

UNIT – II - STEPPER MOTORS

1. What is stepper motor?

A stepper motor is a digital actuator whose input is in the form of programmed energization of the stator windings and whose output is in the form of discrete angular rotation.

2. Define step angle.

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

$$\beta = (N_s - N_r / N_s \cdot N_r) 360 \quad (\text{or}) \quad 360 / (mNr)$$

3. Define slewing

The stepper motor operates at very high speed is called slewing angle. i.e. (25000 steps per sec).

4. Define resolution

It is defined as the no. of steps needed to complete one revolution of the shaft.

Resolution = no. of steps / revolution

5. Mention some applications of stepper motor

- i. floppy disc drives
- ii. quartz watch
- iii. camera shutter operation
- iv. dot matrix and line printers
- v. small tool application
- vi. robotics

6. What are the advantages and disadvantages of stepper motor?

Adv:

- 1. it can be driven in open loop without feedback
- 2. it is mechanically simple
- 3. it requires little or no maintenance.

Disadv:

- 1. low efficiency

- 2.fixed step angle
- 3.limited power output

7. Define holding torque.

Holding torque is the maximum load torque which the energized stepper motor can withstand without slipping from equilibrium position

8. Define detent torque

Detent torque is the maximum torque which the unenergised stepper motor can withstand without slipping.it is also known as cogging torque.

9. What is meant by full step operation?

Full step operation or single phase on mode is the one in which at a time only one phase winding is energized, due to which one stator winding is energized and causes the rotor to rotate some angle.

10. What is meant by two phase mode of operation?

Two phase on mode is the one in which two phase windings are energized at a time, due to which two stator windings are energized and causes the rotor to rotate through some angle.

11. Define pull in torque.

It is the maximum torque the stepper motor can develop in start - stop mode at a given stepping rate F_s (step/sec) without losing synchronism.

12. Define pull out torque.

It is the maximum torque the stepper motor can develop in slewing mode at a given stepping rate F_s (step/sec) without losing synchronism.

13. What is synchronism in stepper motor?

It is the one to one correspondence between the number the number of pulses applied to the stepper motor and the number of steps through which the motor has actually moved.

14. Define mid frequency resonance in stepper motor.

The phenomenon at which the motor torque drops to a low value at certain input pulse frequencies.

15. Define static stiffness.

It is a measure of ability of the actuator to resist disturbing torques and forces and thereby to maintain position. it is defined as

$$S = \text{torque} / \text{rad}$$

16. Give the types of driver circuits.

- Resistance or L/R drive
- Dual voltage or bilevel drive
- Chopper drive

17. What is multi stack VR motor

Multi stack VR motor is the one in which the stepper motor has three separate magnetically nisolated sections or stacks. here the rotor and stator teeth are equal.

18. What is meant by micro stepping in stepper motor.

The methods of modulating currents through stator windings so as to obtain rotation of stator magnetic field through a small angle to obtain micro stepping action is known as micro stepping.

19. What are the advantages of micro stepping?

- Improvement in resolution.
- Dc motor like performance
- Elimination of mid frequency resonance
- Rapid motion at micro stepping rate.

20. Define bandwidth in stepper motor.

It is a measure of the frequencies upto which the actuator or servo motor system can respond.

UNIT-2

Stepper Motor.

1. Explain the construction & various modes of excitation of VR stepper motor.

Stepper motor:-

It is a brushless dc motor whose rotor rotates in a discrete angular displacement when its stator winding are energized in a sequence manner.

Variable reluctance principle:-

VR stepper motors have no permanent magnet, so the rotor spins freely w/o "detent" torque.

This type of motor is used frequently in small sizes for applications such as micro-positioning tables.

VR stepper motors are seldom used in industrial applications (having no PM). They are not sensitive to current polarity & require a different driving arrangement than the other motor types.

Modes of operation:-

- One phase 'on' mode
- Two phase 'on' mode
- Alternate one phase & two

→ Diagram
→ explanation

phase on mode.

→ Microstepping

Full step mode operation:-

For each pulse the rotor moves 30° .

Hence this mode of operation is also called as full step mode operation.

Half-stepping mode:-

For each pulse the rotor moves 15° , but step angle of motor as per design is 30° , hence this mode of operation called as half-stepping mode.

