SNS COLLEGE OF TECHNOLOGY

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DEPARTMENT OF AUTOMOBILE ENGINEERING

COURSE NAME : 23AUB201 – AUTOMOTIVE ELECTRICAL DRIVES AND CONTROLS

II YEAR / III SEMESTER

Unit 5 – Electric Motor Drives

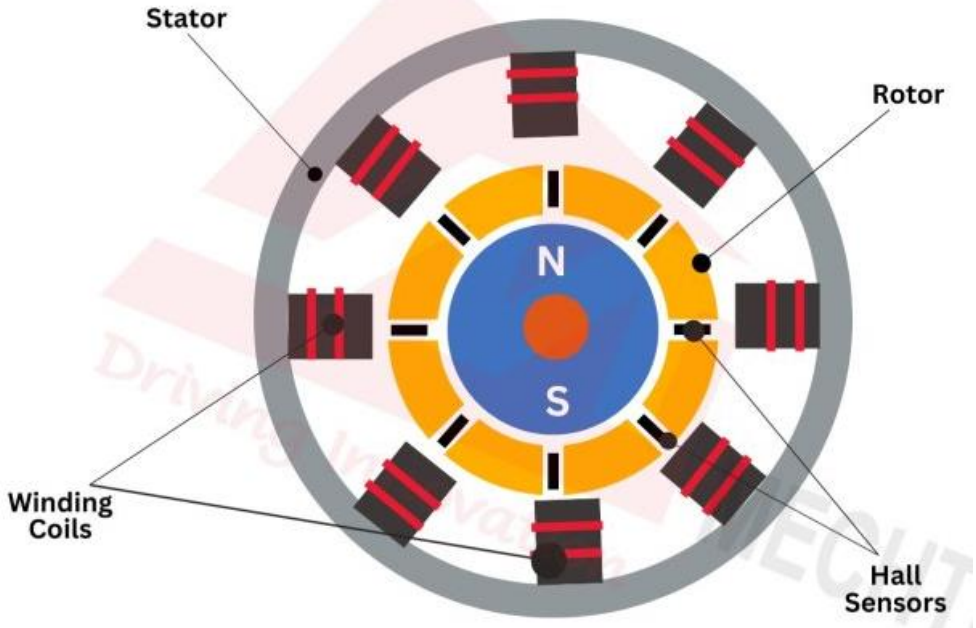
Topic : BLDC Motor and Control

INTRODUCTION

- Brushless DC (BLDC) motors are widely used in applications requiring high efficiency, reliability, and precision.
- BLDC motors operate based on the interaction between the stator's electromagnetic field and the rotor's permanent magnetic field.
- The current supplied to the stator coils is switched electronically based on the rotor's position to maintain continuous rotation.

COMPONENTS

- **Stator**: Consists of laminated steel with windings. The windings are often wound in three phases (A, B, C).
- **Rotor**: Contains permanent magnets that create a magnetic field.
- **Position Sensors**: Hall effect sensors or encoders are typically used to detect the rotor's position.



