

ELEMENTS OF ELECTRICAL ENGINEERING

Course Code : UE25EE141A/B



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ELEMENTS OF ELECTRICAL ENGINEERING

Stepper Motor – Construction & Principle of Operation

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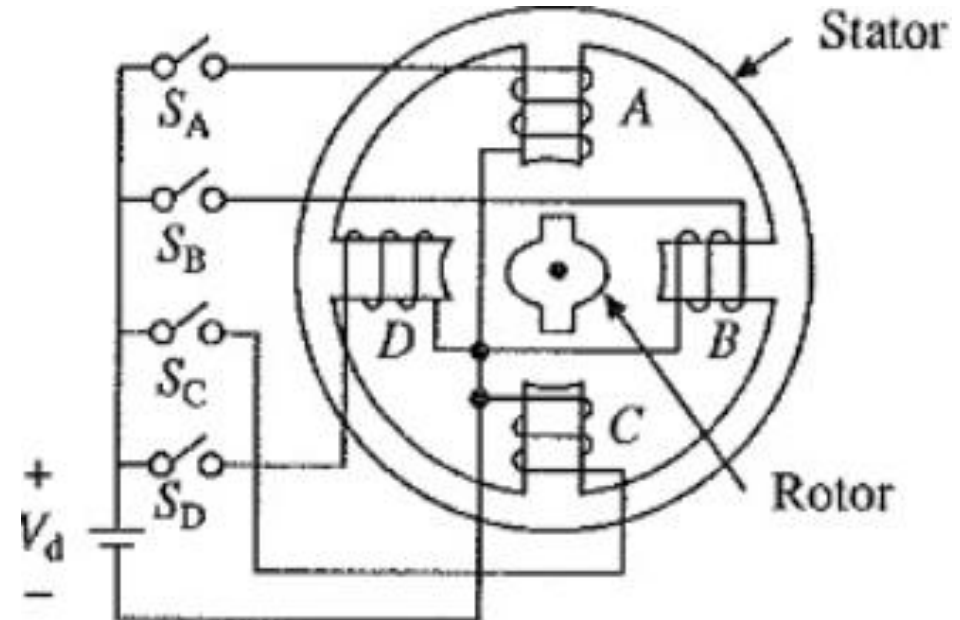
- Digital Electromechanical device which receives DC pulses and rotates in steps.
- Used for position and speed control applications.
- Because of simple control and compatibility with digital systems, used in a variety of applications such as printers, computer disk drives, Robotic arms, Electric watches etc.
- They come in three categories:
 - i) Variable Reluctance Stepper Motor
 - ii) Permanent Magnet Stepper Motor
 - iii) Hybrid Stepper Motor

Stator: Consists of Electromagnets excited by coils.

Rotor: A Salient pole type of structure with out any coils or permanent magnets.

Advantages: Low cost, High Torque to Inertia Ratio

Disadvantages: Higher Audible Noise, Relatively Low Torque

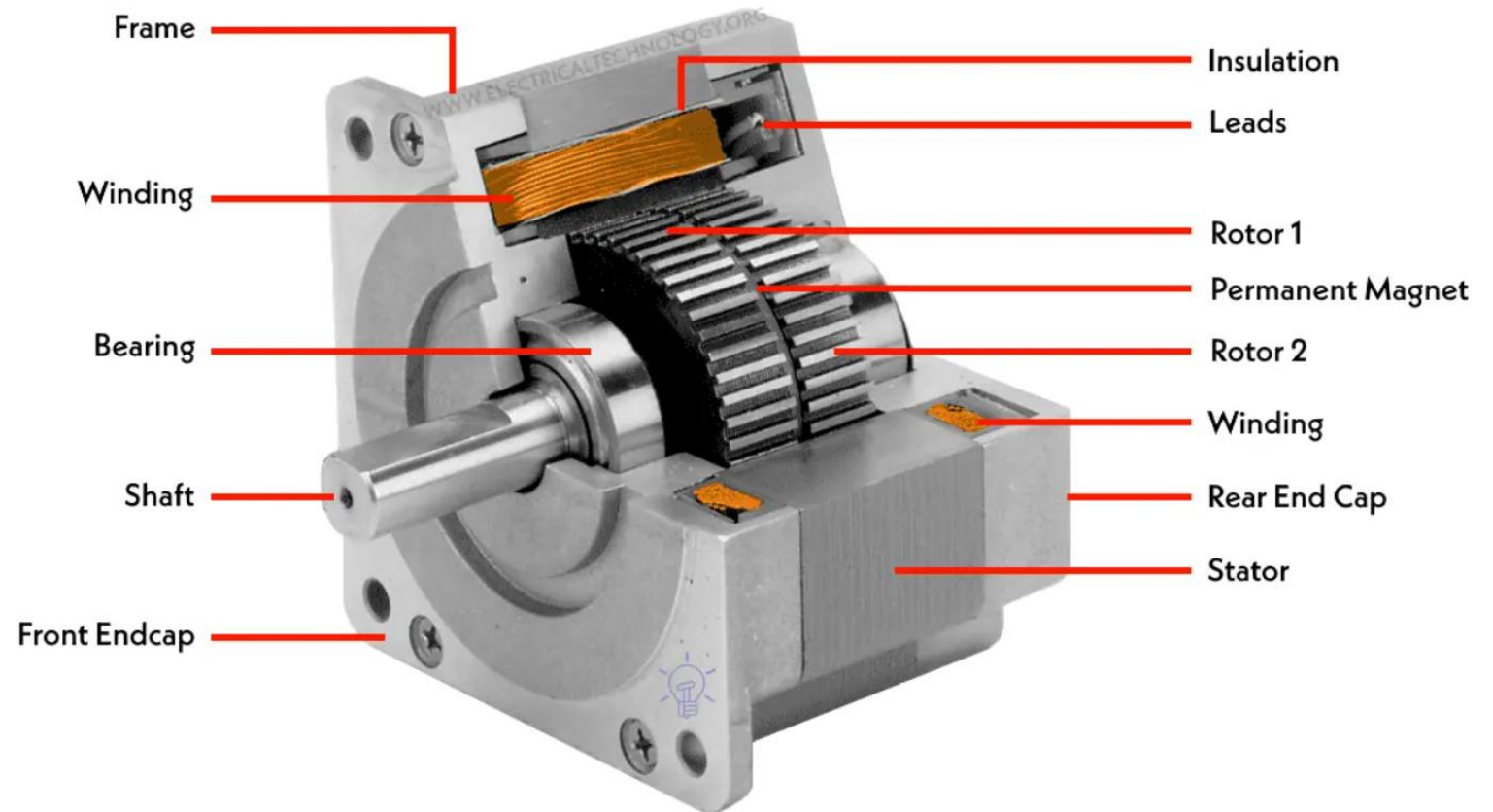


Stator: Consists of Electromagnets excited by coils.

Rotor: consists of radially magnetized permanent magnets.

Advantages: Higher Low speed torque, Quieter operation

Disadvantages: Higher cost due to Permanent Magnets.

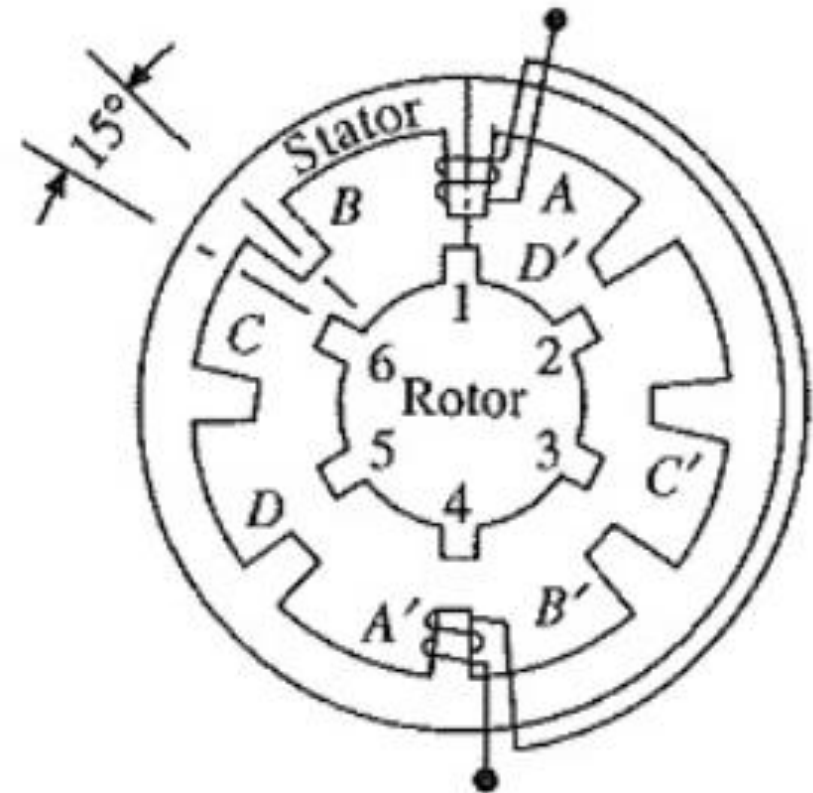


Let us consider 8/6 Variable reluctance stepper motor as shown:

[i.e., 8 electromagnets on stator & 6 salient poles on rotor]

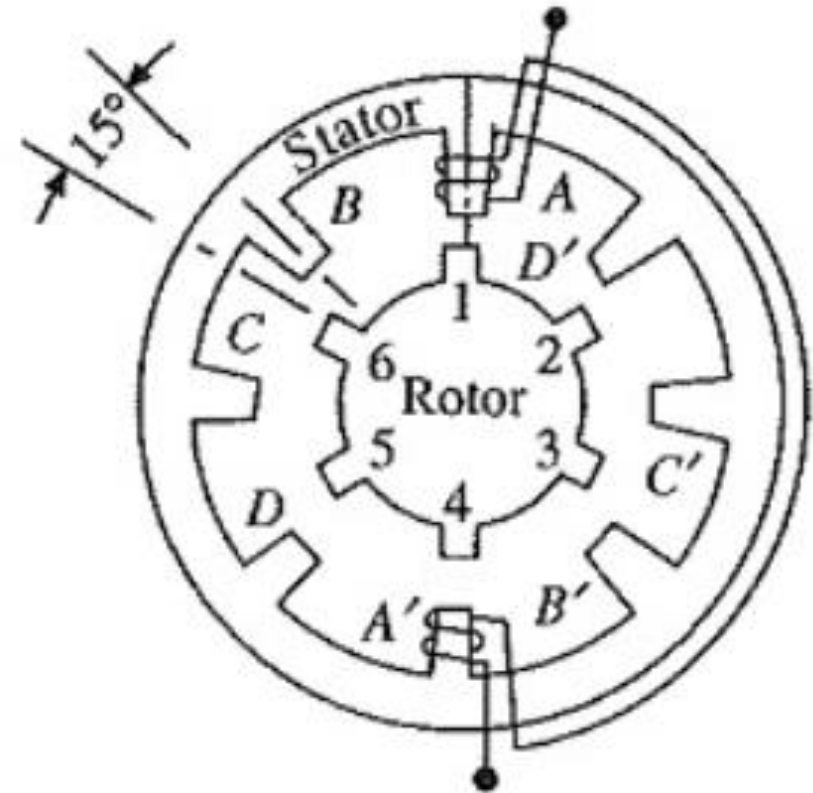
When phase A is magnetized as shown, poles 1 & 4 are aligned with phase A poles as shown.

Next, phase A is turned OFF and phase B winding is turned ON which then attracts rotor poles 3 & 6 into alignment with phase B poles on stator.



Next, phase B is turned OFF and phase C winding is turned ON which then attracts rotor poles 2 & 5 into alignment with phase C poles on stator.

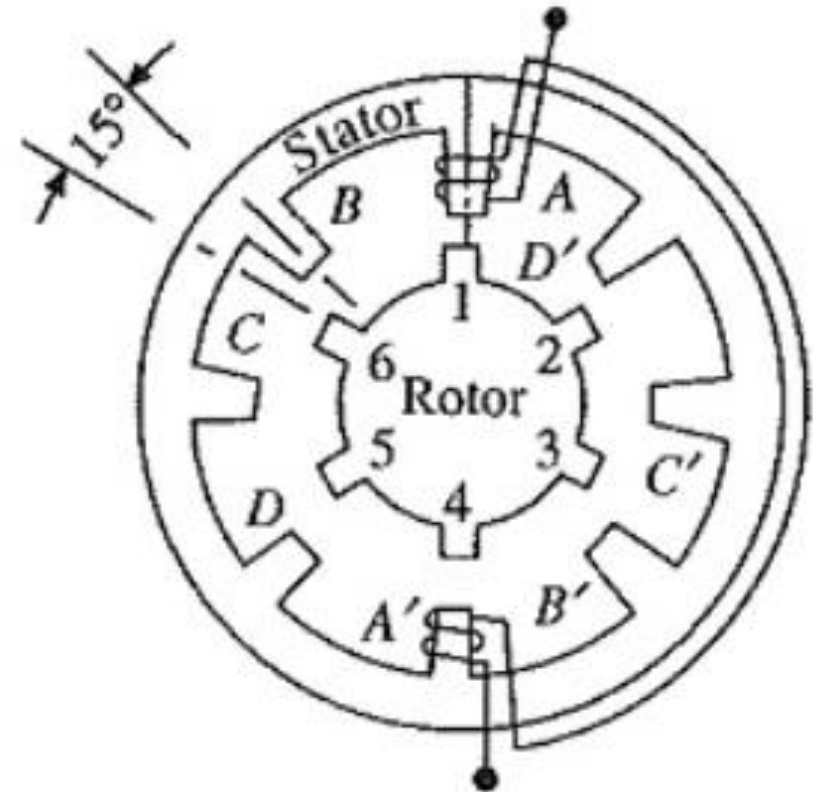
Next, phase D is turned ON and phase C winding is turned OFF which then attracts rotor poles 1 & 4 into alignment with phase D poles on stator.



