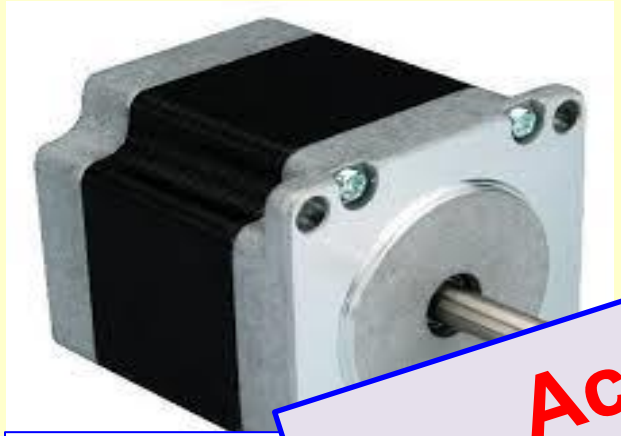
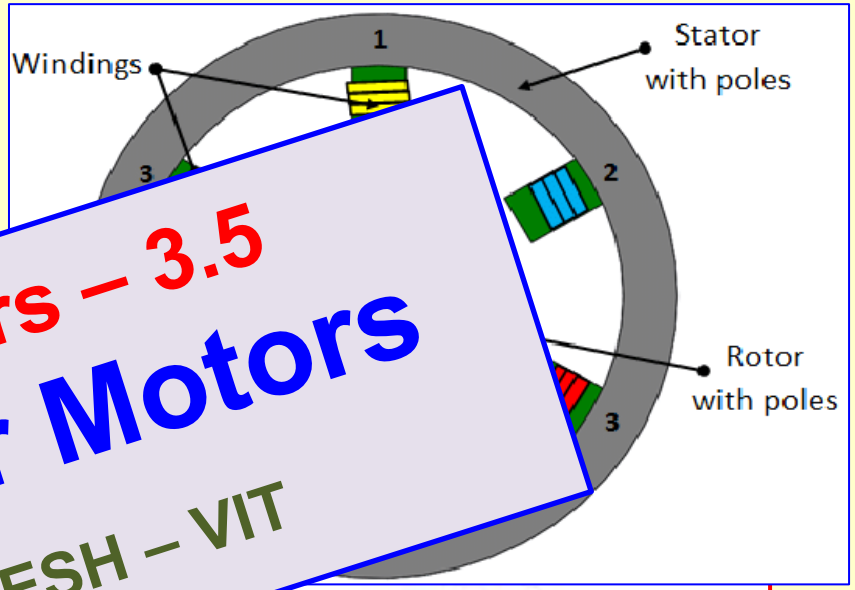
Vishwakarma Institute of Technology

FY - Department of Engineering, Sciences and Humanities

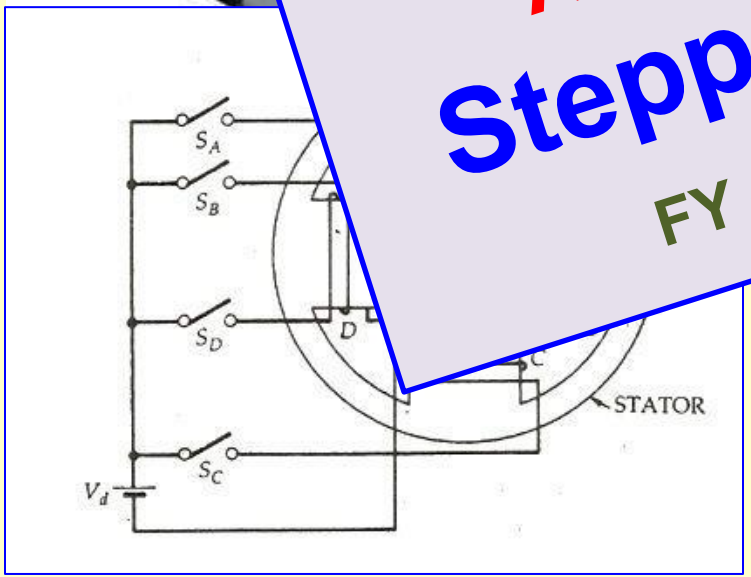




Actuators – 3.5

Stepper Motors

FY – DESH – VIT



What is a Stepper Motor ?

- ✓ How does a robotic arm in manufacturing unit repeats exact same movement over and over?

- ✓ How does an automated machine move with precision?

- ✓ Answer is:
- ✓ Using Stepper Motors

What is a Stepper Motor ?

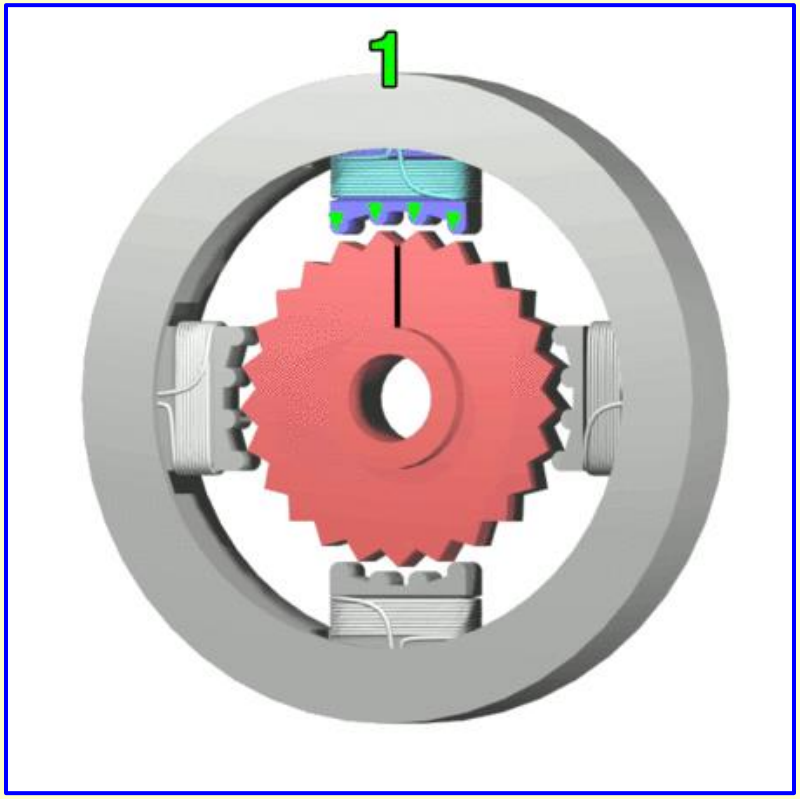
✓ Basic difference between Stepper motor and any other motor is that it runs in discrete steps rather than a continuous rotation.

Important features of Stepper Motor –

✓ Works on a train of pulses sent at a particular frequency.

✓ The pulses are square shaped.

✓ For each pulse, the rotor rotates through a specific degrees.

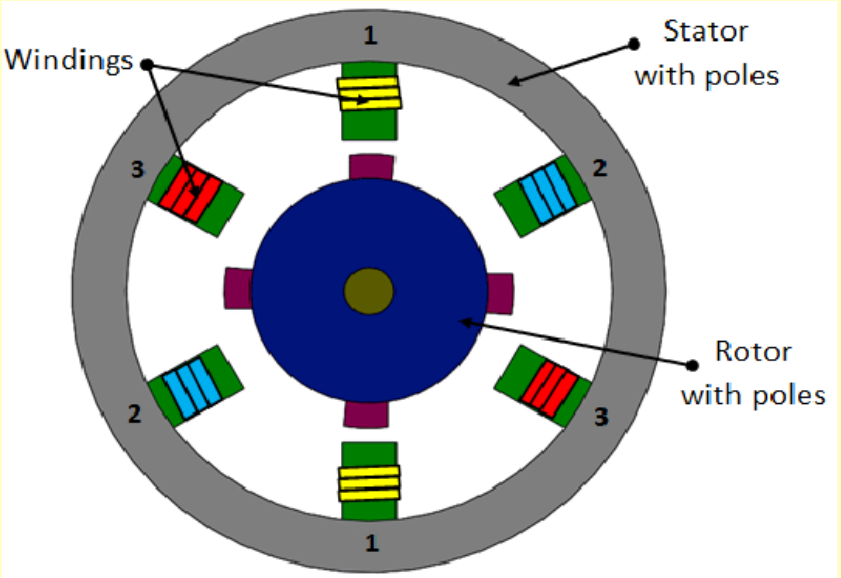


Important features of Stepper Motor …. contd.–

- ✓ The angle through which the shaft rotates for one pulse given, is called as the step angle of the motor.
- ✓ If the pulses are sent at a faster rate, the speed of the motor increases.
- ✓ At higher pulse rates, the motor runs smoothly almost like a normal DC motor.
- ✓ As the speed is a function of the number of pulses sent, accurate positioning of the shaft (rotor) can be done.
- ✓ Stepper motors are very much compatible with digital devices like computers.

Types of Stepper Motors –

1) Variable Reluctance type –
2) Permanent Magnet type –
3) Hybrid type –

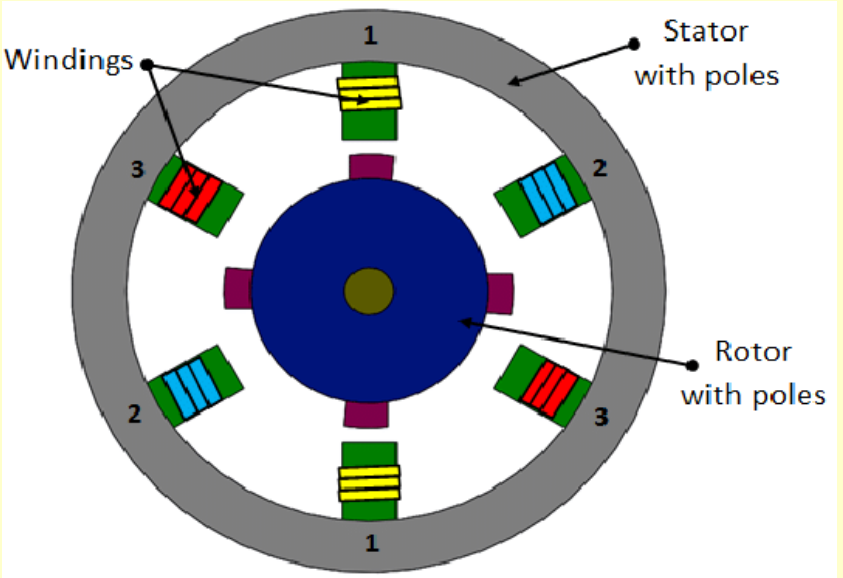


1) Variable Reluctance type – Features…

- The rotor is made up of stack of steel laminations.
- The number of poles on the stator and rotor are different.
- The stator is generally wound for 3 phases with 6 poles.
- Stator poles can be switched ON and OFF using a circuit.
- The rotor is made of magnetic material from steel laminations.

Types of Stepper Motors –

1) Variable Reluctance type



It uses , Simple , Accurate and Open loop system

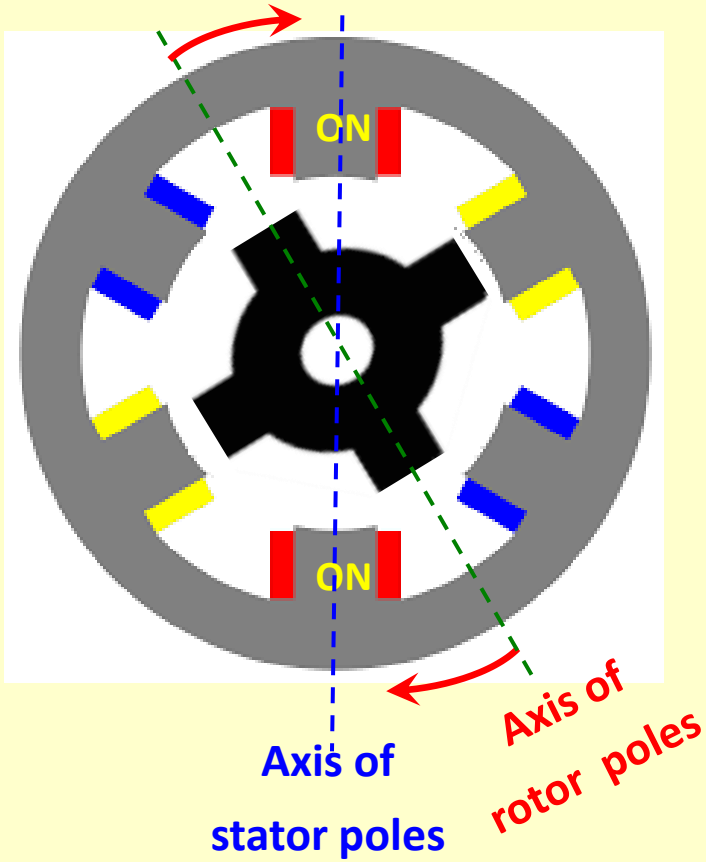
- ✓ 6 Stator Teeth
- ✓ 4 Rotor Teeth
- ✓ 3 coils 1-1, 2 - 2 & 3 - 3 Energized with 03 Power sources

- ✓ Lets consider a stepper motor with 4 Rotor teeth 6 Stator teeth Intentionally rotor teeth are kept less, so as one pair of rotor teeth is aligned with one stator pair at a time.

Stepper Motor

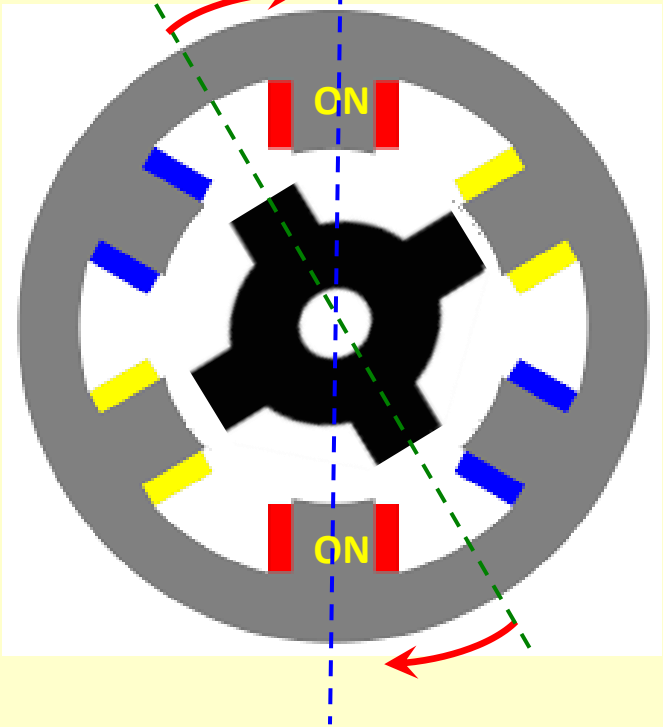
1) Variable Reluctance type –

The rotor tries to move in such a direction so as to achieve a minimum reluctance position.

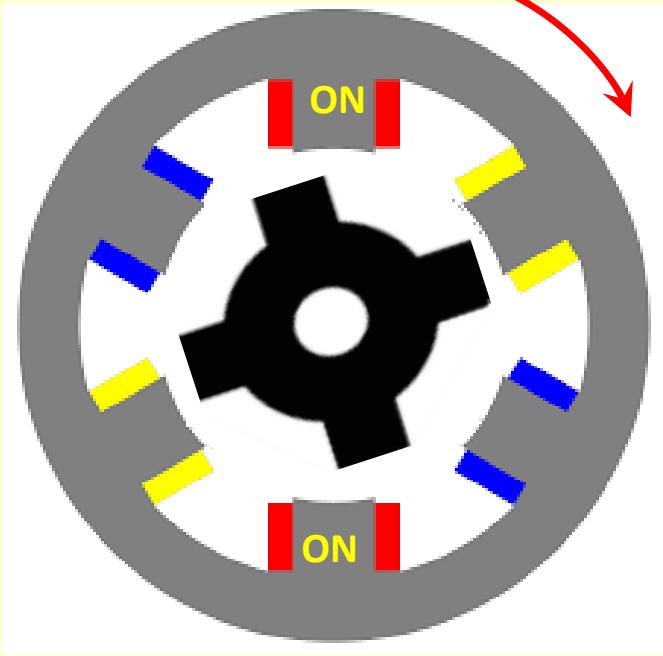


When the rotor approaches the Red phase axis, it is switched OFF and Yellow phase is excited.

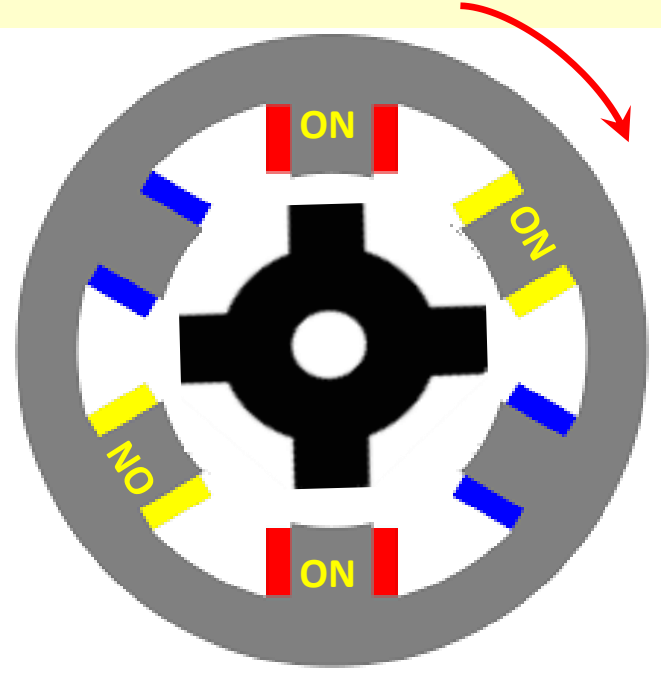
Stepper Motor



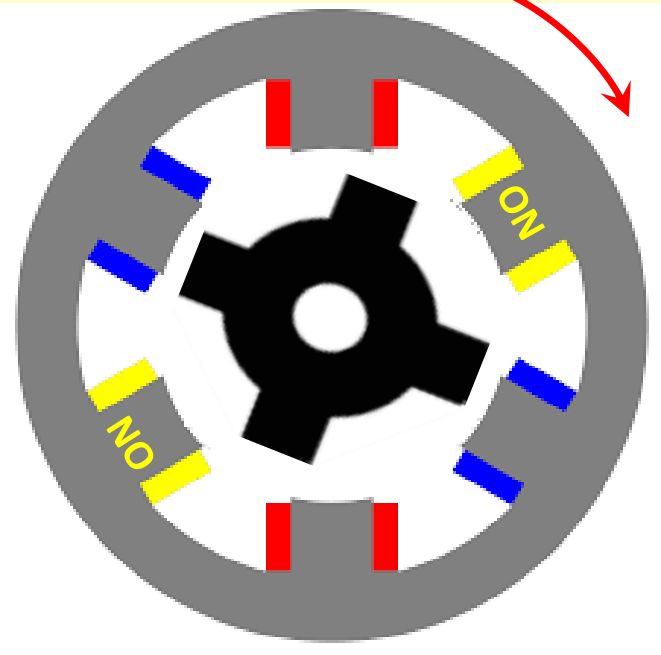
Stepper Motor



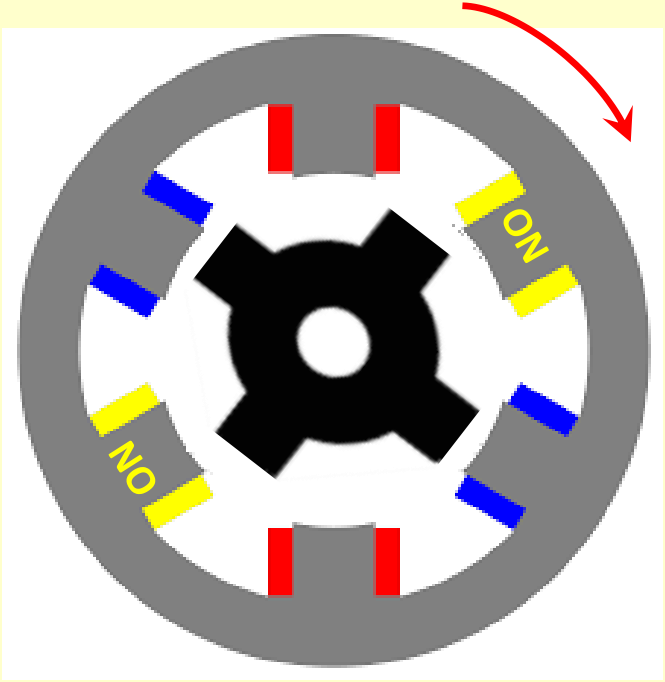
Stepper Motor



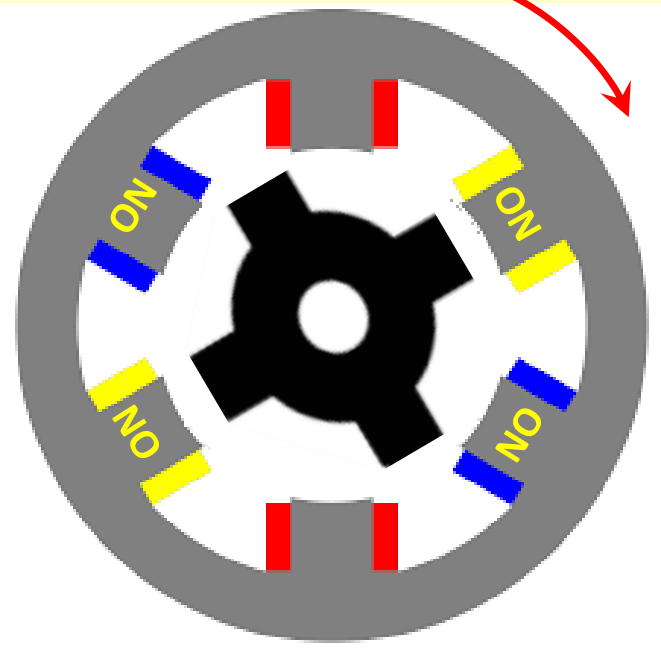
Stepper Motor



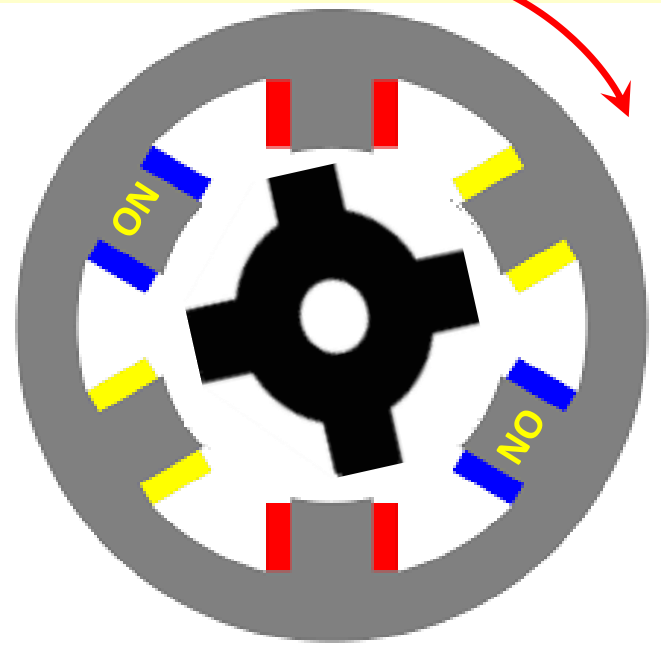
Stepper Motor



Stepper Motor

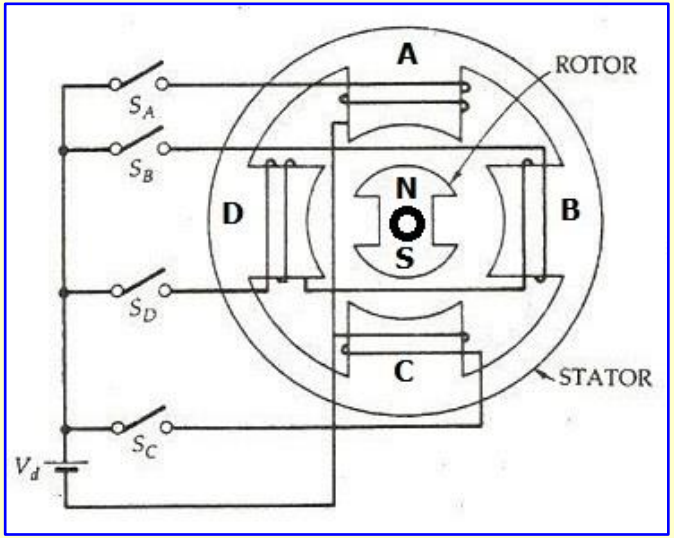


Stepper Motor



Types of Stepper Motors –

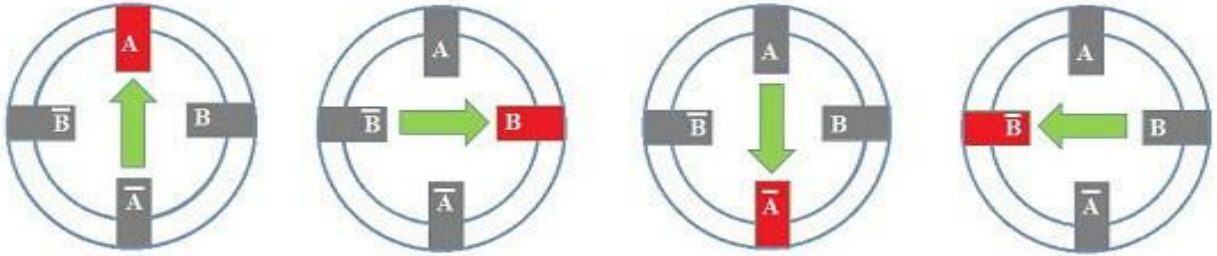
1) Variable Reluctance type –
2) Permanent Magnet type –
3) Hybrid type –



2) Permanent Magnet type – Features…

- There are poles on the stator which can be magnitised.
- Polarity of the stator poles can be changed using a driver circuit.
- The rotor has 2 permanent poles on it. (Cylindrical or projected pole type)
- That is why called as Permanent Magnet motor.
- S_A, S_B etc. are electronic switches which are controlled by a driver circuit.

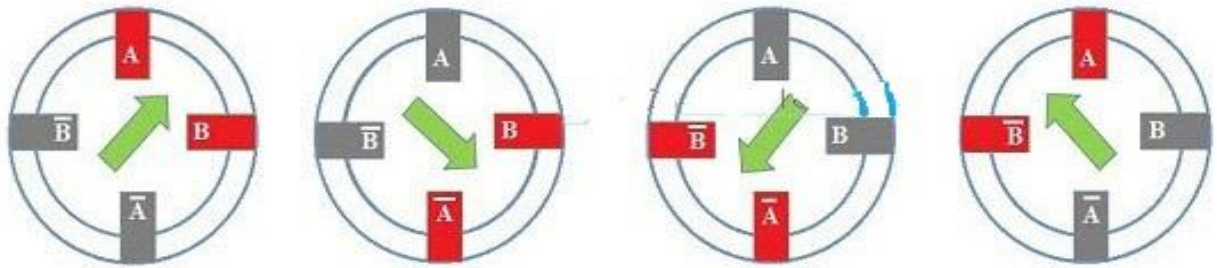
Full Step - One Phase ON



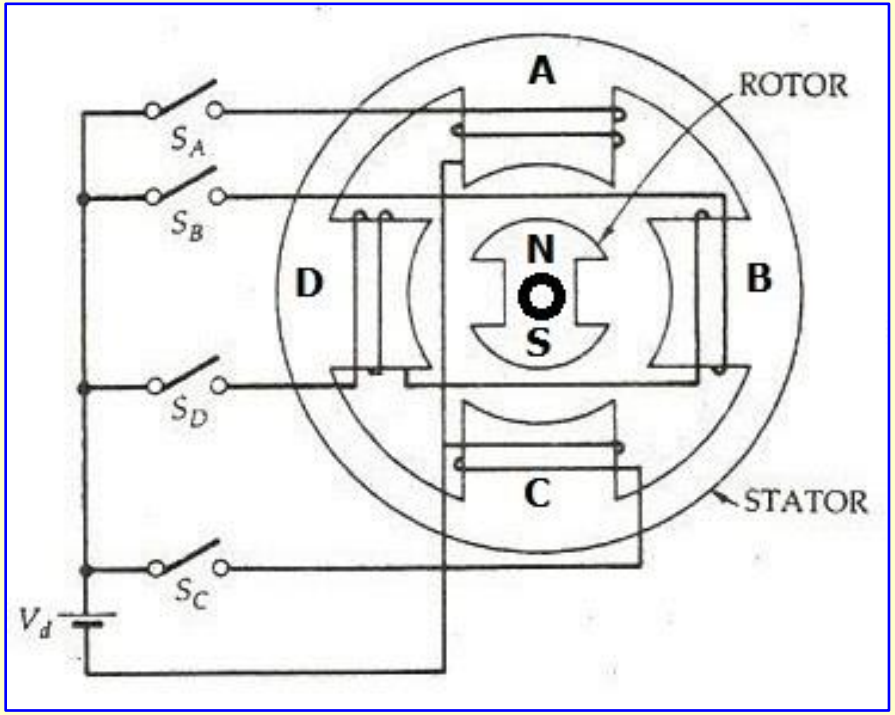
Step	Phase			
	A	B	$\overline{A}$	$\overline{B}$
1	1	0	0	0
2	0	1	0	0
3	0	0	1	0
4	0	0	0	1

What is the direction of rotation of this motor ?

Full Step - Two Phase ON



Step	Phase			
	A	B	$\overline{A}$	$\overline{B}$
1	1	1	0	0
2	0	1	1	0
3	0	0	1	1
4	1	0	0	1

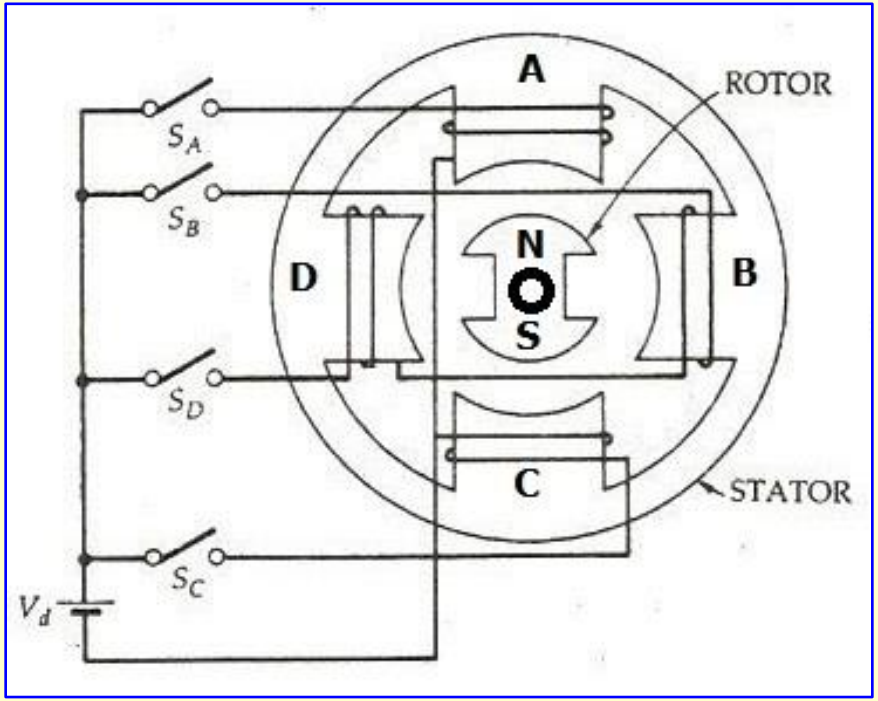


Sequence	Motor coils			
	A	B	C	D
Step 1	0	0	0	1
Step 2	0	0	1	0
Step 3	0	1	0	0
Step 4	1	0	0	0

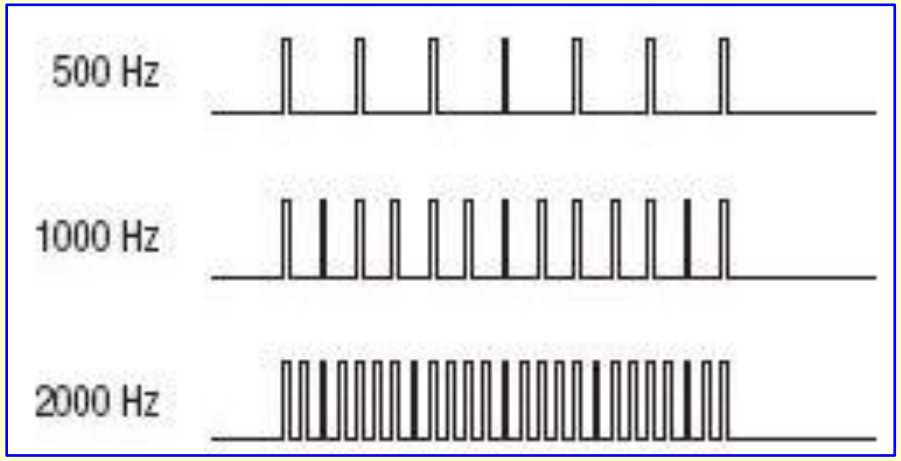
What is the direction of rotation of this motor ?

How much is the step angle ?

How to reduce the step angle to half of the present value ?



sequence	Motor coils			
	A	B	C	D
Step 1	0	0	0	1
Step 2	0	0	1	1
Step 3	0	0	1	0
Step 4	0	1	1	0
Step 5	0	1	0	0
Step 6	1	1	0	0
Step 7	1	0	0	0
Step 8	1	0	0	1



Assume step angle as 0.9 deg.

Find the speed of the motor for the given pulse frequencies

Solution –

500 Hz = 500 pulses per second.

For every pulse rotor goes through 0.9 deg.

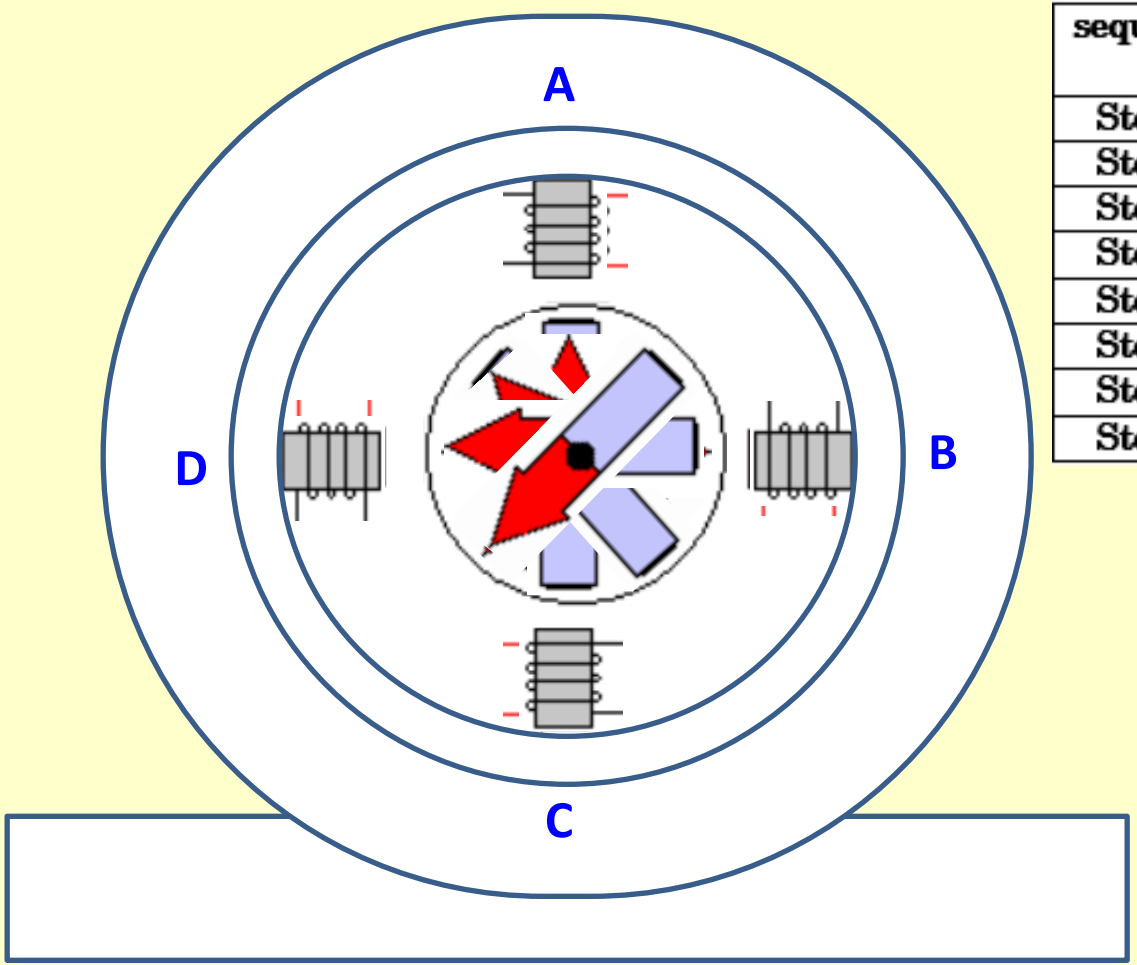
Thus, for 360^0 to rotate, the motor needs

360/0.9 = 400 pulses.

For 1 rotation it will need 400 pulses. i.e. when 400 pulses are given, the motor will complete 1 rotation in 1 second.

But, 500 pulses are given in 1 second.

So, 1.25 Rev per sec. i.e. **Speed = 75 RPM**



sequence	Motor coils			
	A	B	C	D
Step 1	0	0	0	1
Step 2	0	0	1	1
Step 3	0	0	1	0
Step 4	0	1	1	0
Step 5	0	1	0	0
Step 6	1	1	0	0
Step 7	1	0	0	0
Step 8	1	0	0	1

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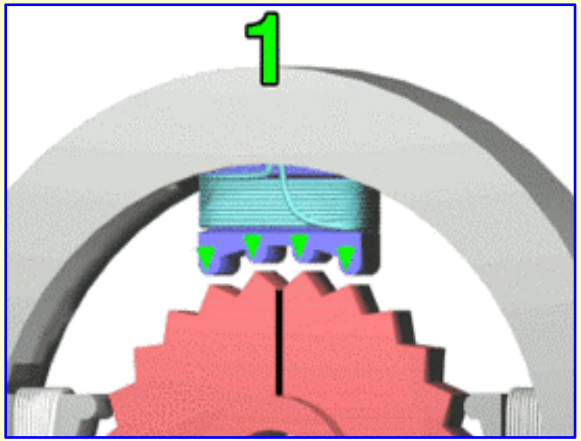
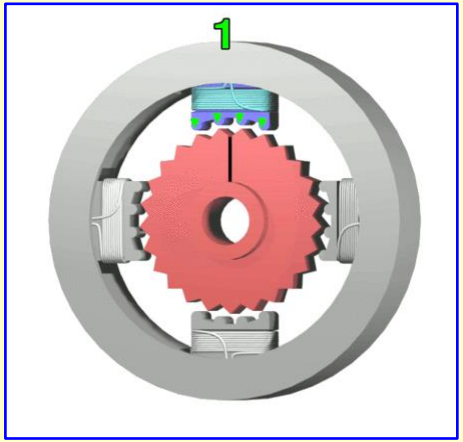


