# Course Code - EEE-401
# Course Title – Energy Conversion and Special Machine
# Lecture- Reluctance Motor

# Reluctance Motor

## Unexcited Single-phase Synchronous Motors

These motors

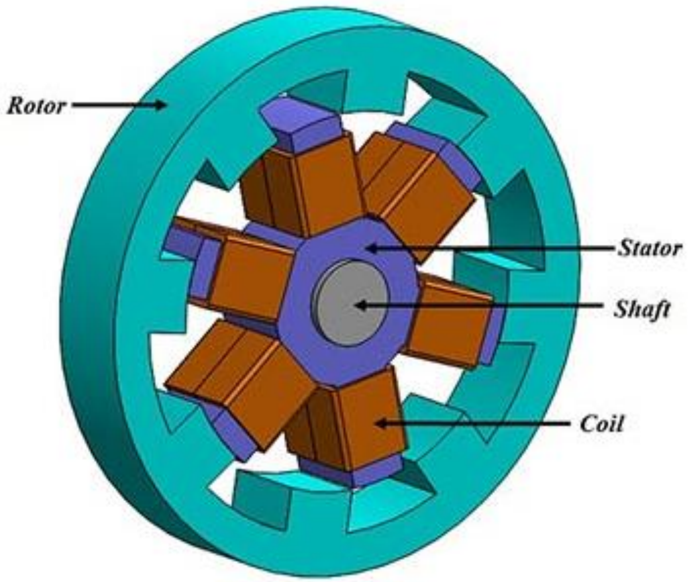
- operate from a single-phase AC supply
- run at a constant speed – the synchronous speed of the revolving flux
- need no DC excitation for their rotors (that is why they are called unexcited)
- are self-starting.

**These are of two types**

- Reluctance motor and
- Hysteresis motor.

## Reluctance Motor

- A reluctance motor is a advanced type of electric motor which includes both the stator and the rotor similar to a normal electric motor.
- It is based on the principle that whenever a magnetic material is located within the magnetic field, then it always brings into line in the less reluctance way.



