
*In The Name of God The Most
Compassionate, The Most Merciful*



Electric Machines I





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References



1

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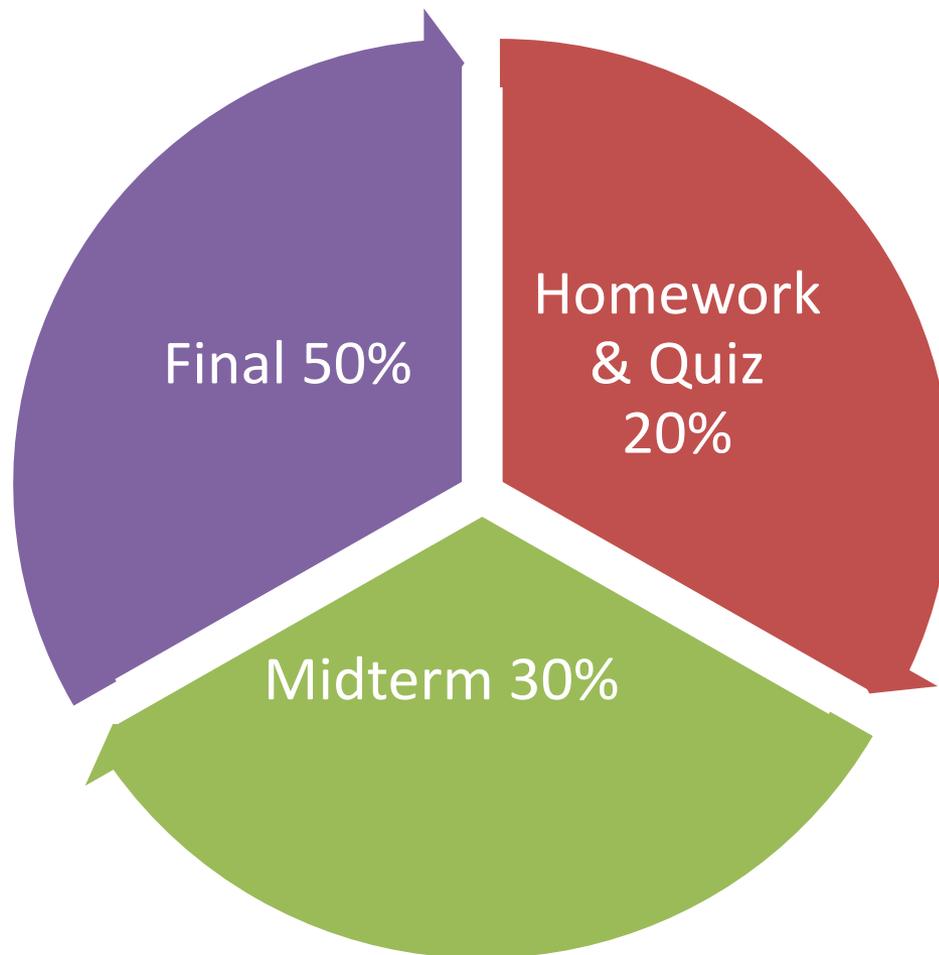
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Evaluation





Chapter 1

Introduction to Electric Machines

1.1. Electromagnetic Devices

1.2. Motors vs. Generators

1.3. Importance of Electric Machines

1.4. Electric Machine Classification

1.5. Electric Machine Applications

Electromagnetic Devices



1. Electric motors
2. Electric generators
3. Transformers
4. Magnetic relays
5. Magnetic bearings
6. Magnetic gears
7. Magnetic suspension systems (Electromagnetic damper)
8. Magnetic levitation systems



Electromagnetic Devices



9. Magnetic coupling
10. Eddy current coupling
11. Eddy current brake
12. Magnetic continuously variable transmission (CVT)
13. Electromagnetic Aircraft Catapults (are linear motors)
14. Electromagnetic bomb/EMP (electromagnetic pulse)
15. Electromagnetic crane
16. Magnetic refrigerator

