Power Screws and Bolted Connections

ME4020 - Applied Machine Design

Mechanical Engineering
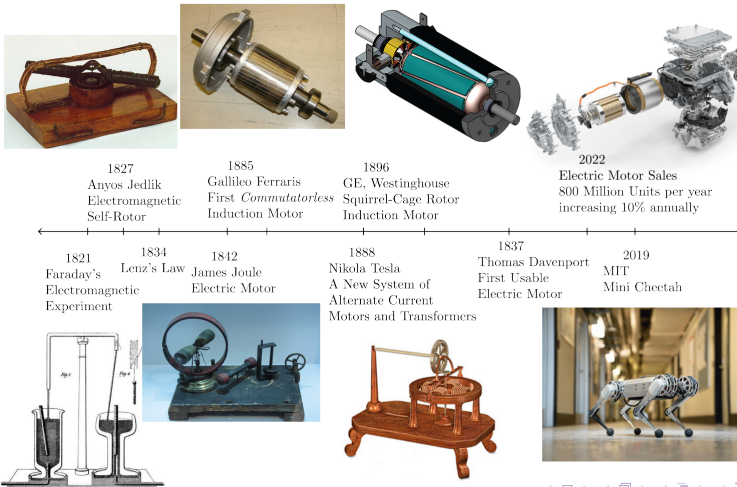
Tennessee Technological University
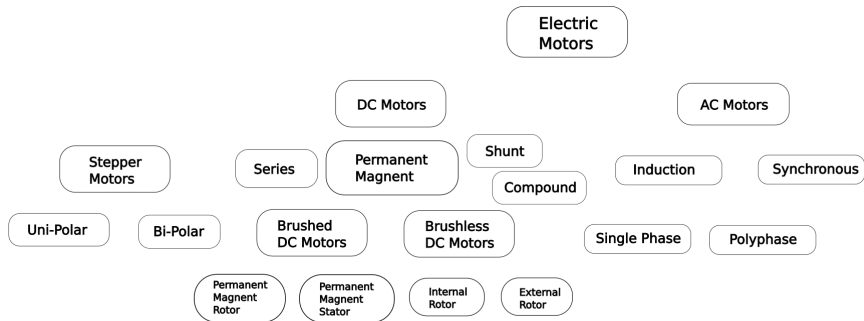
Motor Selection

Motor Selection

- Overview and Classification

- Open Loop and Closed Loop Control

- Motor Torque-Speed Curves

- Motor Driver/Controller

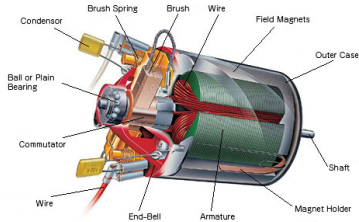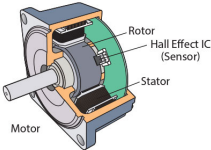- Analysis and Selection

Overview and Classification

1827
Anyos Jedlik
Electromagnetic
Self-Rotor

1885
Gallileo Ferraris
First *Commutatorless*
Induction Motor

1896
GE, Westinghouse
Squirrel-Cage Rotor
Induction Motor

2022
Electric Motor Sales
800 Million Units per year
increasing 10% annually

1821
Faraday's
Electromagnetic
Experiment

1834
Lenz's Law

1842
James Joule
Electric Motor

1888
Nikola Tesla
A New System of
Alternate Current
Motors and Transformers

1837
Thomas Davenport
First Usable
Electric Motor

2019
MIT
Mini Cheetah

Overview and Classification

```
                    ┌─────────────┐
                    │  Electric   │
                    │   Motors    │
                    └─────────────┘
```

Electric Motors

DC Motors   AC Motors

Stepper Motors   Series   Permanent Magnent   Shunt   Induction   Synchronous
                                                Compound

Uni-Polar   Bi-Polar   Brushed DC Motors   Brushless DC Motors   Single Phase   Polyphase

Permanent Magnent Rotor   Permanent Magnent Stator   Internal Rotor   External Rotor

Overview and Classification

Common Electric Motor Types

— Type —	— Example —	— Application —

Overview and Classification

Common Electric Motor Types (cont.)

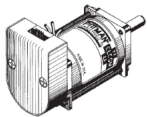| — Type —	— Example —	— Applications —

Overview and Classification
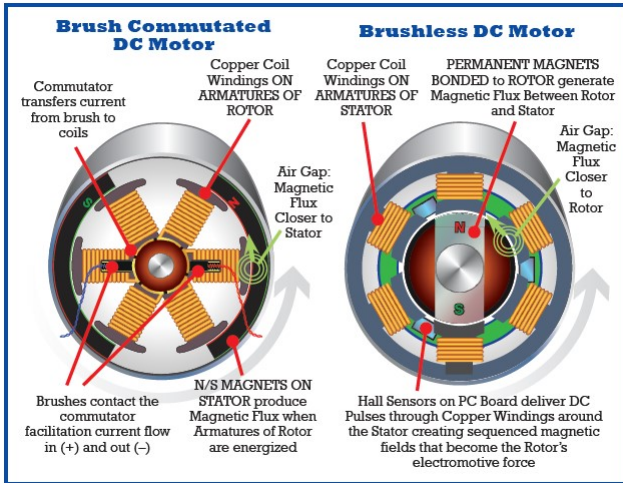
Open Loop and Closed Loop Control