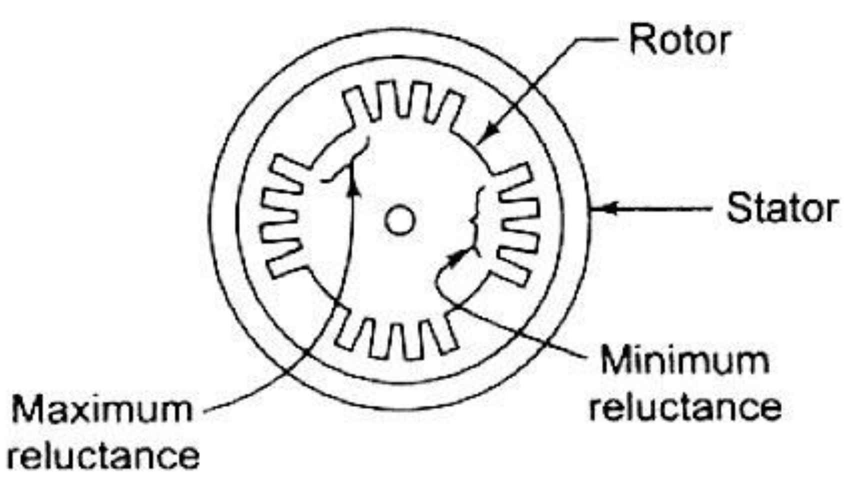

## Types of Reluctance Motor

- Synchronous Reluctance Motor
- Switched Reluctance Motor

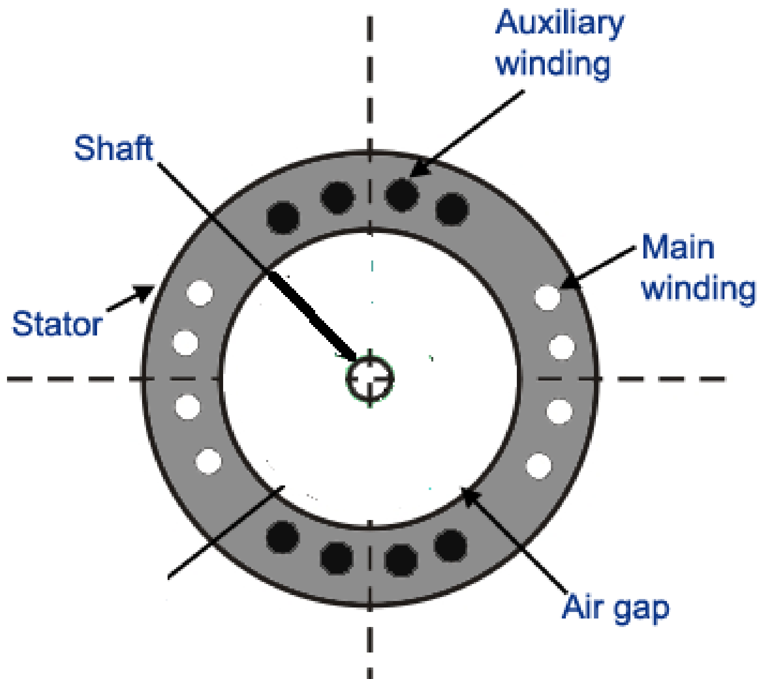
# Construction of synchronous Reluctance Motor

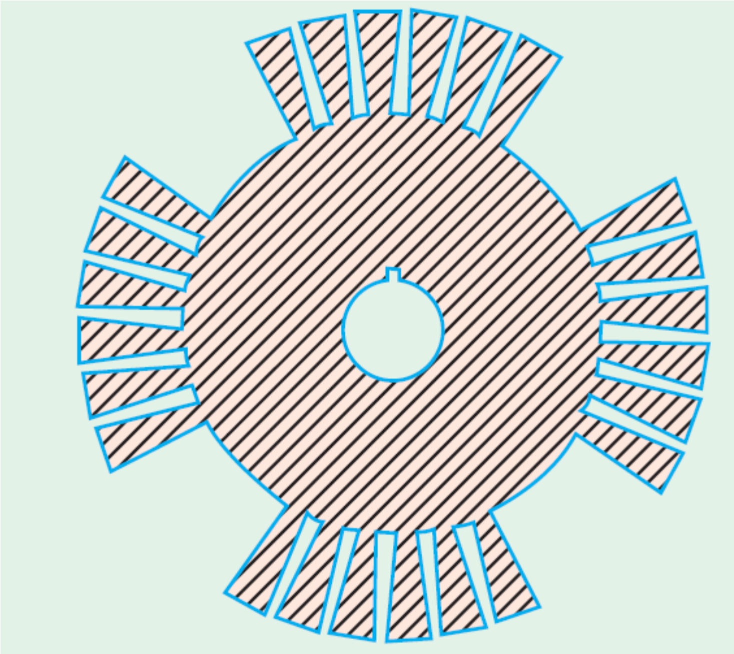
## Construction of Reluctance Motor

- It has the conventional split-phase stator . The stator has two winding (main winding and auxiliary winding) and a centrifugal switch for cutting out the auxiliary winding at synchronous speed.
- The stator produces the revolving field with the help of two winding.
- The squirrel-cage rotor is of unsymmetrical magnetic construction. This type of unsymmetrical construction can be achieved by removing some of the teeth of a symmetrical squirrel-cage rotor. The rotor has no winding.
- In this way, the rotor offers variable magnetic reluctance to the stator flux, the reluctance varying with the position of the rotor.