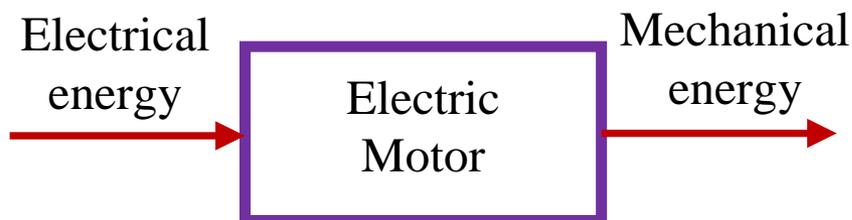




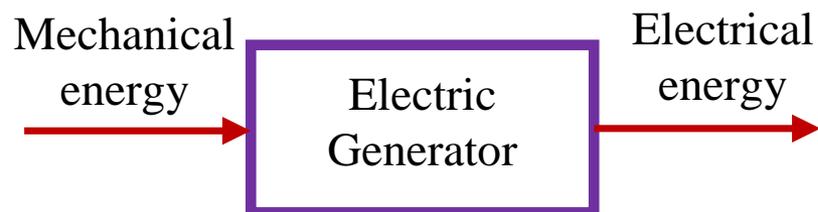
Electric Motors and Generators

An electric machine can be used as an electric motor or a generator.

- **Electric motors** receive electrical energy as input and provide mechanical energy as output.

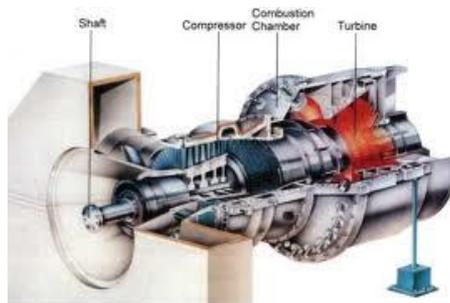


- **Electric generators** receive mechanical energy as input and provide electrical energy as output.



Importance of Electric Machines

- More than 99% of electricity is generated via electric generators.
- The prime mover of electric generators can be
 - Steam turbines
 - Gas turbines
 - Hydro turbines
 - Wind turbines

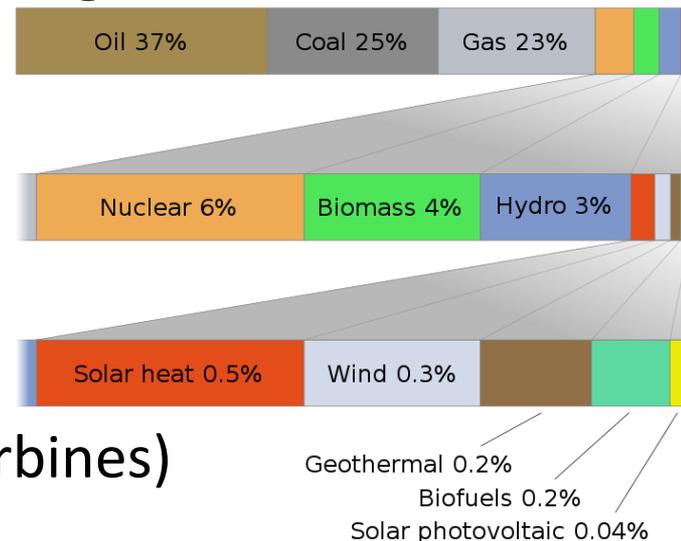




Importance of Electric Machines

Different types of power plants in which electric generators are used:

- Fossil fuelled power plants
 - Coal (Steam turbine)
 - Oil (Steam turbine)
 - Natural gas (Gas turbine)
 - Combined cycle (Both gas and steam turbines)
- Nuclear power plants (Steam turbine)
- Biomass fuelled power plants (Steam turbine)
- Hydro power plants (hydro turbine)
- Solar heat electric plants (Steam turbine)
- Wind farms (Wind turbine)
- Geothermal power plants (Steam turbine)



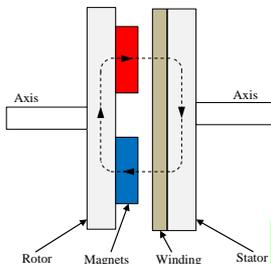
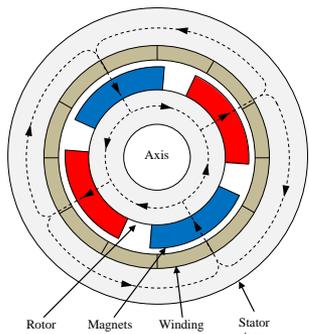
Importance of Electric Machines

- More than 65% of electricity consumed in industrial sectors is due to electric motors.



