by any one speed sensor and this signal is compared with reference speed. This error signal is given to speed controller. The speed controller produce control signal to the power converter.

6. What are the two types of speed controller?
   a. Proportional controller
   b. Proportional Integral controller

7. What is current feedback?
   The motor current can be sensed by current transducer. This signal is compared with reference signal. The error signal is fed to the current controller produces a control signal. This signal is fed to the power converter for controlling the output.

8. What is armature voltage control?
   The dc motor sped can be varied by varying armature voltage and field voltage is constant. This voltage can be varied by using power converter. This method only applicable for below base speed.

9. What is field weakening control?
   The dc motor speed can be varied by varying the field current and armature voltage is kept constant. The field current can be controlled by using power converter. By using this method the motor field flux decreases i.e., field weakening mode. This method is only applicable foe speeds above base speed because speed is inversely proportional to flux.

10. What is the purpose of current control in dc drives?
    The current control loop is used for the purpose of limiting the transient over current

11. What happens if the control loop is without current loop?
    If inner current loop is not added in the control circuitry, transient over current is produced which is undesirable from the standpoint of converter rating and protection. This is particularly in case of starting or other large changes.

12. What are the main disadvantages of phase controlled converter fed dc motor drives?

The phase controlled rectifiers always consume reactive power. Due to this, they are expensive to operate where the reactive power is to be paid for. It also generates harmonics.

13. What is the advantage of using PI type speed controller?

The addition of an integral feedback can be used to eliminate the steady-state error and to reduce the forward gain required.

14. Which type of converter can be selected if the input is ac?

When the input is ac, the dc motor can be operated from rectifiers. If the motor ratings are low, we can use single phase controlled rectifiers and for high ratings, three phase controlled rectifiers are used.

15. What is the advantage of closed torque control scheme?

It finds application in battery operated vehicles such as electric trains.

16. What is the use of current limiter in the closed loop control system?

It saturates and sets current reference for inner current loop at a value corresponding to the maximum allowable current.

17. What are the advantages of using PI controller in closed loop controller of dc drive?
- Stabilize the drive
- Adjust the damping ratio at the desired value
- Makes the steady state speed error close to zero by integral action and filters out noise again due to the integral action.