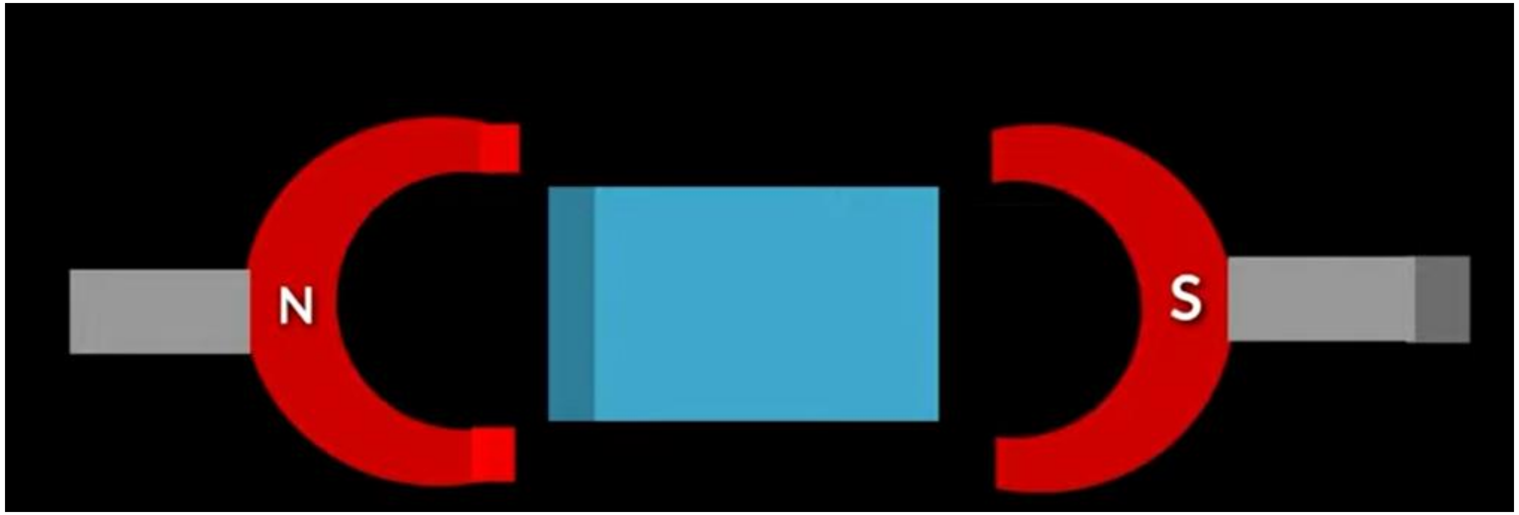


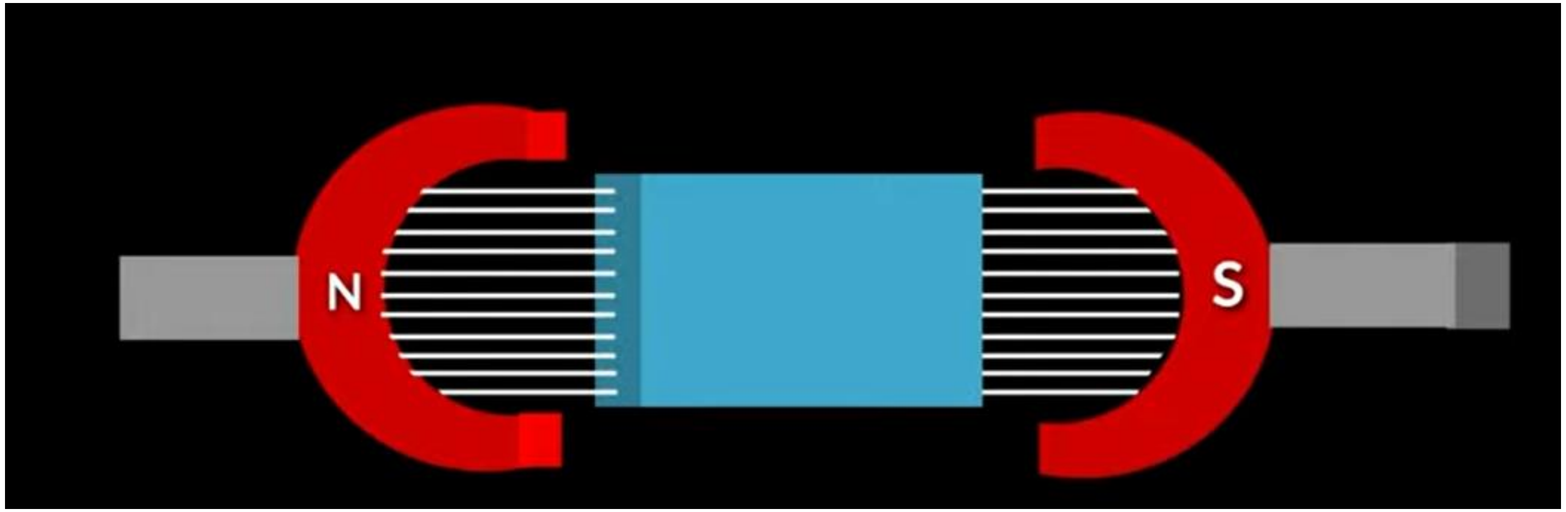

Reluctance Motor



