Experiment No. 7 **Date:**

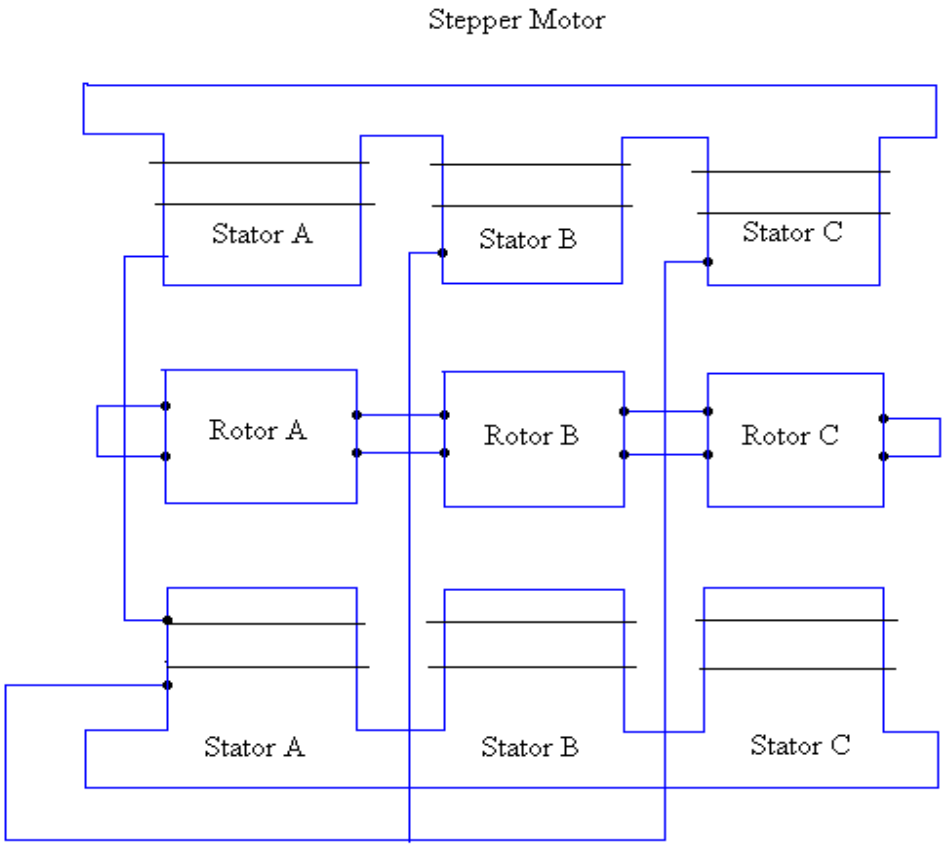
Aim:

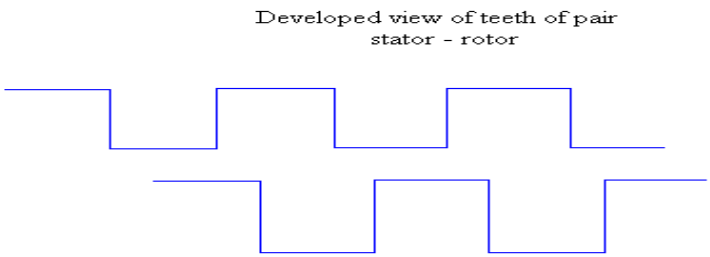
Study of Stepper motor.

Apparatus:

Stepper motor, wires, power supply etc.

Diagram:





Theory:

A stepper motor is low speed high torque which characterizes itself with a number of unusual features. A stepping motor when supplied with these pulses will move the load attached to its shaft through a distance proportional to the time integral of the signal.

Types of Stepper Motor:-

A) 3 lead.

B) 4 lead.

C) 5 lead.

A) 3 Lead Types:

This require a center tapped D.C. power supply & single pole double switching as shown in fig. it take 200 steps to make one revolution of rotor. In this case each switching action rotates the shaft by one step of 1.8^0.This error is not cumulative & is same when run at any speed within its limit. The O/p torque decrease as increasing stepping rate. Torque can increase by inserting a resistance in series with each winding. Fig shows torque Vs speed characteristics.