2) Explain the construction of various modes of excitation of PM stepper motor.

PM stepper motor is differs from VR stepper motor (ie) the rotor is permanent magnet in PM stepper motor. The stator construction is same in both motors.

Modes of operation:-

- 1-phase on mode
- 2-phase on mode
- Half Step mode

Diagram
Explanation

3. Explain the construction & working principle of Hybrid stepper motor.

It combines the features of VR stepper motor & PM stepper motor.

Construction - Diagram, Explanation

Stator \rightarrow It has 4 projected pole wound with exciting coil.

Rotor \rightarrow At one end it has 3 projected North pole, At another end it has 3 projected South pole.

The direction of rotation can be change by changing the sequence of excitation.

4.) State & explain the static & dynamic characteristics of a stepper motor.

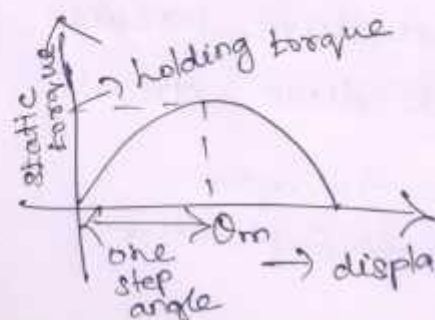
Static characteristics:-

The characteristics relating to stationary motors are called static characteristics.

\rightarrow Torque-angle characteristics

\rightarrow T-I characteristics

T- ϕ

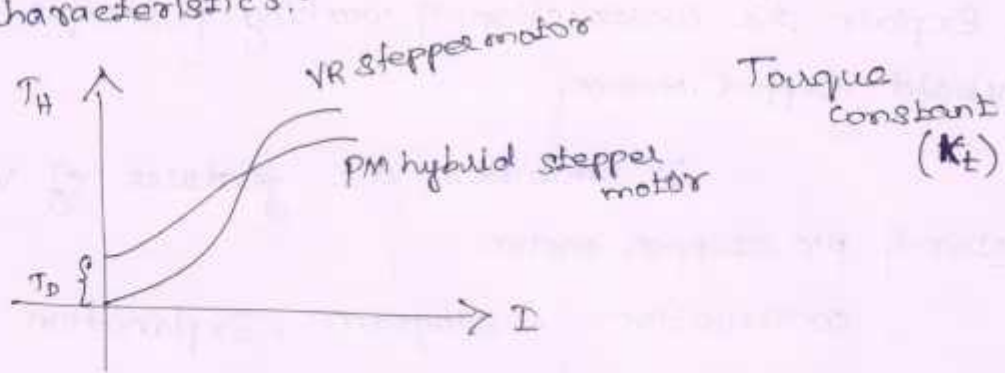


\rightarrow Holding torque (T_H)

\rightarrow Detent torque (T_D)

θ from an equilibrium position

T-I characteristics:-

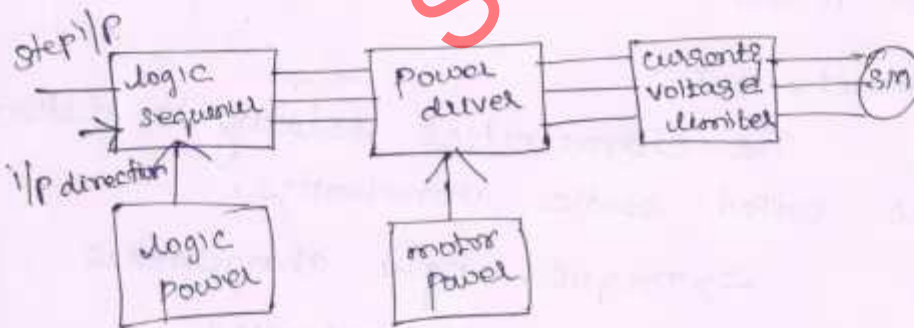


6) Explain the mechanism of torque production in VR stepper motor.

$$T = \frac{1}{2} i^2 \frac{\partial L}{\partial \theta} \quad \text{N-m}$$

5) Explain in detail about different types of power drive circuits for stepper motor. (or)

7) Draw any two drive circuits for stepper motor



Power driver circuits:-

unipolar drive circuits

Bipolar drive circuits

→ Diagram

→ Explanation