Electric Machines Classification

Classification in terms of motion and flux direction



Rotary motion

Electric machines

Linear motion

Radial flux

Axial flux

Transverse flux

Transverse flux

Longitudinal flux

Inner rotor

Outer rotor

Single sided

Double sided

Multi-stage

Surface mounted

Flux focusing

Flat (planar)

Tubular

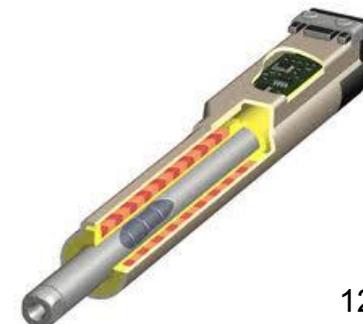
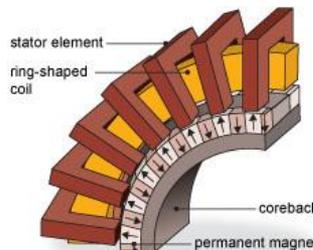
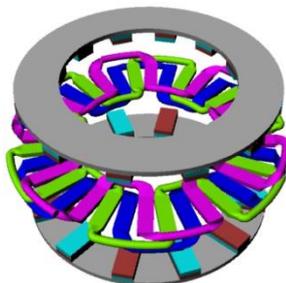
Slotted stator
Slotless stator

Slotted stator
Slotless stator

Slotted stator
Slotless stator
Salient-pole stator

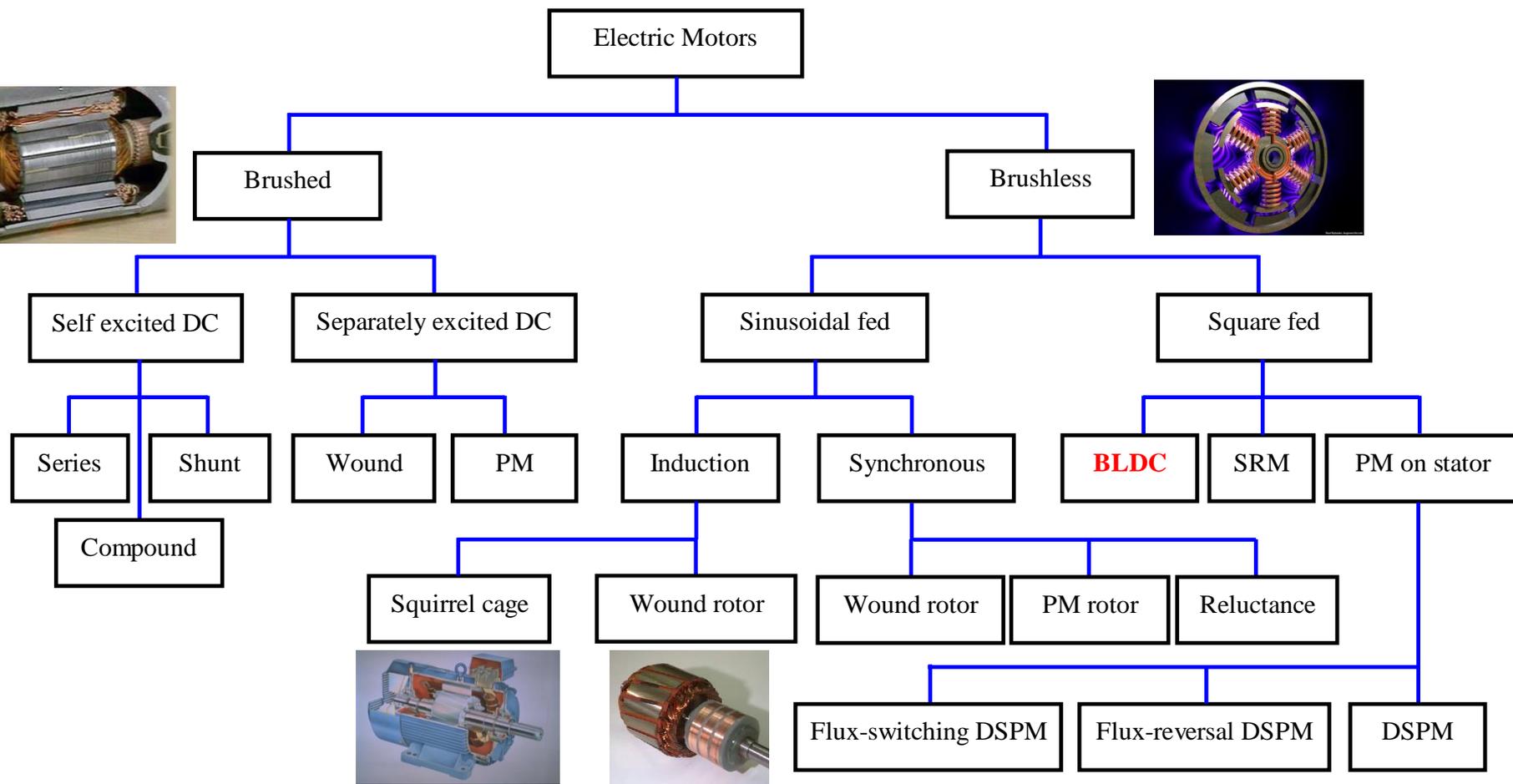
Internal stator
Internal rotor

Single sided
Double sided



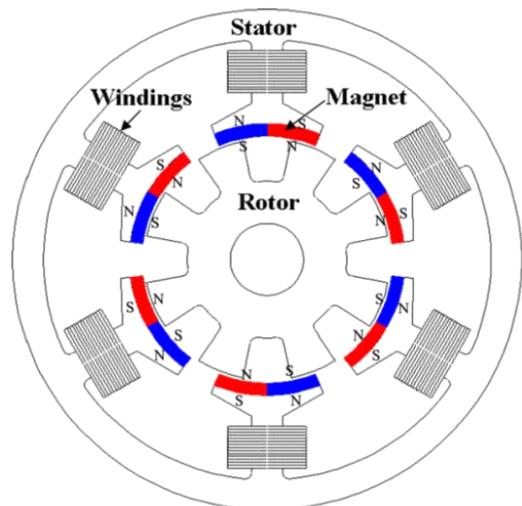
Electric Machines Classification

Classification in terms of brush and input sources

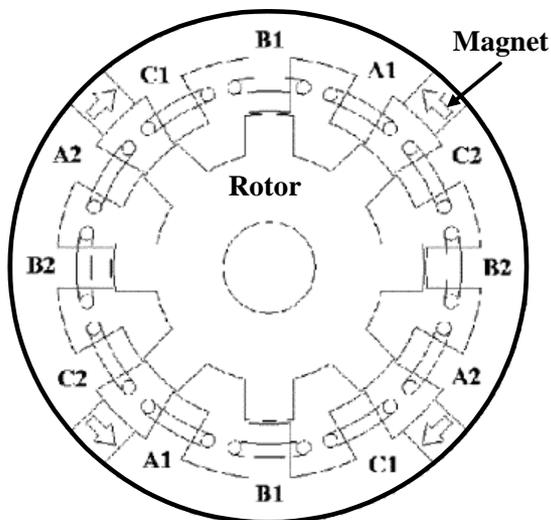


13 **BLDC**: Brushless DC **SRM**: Switched Reluctance Motor **PM**: Permanent Magnet **DSPM**: Doubly Salient PM

Magnet on Stator Concept

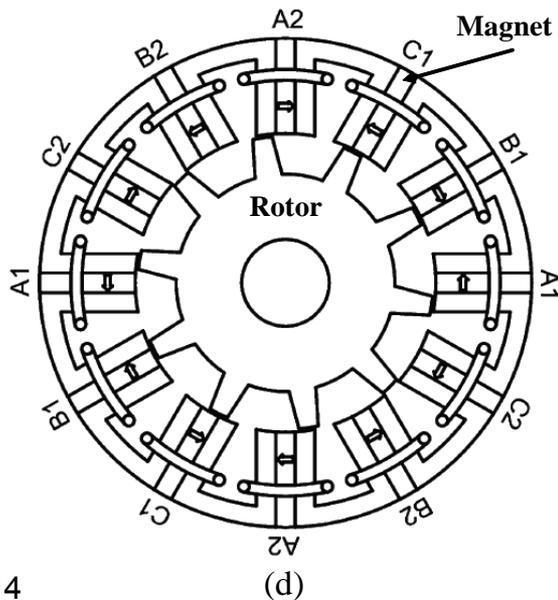


(b)