# Low Reluctance path of Reluctance Motor

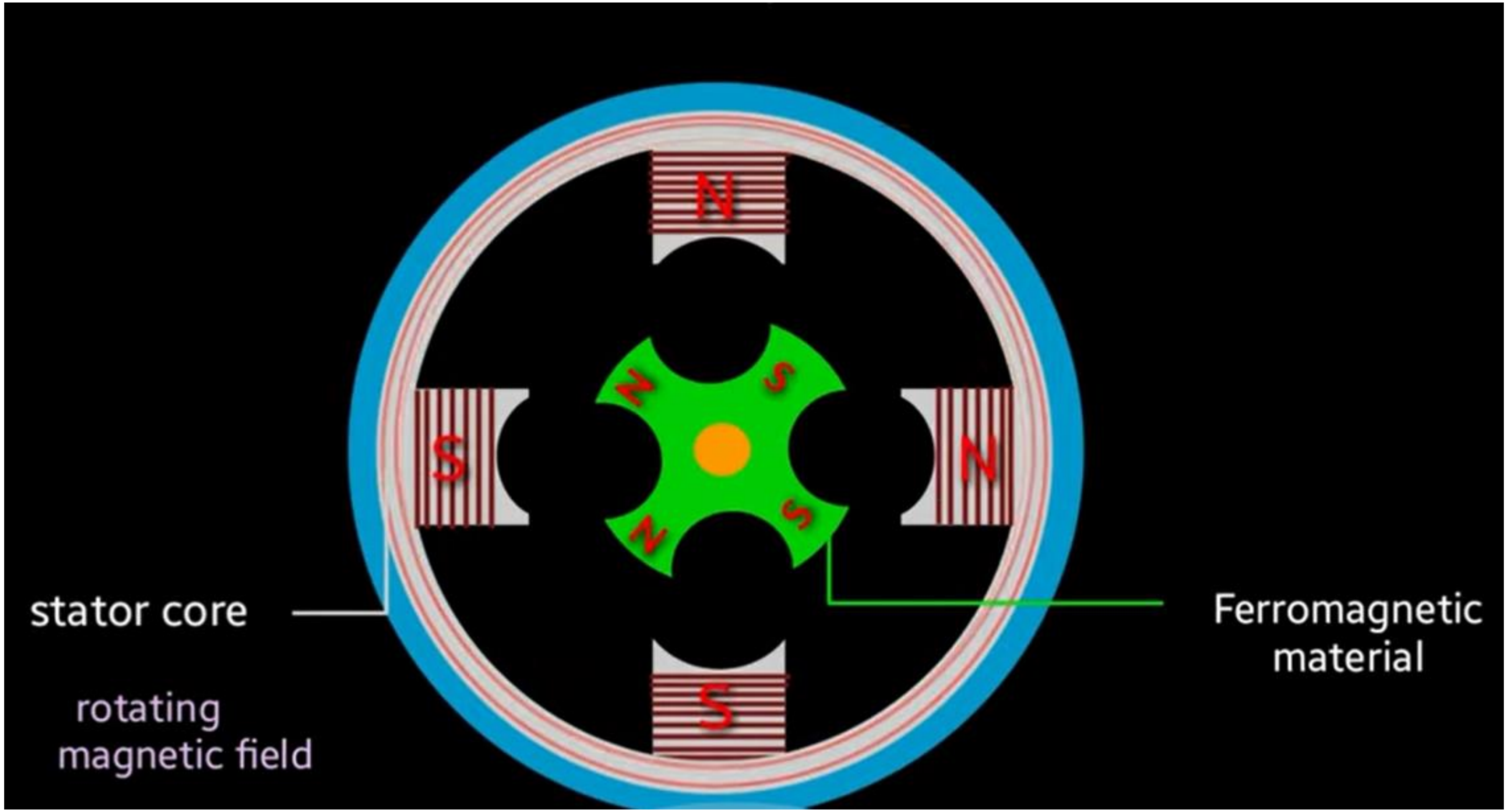


# Working principle of Reluctance