Thus, phases are provided DC pulses in the sequence A , B , C , D , A , B , C , D so on, which leads to step wise rotation of the rotor clockwise in steps of 15° .

To rotate rotor stepwise anticlockwise, sequence must be A , D , C , B , A , D , C , B so on.

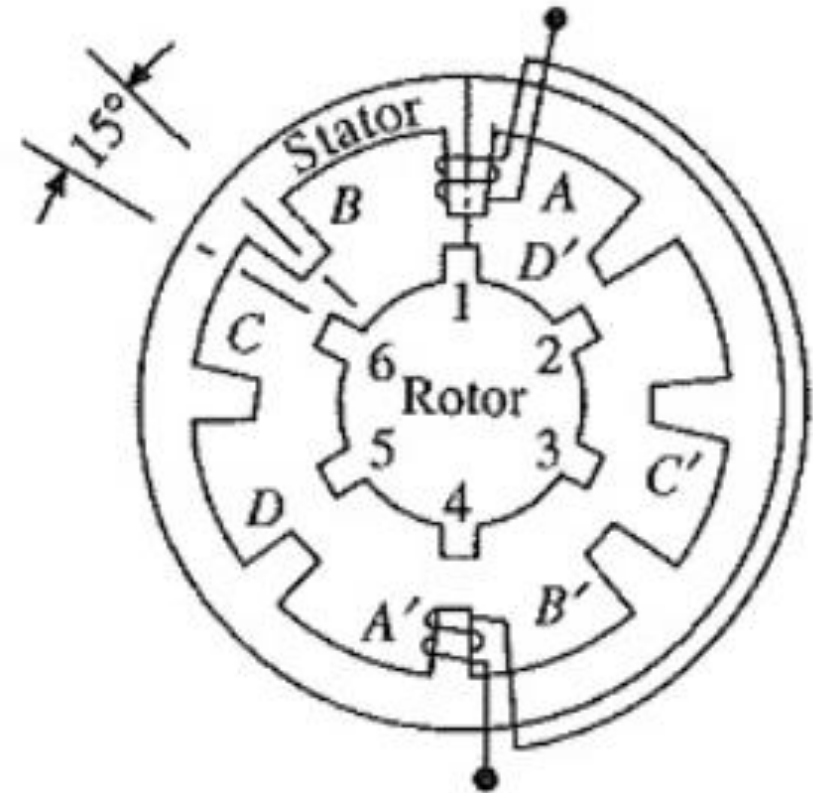
When only one phase is excited at a time, it is called Full Step Rotation where step angle would be 15°



By transitioning excitation from one phase to another phase with both phases excited in between, we can achieve micro stepping.

For instance, when excitation sequence such as A , A&B , B , B&C , C , C&D so on is followed, step size will be 7.5° . This is called Half Step rotation.

By different stator & rotor pole combinations, desired step angle can be achieved.



Text Book:

1. **“Basic Electrical Engineering” S.K Bhattacharya, 1stEdition Pearson India Education Services Pvt. Ltd., 2017**
2. **“Basic Electrical Engineering”, D. C. Kulshreshta, 2ndEdition, McGraw-Hill. 2019**
3. **“Special Electrical Machines” E G Janardanan, PHI Learning Pvt. Ltd., 2014**

Reference Books:

1. **“Engineering Circuit Analysis” William Hayt, Jack Kemmerly, Jamie Phillips and Steven Durbin, 10th Edition McGraw Hill, 2023**
2. **“Electrical and Electronic Technology” E. Hughes (Revised by J. Hiley, K. Brown & I.M Smith), 12th Edition, Pearson Education, 2016.**
3. **“Fundamentals of Electric Drives” , G K Dubey, 2nd Edition, Narosa Publishing House**



THANK YOU

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