(a)

(a) Doubly-salient permanent magnet (DSPM)

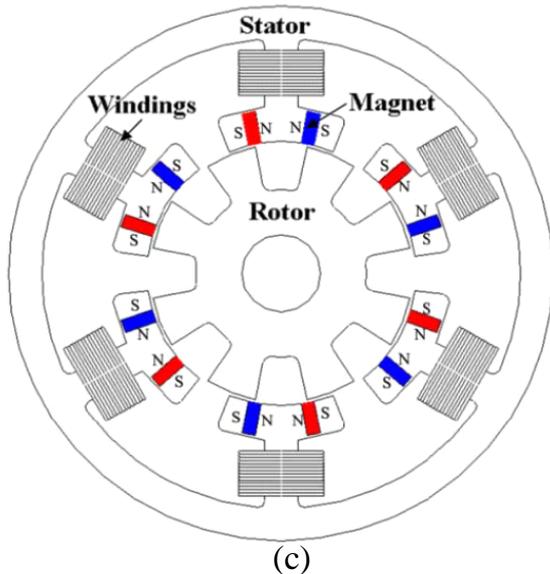


(d)

(b) Flux-reversal DSPM with surface mounted

(c) Flux-reversal DSPM with surface inset

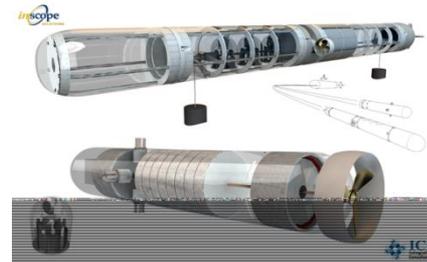
(d) Flux-switching DSPM



(c)

PM Machines Applications

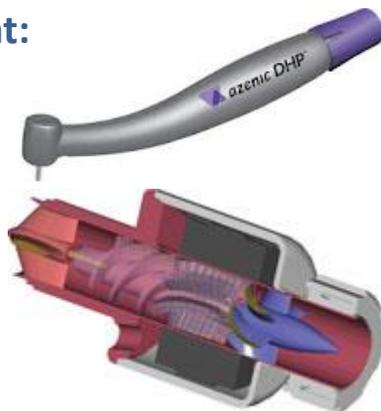
- **Automobiles with combustion engines:**
- **Transportation:**
 - elevators and escalators
 - people movers
 - light railways and streetcars (trams)
 - electric road vehicles
 - aircraft flight control surface actuation
 - electric ships
 - boats
- **Defence forces:**
 - tanks
 - missiles
 - radar systems
 - submarines
 - torpedoes
 - rockets
 - space shuttles
 - satellites



Electric Machines Applications

- **Medical and healthcare equipment:**

- dentist's drills
- electric wheelchairs
- air compressors
- rehabilitation equipment
- artificial heart motors



- **Power tools:**

- drills
- hammers
- screwdrivers
- grinders
- polishers
- saws
- sanders
- sheep shearing hand-pieces



- **Renewable energy systems**

- **Research and exploration equipment**

Electric Machines Applications

- **Industry:**

- industrial drives, e.g., pumps, fans, blowers, compressors, centrifuges, mills, hoists, handling systems, etc.
- machine tools
- servo drives
- automation processes
- internal transportation systems
- robots

- **Public life:**

- air conditioning systems
- catering equipment
- coin laundry machines
- autobank machines
- automatic vending machines
- money changing machines
- ticketing machines
- bar-code readers at supermarkets
- environmental control systems
- amusement park equipment



Electric Machines Applications



- **Domestic life:**

- clocks
- kitchen equipment (refrigerators, microwave ovens, mixers, dishwashers, etc.)
- bathroom equipment (shavers, hair dryers, tooth brushes)
- washing machines and clothes dryers
- heating and air conditioning systems
- vacuum cleaners
- lawn mowers
- swimming pool pumps
- toys
- vision and sound equipment
- security systems (automatic garage doors, automatic gates)



- **Information and office equipment:**

- computers
- printers
- plotters
- scanners
- facsimile machines
- photocopiers