Types of Stepper Motor Construction:

There are 3 basic types

1. Permanent magnet
2. Variable reluctance
3. Hybrid

1. Permanent Magnet Motor

As name suggest this have a permanent magnet rotor. Rotor has 2 identical discs with a permanent magnet between them. It has teeth, the nb. of which decides the degree of angular movement of the shaft per switching pulse. Stator has 2 phase winding. When supplied with two phase a.c. supply a rotating magnetic field produced which make the permanent magnet rotor to rotate. In D.C. operation pulses are applied to each stator winding creating a magnetic field. By changing the exciting sequence, the motor can be made to rotate in the clockwise or anticlockwise direction. Hence it is bidirectional motor. This motor can have single winding coil per phase or two winding per phase.

2. Variable Reluctance Motor:

It is made of soft iron with negligible residual magnetism & has nb. of pole teeth differing from that for the stator. When pulses are applied to coil on stator the rotor tries to seek a position of min. reluctance & moves by a step of angle which depends on stator & rotor pole number. Torque is produced by electromagnetic flux.

3. Hybrid Motor:

These combines the above two types of motor. It has a rotor comprising or axially magnetized permanent magnet with two cup shape end piece with axial teeth. The number of rotor & stator teeth governs the stepping angle.

Sr.No		Permanent magnet	Variable Reluctance	hybrid
1	Max. pulse rate/ sec	400	1000	20000
2	Stepping angle	40-120	1.8-30	0.9-15
3	Max. torque	0.3-20	30-40	0.15-8
4	Inertia Kg-m^2	1-20	2-200	3-4000

Terminology Used In Stepper Motor:

1. Step Angle:

The specific degree of rotation on increment is called the step angle. It specifies in degrees. Normally it is 0.9 degree

2. Step per Revolution:

Total number of steps required for the o/p shaft to rotate through 360^o or one complete revolution. This can calculate as 360/step angle.

3. Steps per Second:

Number of angular moments accomplish by motor in one second. It corresponds to pulse rate.

4. Step Accuracy:

This defines as positional accuracy tolerance. This is expressed in % and indicates total error introduced by motor.

5. Holding Torque:

The amount of torque from an external source required to break away the shaft from its holding position.

6. Residual Torque:

This ratio is determined by dividing the rated holding torque of the motor by its inertia.

7. Step Response:

With a pulse to move motor, it should response in specific time. This "time for a single step " is called as step response.

8. Drives:

This used to define a circuitry which controls the stepping motor& usually consist of power supply.

9. Ramping:

The process of controlling pulse frequency to accelerate the rotor from zero speed to max. speed as well as de-accelerate the rotor is called ramping.

10. Slew Rate:

An area of high speed operation where the motor can run unidirectional in synchronism. A stepper motor is brought up to slewing rate using acceleration & is then de-accelerate to stop under condition whereon step loss can be tolerated.

11. Damping:

The reduction or elimination of step overshoot is defined as damping. Used where setting down time is important.

Truth table:

Clockwise Direction:

Step	A1	B1	A2	B2
1	1	1	0	0
2	0	1	1	0
3	0	0	1	1
4	1	0	0	1
5	1	1	0	0

Application:

1 Remote control of dimmerstat, potentiometer

2. Controlled machine tool & robots.

3. Punched tape drives.

4. As variable speed drives.

5. Paper feed drive to recorder.

6. Drive for electronic sweep generator.

7. Curve tracer.

Procedure:

1. C,M,R, i/p are to be connected from auto operation block

2. Make power on to the unit.

3. Keep clock speed min.

4. Study o/p pulse pattern & verify truth table.

5. Keep FW/REW switch on reverse position & observe the o/p pulse pattern.

6. Count total number of steps for one complete revolution & hence calculate the step angle.

7. Press reset switch & observe that the motor stops.

Conclusion: