

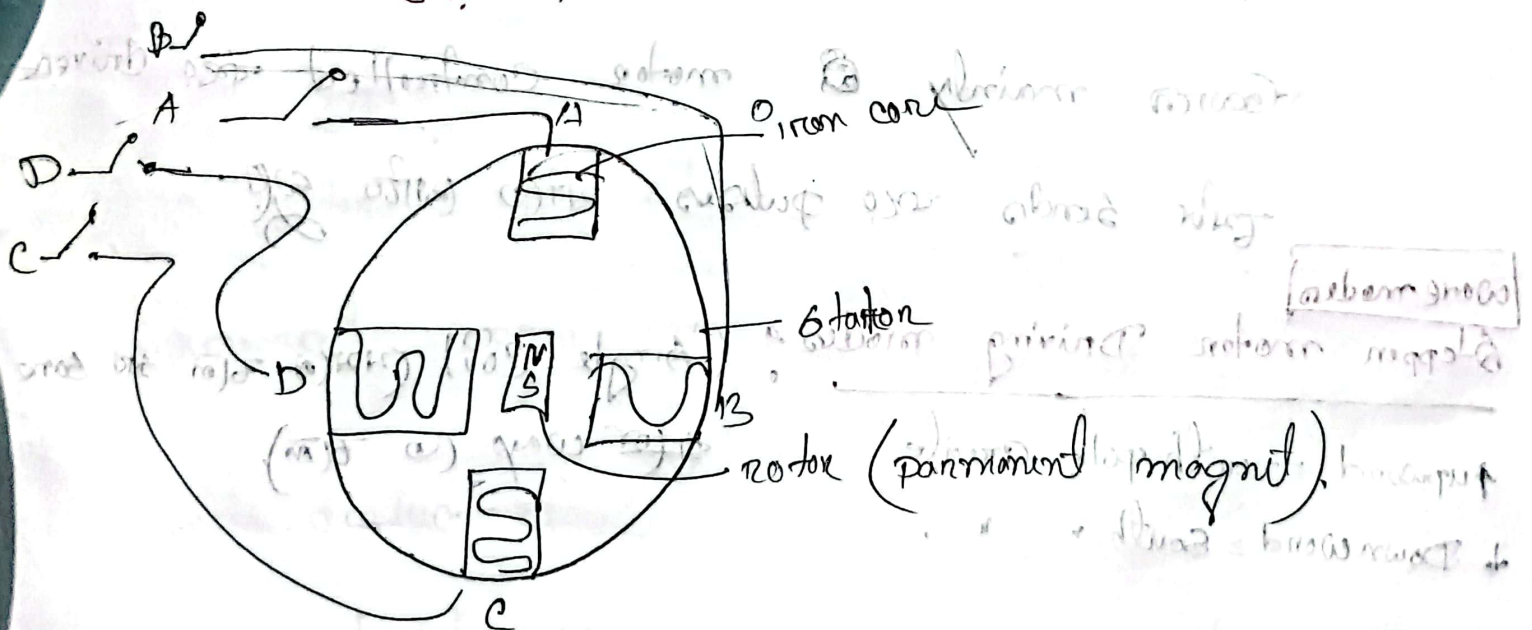
Seg 2

Stepper motor & synchronous motor.

- A stepper motor is an electric motor and have a stationary part (the stator) and moving part (the rotor).
- Rotates by performing steps. Moving fixed amount of.

Diagram: [Stepper motor rotate by stepwise]

Can speed and torque in 2/1.



Def: It rotates in a series of small angular steps. It rotates continuously.

Working Principle

କାରଣ ଅନ୍ୟମାନ pole କାରଣରୁ ~~ଅନୁପ୍ରାପ୍ତ~~ energized ବା

powered

ଯାଏ ନା, ଆଉ କାରଣରୁ ଅନ୍ୟ step ଦ୍ୱାରା Control ବା

ଯାଏ, କାରଣ Stepper motor କାର୍ଯ୍ୟକାରୀ ଏକ cycle

Complete କରି 200 steps ମଧ୍ୟ ଗ୍ରହଣ ହୁଏ, ଏହା

Step $\theta = \frac{360}{200} = 1.8^\circ$ Step angle ବା θ ଏହା Max^m

୨୦° ମଧ୍ୟ step angle ବା θ ଏହା, Min^m step

angle 0.72° , Max^m 90°

କାରଣ mainly ଏହି motor controlled ବା Driven

ହାତର sends ବା pulses ଆଉ କାର୍ଯ୍ୟ ହୁଏ.

Wave mode

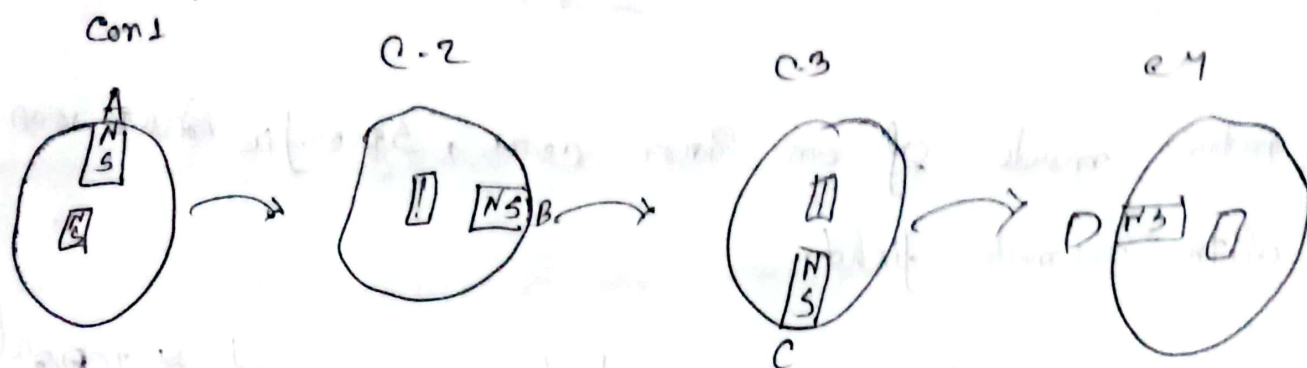
Stepper motor Driving modes: (Single coil ମଧ୍ୟରେ ଚଳିବା ବା same

↑ upward = north pole create) - ~~ଅନ୍ୟ~~ way (ବା ଚଳିବା)

↓ Downward = South " " "

• here 1. phase is powered at a time. If (A) coil is powered then (N) and (S) is created here. As a result the motor is aligned with magnetic field generated by the coil.

when magnetic field create zero flux then



go clockwise direction.

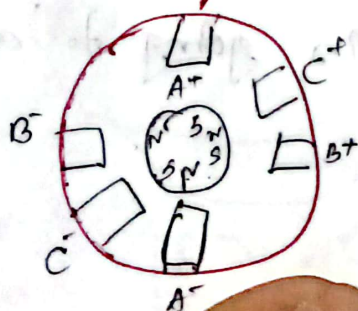
Same zero B, C, D etc.

Main things here when A on B, C, D off
 B on A, C, D "
 C " A, B, D "
 D " A, B, C "

Stepper Motor types

Stepper motor 3 types of rotors.

- ① permanent magnet motor
- ② Variable reluctance
- ③ ~~hybrid~~ hybrid motor



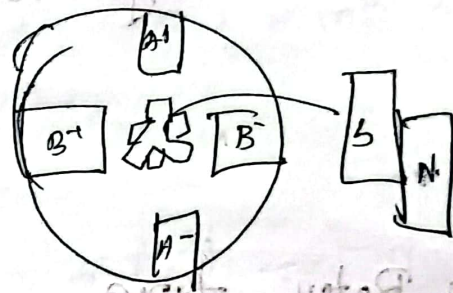
It aligns with magnetic field.
 that generated by the stator circuit.
 good torque so motor resist.
 if not strongly to change of.
 position regardless of weather
 a coil is powered
 Drawback is lower speed.
 lower resolution.

① Variable reluctance Stepper motor:

- this motor made of an iron core, specific shape can align with magnetic field.
- it is easier to reach a higher speed & resolution.
- but torque is lower, no detent torque.

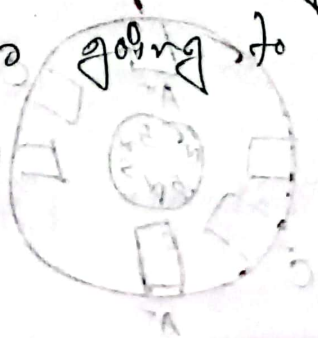
② Hybrid Stepper motor:

- here specific construction and it has between permanent magnet and variable reluctance version.



- It has 2 caps with alternating teeth and is magnetized axially.
- It allows the motor have high resolution, speed and torque.

Stator: It is responsible for creating the magnetic field with which the motor is going to align.

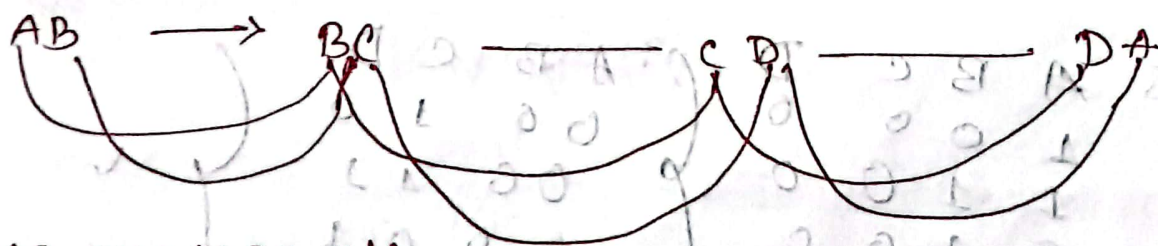
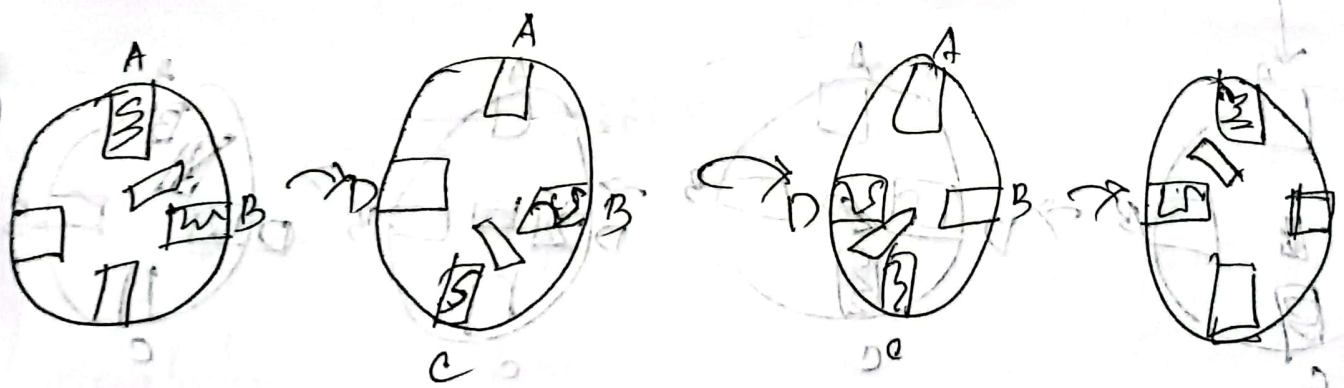


• Full step mode [Stepper motor driving modes]:

- here angle is like in wave mode
- here 2 phases are always ~~one~~ powered at the same time. here step are like in wave mode.