Open Loop vs Closed Loop Control

- Open Loop Control

- Bang-Bang Control

- Armature Control

- Position Control

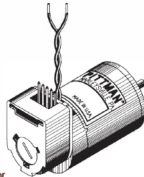- Velocity Control

Open Loop and Closed Loop Control

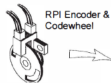Feedback Controlled Brushed DC Electric Motor
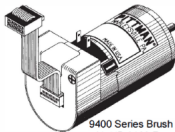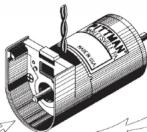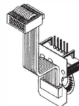
Open Loop and Closed Loop Control

Feedback Controlled Brushless DC Electric Motor
Modern Case Study: Universl Robotics - Arm Joint
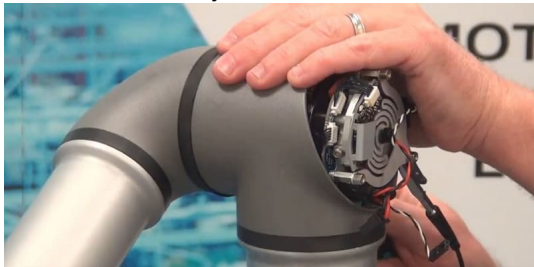
Open Loop and Closed Loop Control
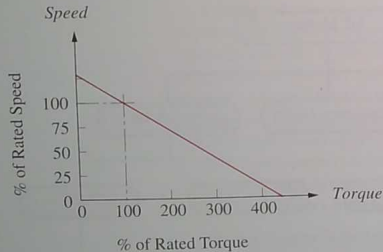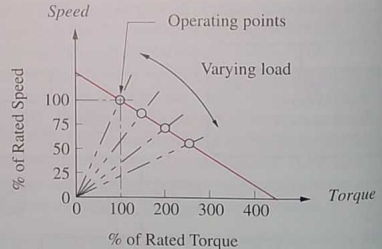
Applications:

-
-
-

Pros

-
-
-

Cons

-
-
-

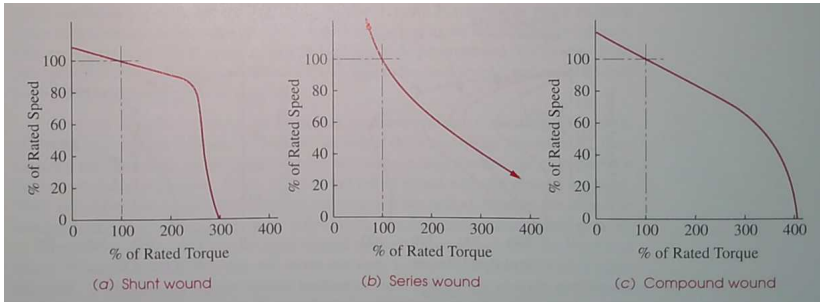# Open Loop and Closed Loop Control

Motor Torque-Speed Curves

(a) Speed–torque characteristic of a PM electric motor   (b) Load lines superposed on speed–torque curve

Motor Torque-Speed Curves
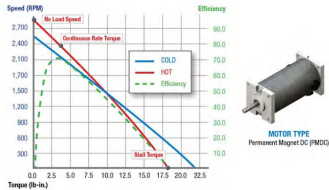
Motor Torque-Speed Curves

Figure 7: Speed, Torque, Efficiency Curves of a PMDC motor
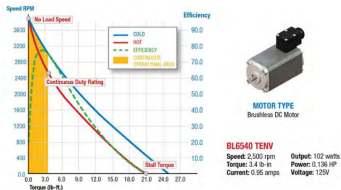

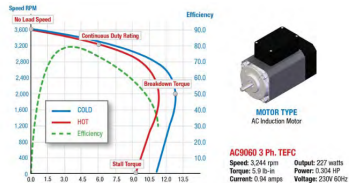Figure 10: Speed, Torque, Efficiency Curves of a BLDC motor

Figure 9: Speed, Torque & Efficiency Curves of an AC Induction Motor

Motor Driver/Controller

A motor driver, aka controller, is required to operate an electric motor.

- low-level -> high-level, high-end

- open-loop, close-loop

- various signal inputs (e.g. analog, PWM, Serial, USB, etc)

- dip switches + potenionmeter configured -

- computer configuration and user interace

- feedback control integration

Analysis and Selection

Considerations for Motor Selection:

- What are the torque requirements?

- What are the speed requirements?

- Does the application require a feedback control?

- What type of motor driver or controller is required?

- Does the form factor of the motor fit in the machine?

Analysis and Selection

Haydon Kerk Pittman Ametek - Brushed DC
Haydon Kerk Pittman Ametek - Brushless DC