Motor

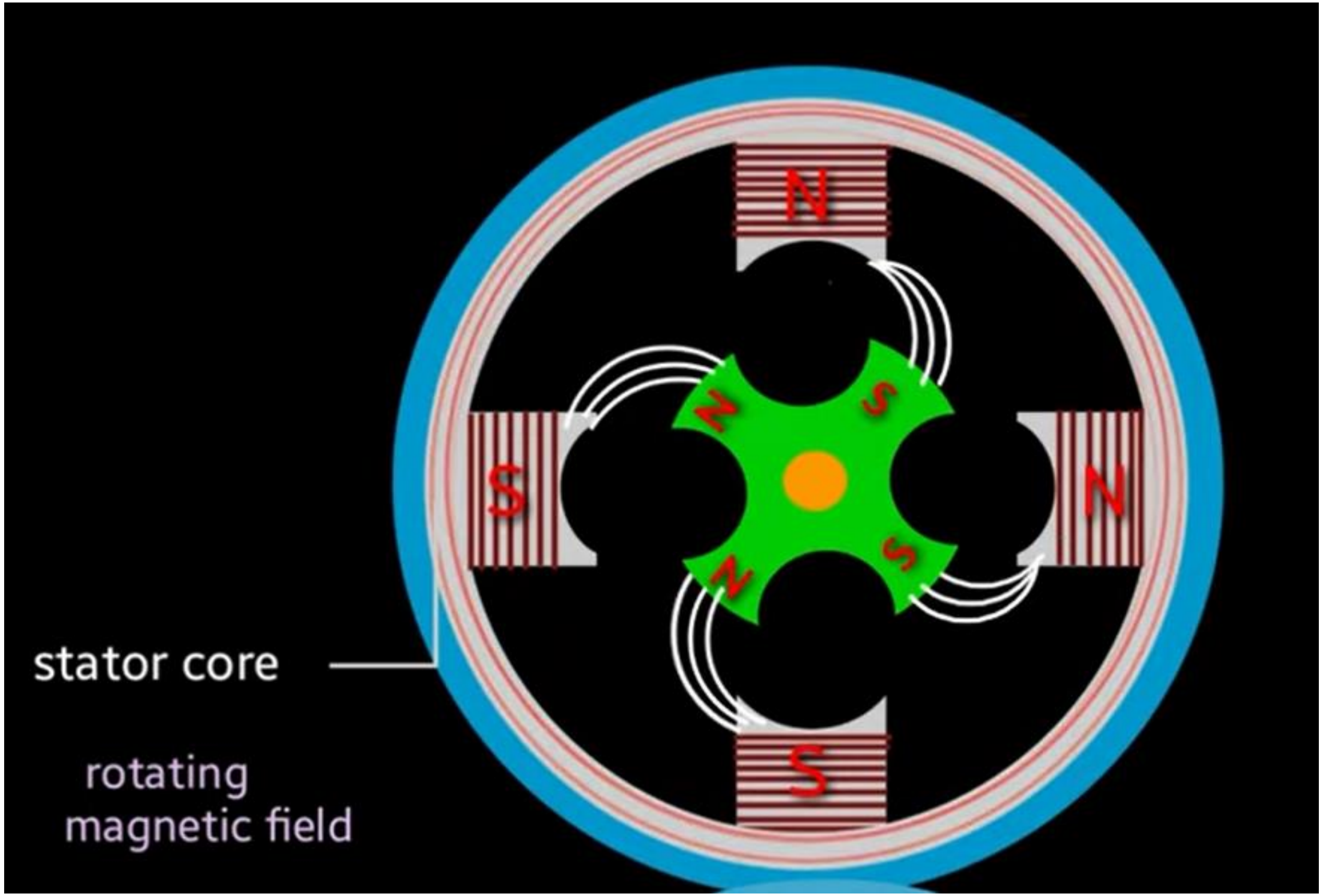
## Rotating magnetic field in stator of Reluctance Motor