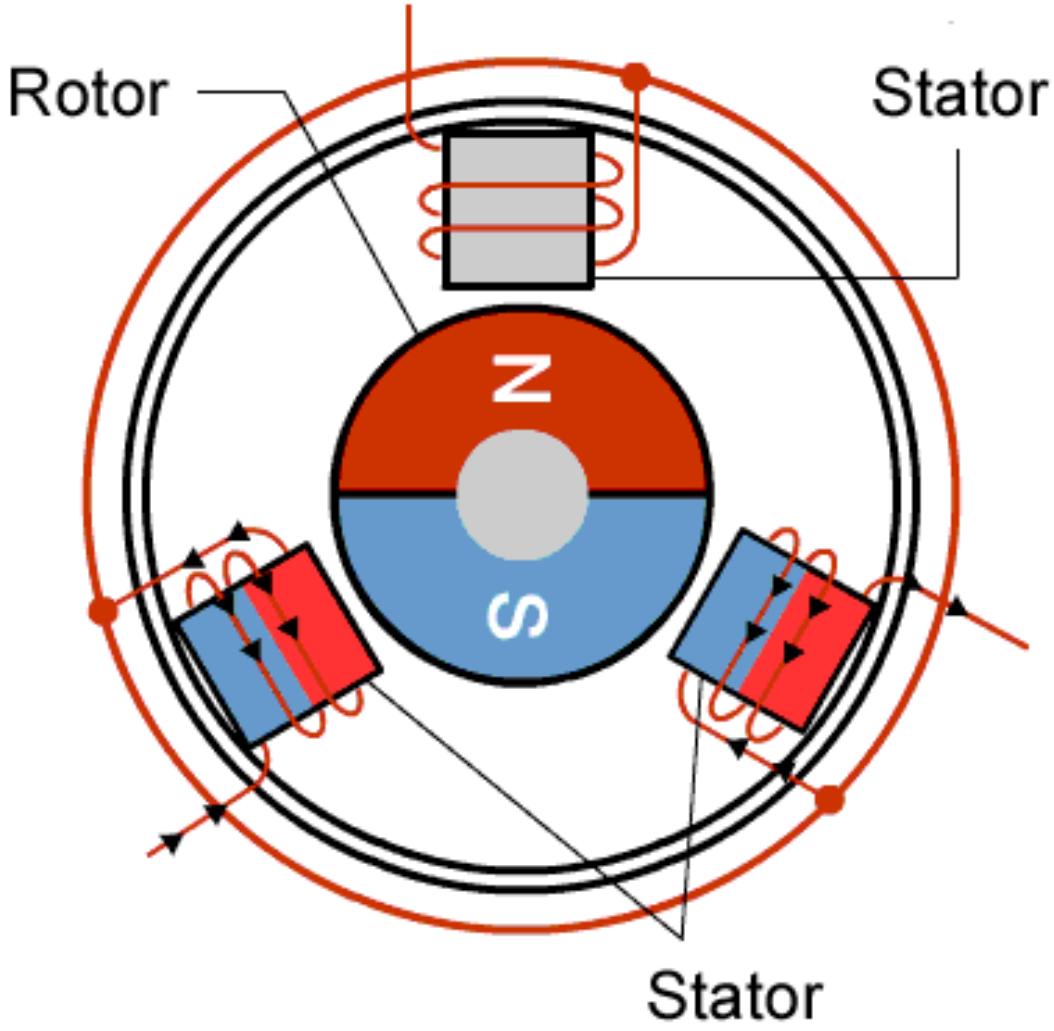
WORKING

- The operation of a BLDC motor is based on the interaction between the rotating magnetic field generated in the stator and the magnetic field of the rotor.
- The stator windings are energized in a controlled sequence to generate a rotating magnetic field.
- This sequence ensures that the magnetic field interacts with the rotor's magnetic field to produce a unidirectional torque.
- Electronic commutation is achieved using a power electronic inverter, eliminating the need for mechanical brushes.

WORKING

- The Hall sensors provide feedback about the rotor's position to the controller.
- Based on this feedback, the controller switches the stator windings appropriately.
- When the stator coils are energized, they produce an electromagnetic force that interacts with the rotor's magnetic field.
- The rotor aligns itself with the stator field, producing torque and rotation.
- By continuously updating the current flow in the stator windings, the rotor is kept in motion.

WORKING



ADVANTAGES

- High efficiency and low power consumption.
- Longer lifespan due to the absence of brushes.
- High speed and torque capabilities.
- Low noise and electromagnetic interference.

APPLICATION

- Electric vehicles (EVs).
- Drones and robotics.
- Industrial automation.
- Household appliances like washing machines and fans.

CONTROL METHOD -SIX STEP COMMUTATION

- Simplest and most widely used method.
- Stator windings are energized in a six-step sequence, with two phases active at any time.
- The switching sequence is determined by the rotor position detected by Hall sensors.
- **Advantages**: Easy to implement.
- **Disadvantages**: Produces torque ripple and less smooth operation.

CONTROL METHOD - PULSE WIDTH MODULATION

- Used to control the voltage applied to the motor windings.
- By adjusting the duty cycle, the speed and torque of the motor are regulated.

CONTROL METHOD - SENSORLESS CONTROL

- Eliminates the need for position sensors, reducing cost and complexity.
- Rotor position is estimated using back EMF, which is proportional to the rotor speed.
- **Advantages**: Cost-effective and reliable in environments where sensors might fail.
- **Disadvantages**: Challenging at low speeds due to weak back EMF signals.

CONTROL METHOD - VECTOR CONTROL

- Advanced control technique for precise torque and speed control.
- Converts stator currents into two components:
- **Direct axis current (d-axis)**: Aligns with the rotor's magnetic field.
- **Quadrature axis current (q-axis)**: Perpendicular to the rotor's magnetic field and controls torque.
- Increases efficiency and provides smooth torque with no ripple.

THANK YOU !!!