[If] A B is powered then N and S pole created here then 1 rotor is aligned with the magnetic field generated by the coil]

- here the motor is able to produce a higher torque since more current is flowing in the motor so strong magnetic field is generated.



Step 1: AB ON, BC OFF
 Step 2: BC ON, DA OFF
 Step 3: CD ON, AB OFF
 Step 4: DA ON, BC OFF

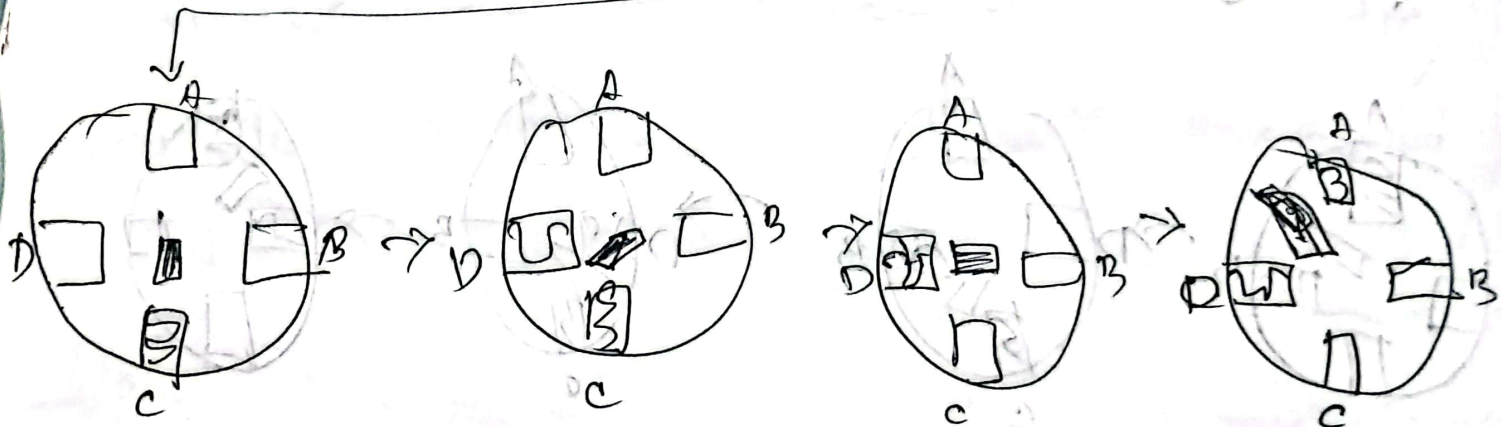
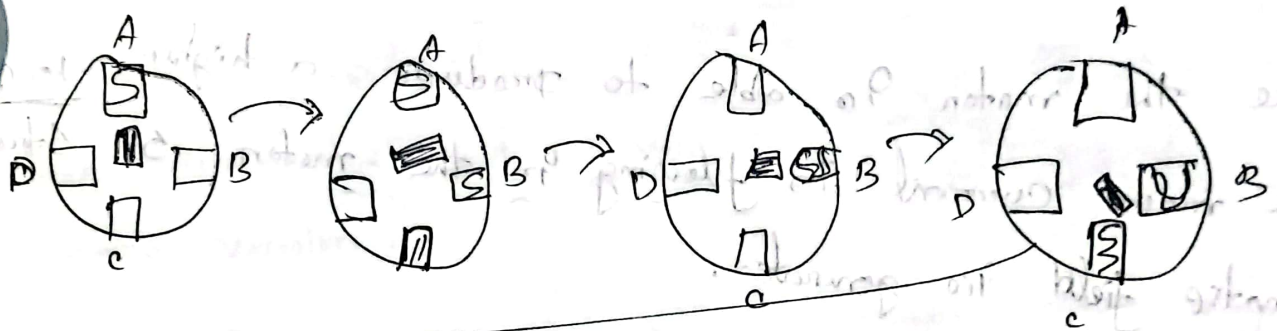
Half step Driving mode.