## Constant magnetic field in rotor of Reluctance Motor



# Working principle of Reluctance Motor

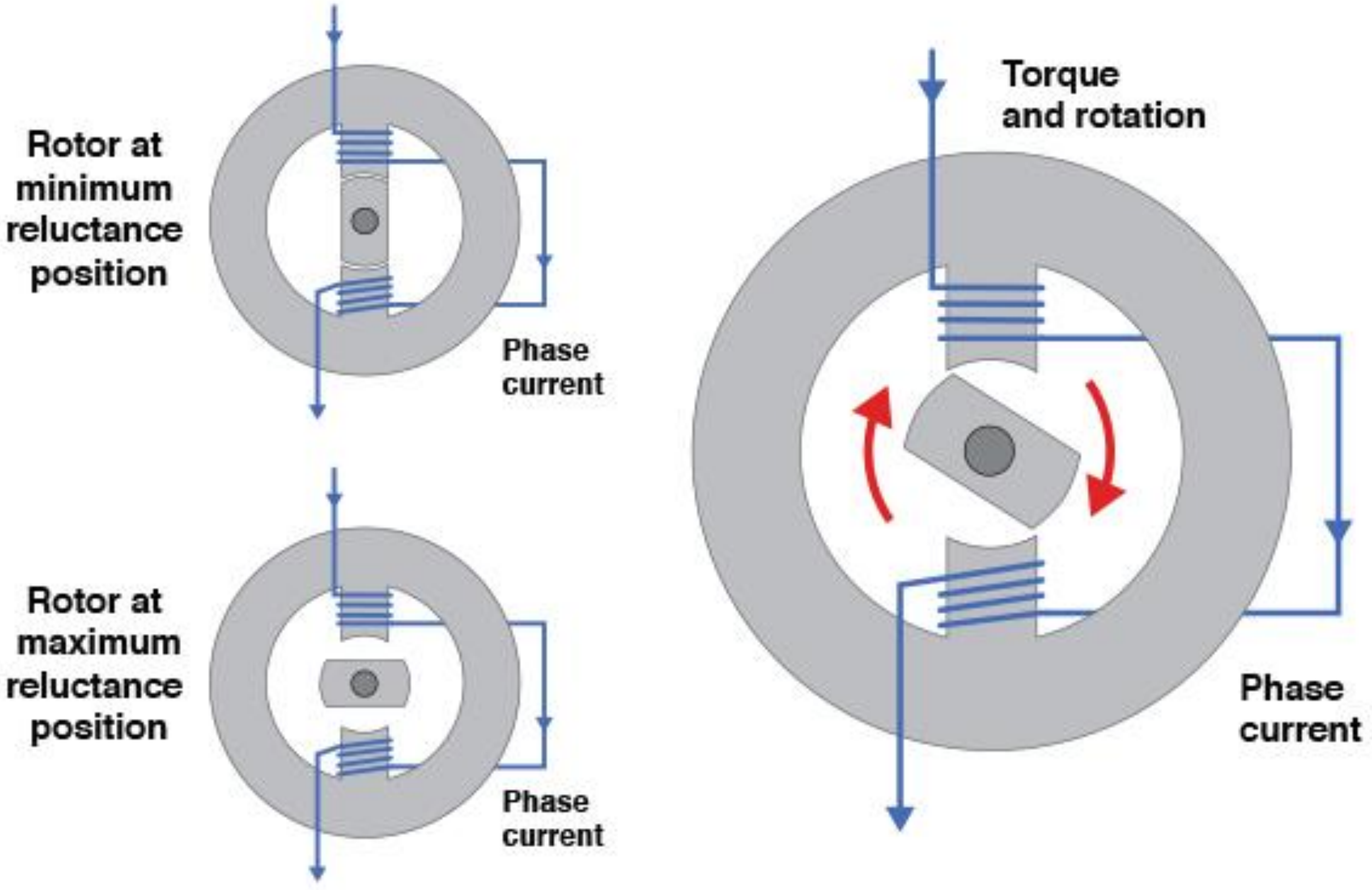
**Magnetic flux follow the low reluctance path**



# Working principle of Reluctance Motor

## Working principle of Reluctance Motor

- When the stator winding is energized, the revolving magnetic field apply reluctance torque on the rotor.
- Reluctance torque tending to align the pole axis of the rotor with the axis of the revolving magnetic field (because in this position, the reluctance of the magnetic path is minimum).
- If the reluctance torque is sufficient to start the motor, the rotor will pull into step with the revolving field and continue to run at the speed of the revolving field