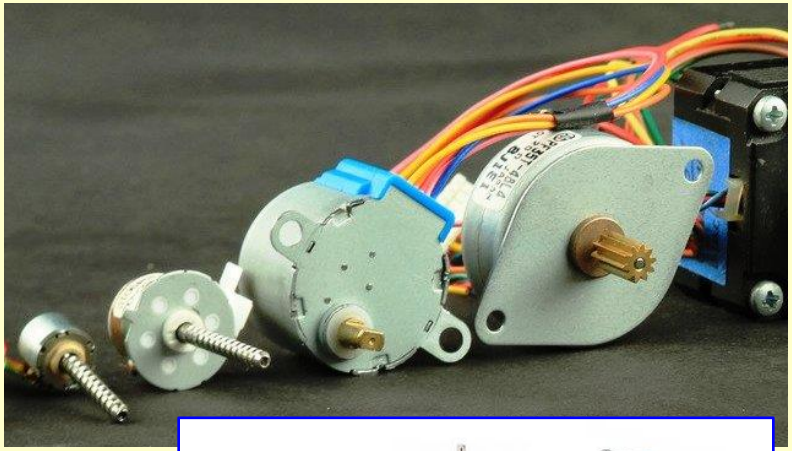


3) Hybrid type – Features…

- Both principles of Variable reluctance and Permanent magnet are used.
- The stator has slots on it which offers variable reluctance.
- The rotor is a permanent magnet with slots on it.
- Minimum reluctance location is searched by rotor during rotation.
- Micro-stepping for more precision and resolution is possible.
- Smooth operation.

Applications of Stepper Motors – Medium and Low power

- Robotics and Automation
- Material handling
- Printers, Photocopy machines
- Floppy / DVD disc drives
- XYZ positioning
- Scanners
- IC manufacturing Hi-Tech equipment
- Medical equipment
- Process control systems
- ATM
- Security cameras
- Air conditioners ….. and many more….



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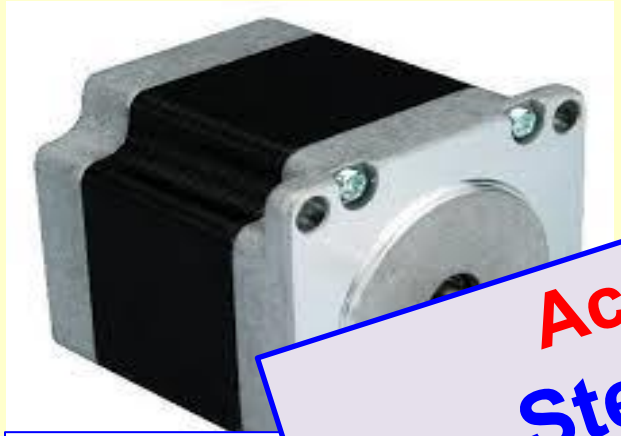
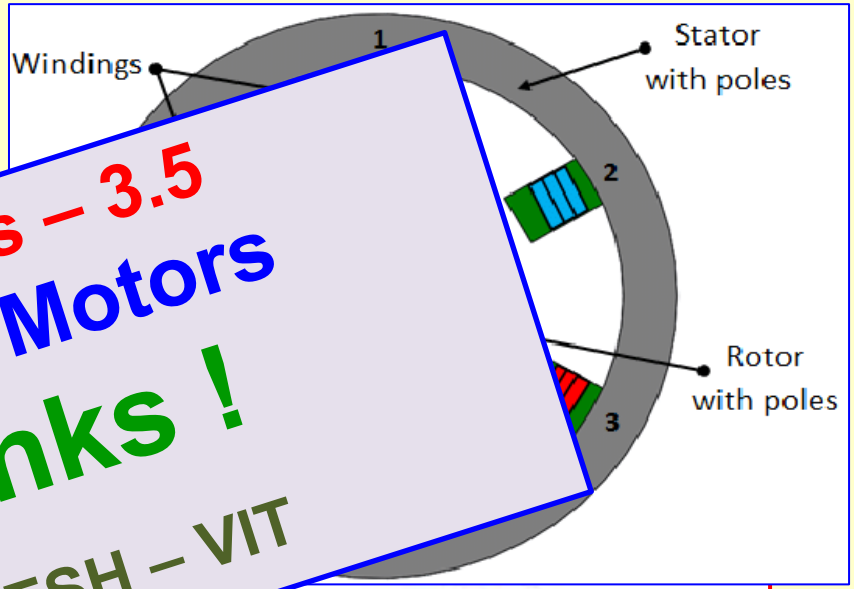
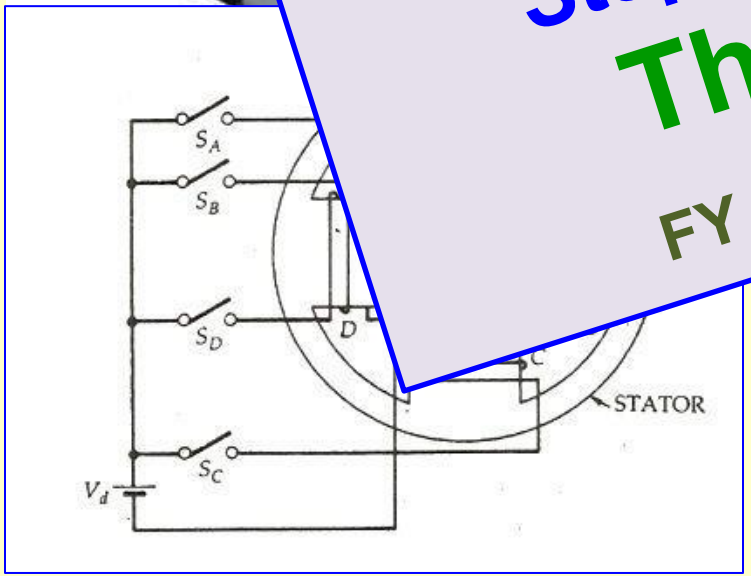




Actuators – 3.5

Stepper Motors

Thanks !

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