It is the combination of wave and full step.

here step size reduced by half $(90 \cdot \frac{1}{2}) = 45^\circ$

Drawback: torque produced by the motor is not constant

when 2 phase are energized θ is higher, one phase is energized then θ is weaker



truth table

A	B	C	D
1	0	0	0
1	1	0	0
0	1	0	0
0	1	1	0

A	B	C	D
0	0	1	0
0	0	1	1
0	0	0	1
1	0	0	1

calculation of step angle. - (Stepper motor)

$$\beta = \frac{N_s - N_r}{N_s N_r} \times 360^\circ$$

Labels:
 - N_s : Stator poles (teeth)
 - N_r : rotor poles (teeth)
 - β : step angle

$$\text{resolution} = \frac{360^\circ}{\text{step angle}}$$

$$\frac{\text{No of steps}}{\text{revolution}}$$

← 360°

Q. A motor has 8 main poles which have 5 teeth each. If rotor 50 teeth. calculate step angle and resolution.

Ans. here $N_r = 50$ teeth

$N_s = (8 \times 5) = 40$ teeth (main & 1/2 stator)

$$\beta = \frac{N_s - N_r}{N_s \cdot N_r} \times 360^\circ = \frac{50 - 40}{50 \cdot 40} \times 360^\circ$$

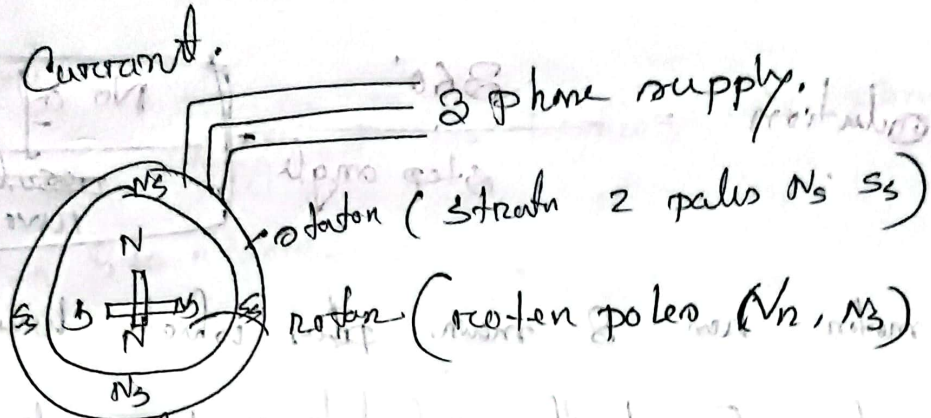
$$\beta = -1.8^\circ$$

$$\text{resolution} = \frac{360^\circ}{\text{step angle } (\beta)}$$

$$= \frac{360^\circ}{1.8} = -200 \text{ steps/revolution}$$

Synchronous Motor

Synchronous motor is an AC motor where the rotation of the motor is synchronized with the frequency of the supply current.



- Clockwise stator rotation
- rotor w/ voltage Φ_{ind} NP space create 2V

Synchronous Motor ~~self start method~~ : working principle

• Given self start gear ready to go

• rotor w/ dc supply Φ_{ind} current flow Φ_{ind} magnetic field Φ_{ind} then South pole north pole enters

Stator w/ AC supply Φ_{ind} 2V

• For given Φ_{ind} NP pole the (rotor stator South pole enter

Φ_{ind} 2V Φ_{ind} backward jabe Φ_{ind} , error some and

R_s are Φ_{ind} same Φ_{ind} so it cannot start itself.
self start torque Φ_{ind} at

Difference

Synchronous

- Construction is complicated
- Not self start
- Separate DC source is required for rotor excitation
- This is comparatively more efficient than DM
- This torque more sensitive to change in supply voltage

Induction

- Construction is easier.
- Self starting
- Rotor gets excited by the induced e.m.f.
- This is less comparatively efficient than DM
- Its torque is less sensitive to change in supply voltage