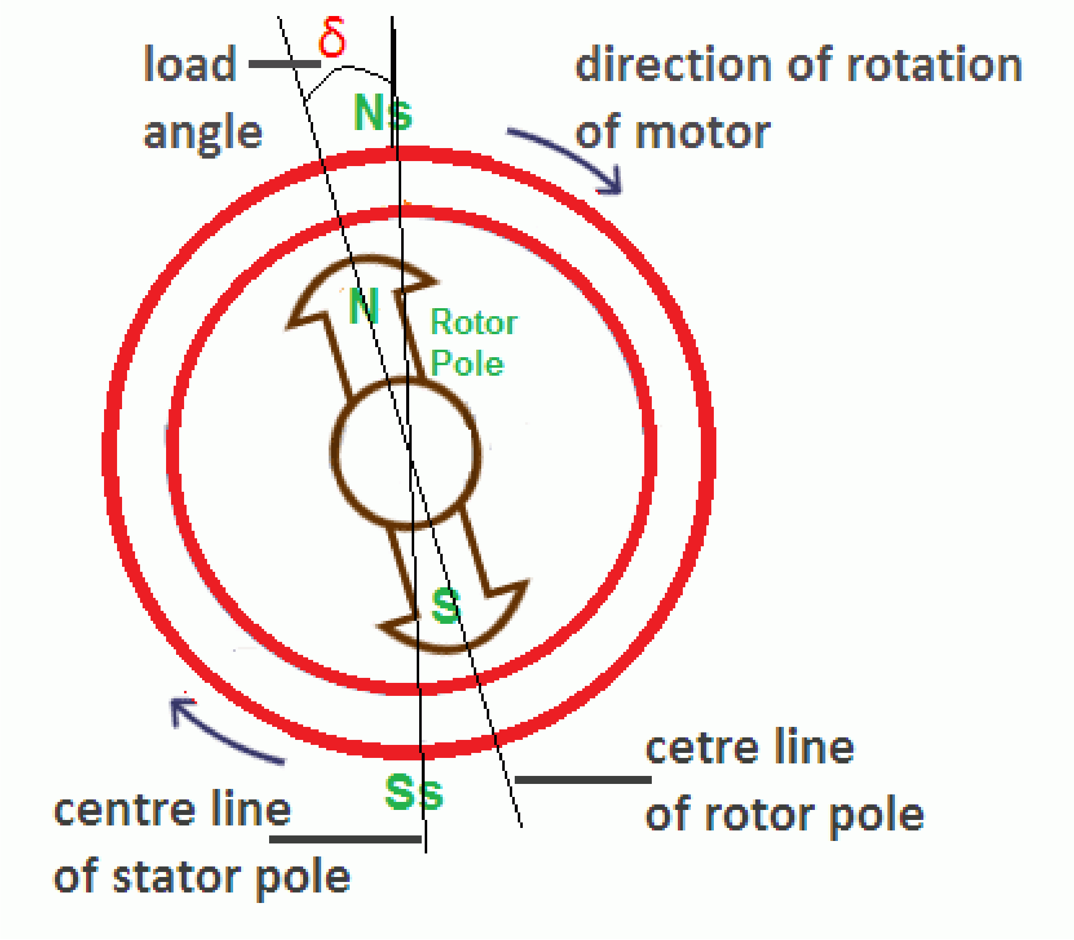
# Torque angle of Reluctance Motor

## Torque angle of Reluctance Motor

- Even though the rotor revolves synchronously, its poles lag behind the stator poles by a certain angle known as torque angle, (something similar to that in a synchronous motor).
- The reluctance torque increases with increase in torque angle, attaining maximum value when α = 45º.
- If it  increases beyond 45º, the rotor falls out of synchronism.
- The average value of the reluctance torque is given by

$$\mathbf{T = K\,(V/f)^2 \sin 2\delta}$$

where K is a motor constant.



# Advantages, disadvantages and application of  Reluctance Motor

## Advantages

- No DC supply, brushes and slip ring are necessary for the rotor.
- Constant speed characteristics.
- Robust construction
- Low cost.
- Low maintenance.

## Disadvantages

- Less efficiency
- Poor power factor
- Need of very low inertia rotor
- Less capacity to drive the loads

## Application of Reluctance Motor

- Signaling Devices
- Control Apparatus
- Automatic regulators
- Recording Instruments
- Clocks
- All timing devices
- Teleprinters
- Gramophones

# Mathematical Problem of Reluctance Motor

**Problem-01**

A 8-kW, 4-pole, 220-V, 50-Hz reluctance motor has a torque angle of 30º when operating under rated load conditions. Calculate (i) load torque (ii) torque angle if the voltage drops to 205 V and (iii) will the rotor pulled out of synchronism ?

**Solution**

. (i) Ns = 120 * 50/4 = 1500 rpm;

Tsh = 9.55 * output/N

= 9.55 * 8000/1500

= 51N-m

(ii) With the same load torque and constant frequency,

$$(V1)^2 \sin 2\delta_1 = (V2)^2 \sin 2\delta_2$$

$$220^2 * \sin(2 * 30^o) = 205^2 * (\sin 2 * \delta_2)$$

$$\delta_2 = 42.9^o$$

(iii) since the new load angle is less than 45º, the rotor will not pull out of synchronous.