# Power Screws and Bolted Connections

ME4020 - Applied Machine Design

Mechanical Engineering

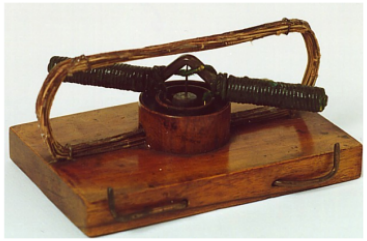
Tennessee Technological University

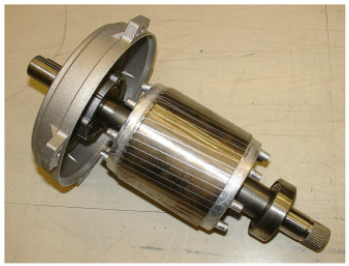
## Motor Selection

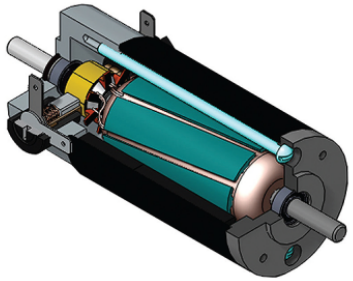
## Motor Selection

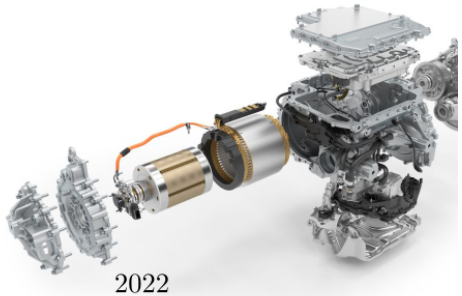
- Overview and Classification
- Open Loop and Closed Loop Control
- Motor Torque-Speed Curves
- Motor Driver/Controller
- Analysis and Selection

# 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

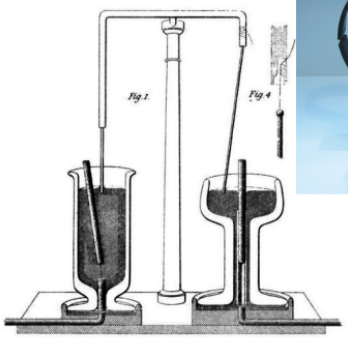
1834
Lenz's Law

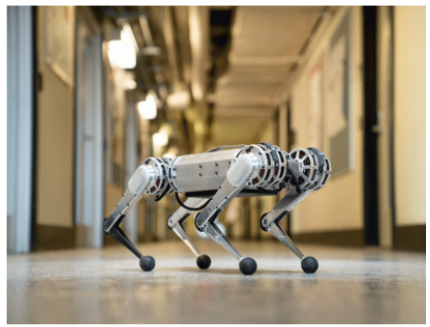
1842
James Joule
Electric Motor

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

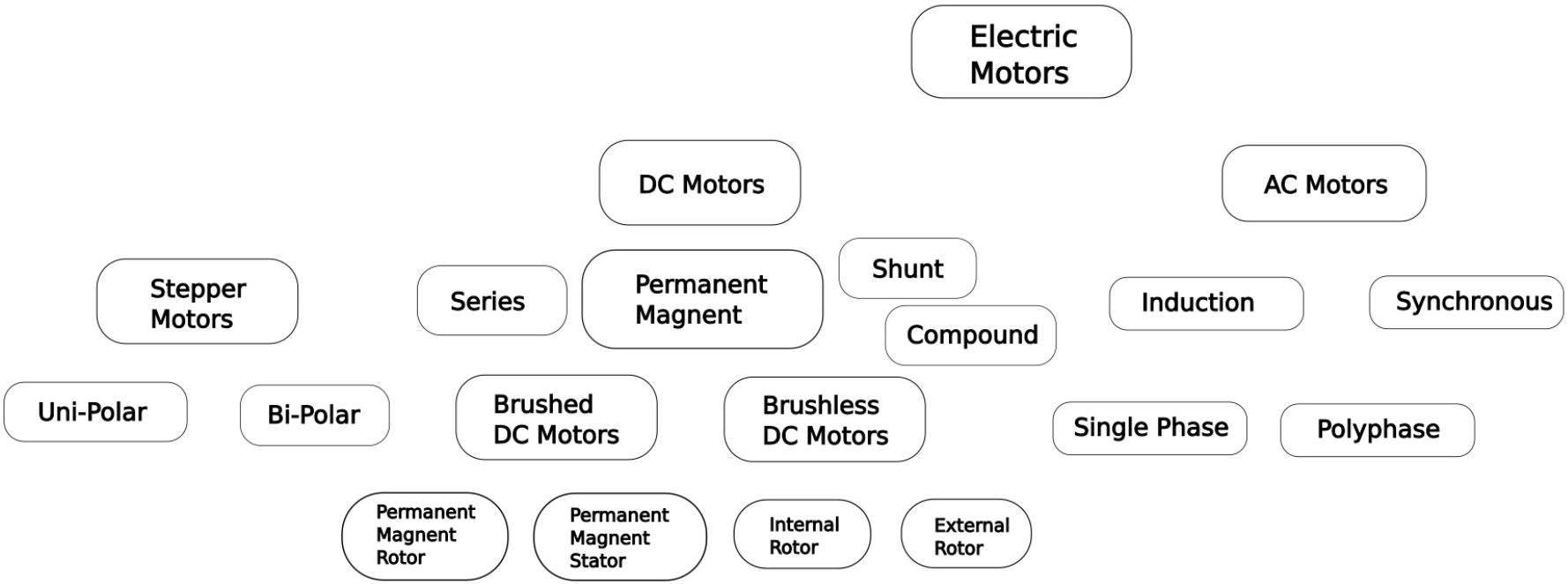
1837
Thomas Davenport
First Usable
Electric Motor

2019
MIT
Mini Cheetah



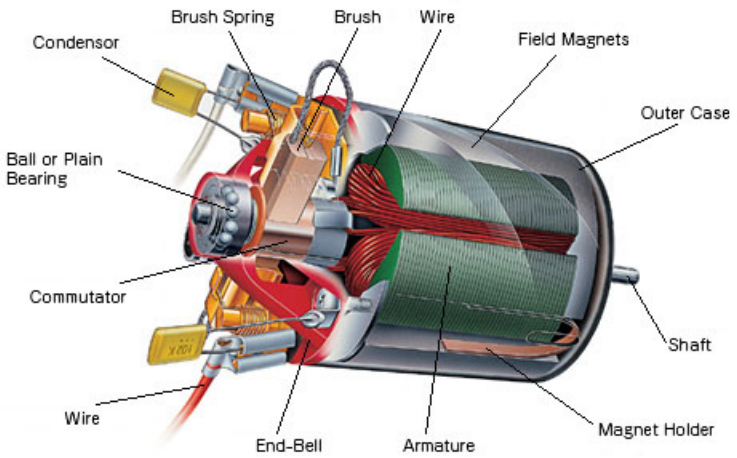


# Overview and Classification



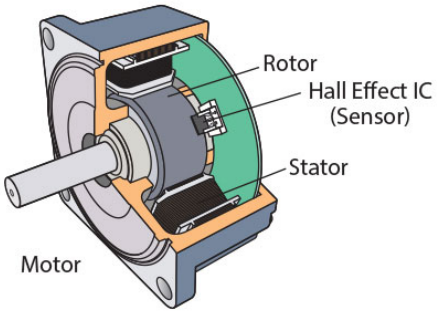
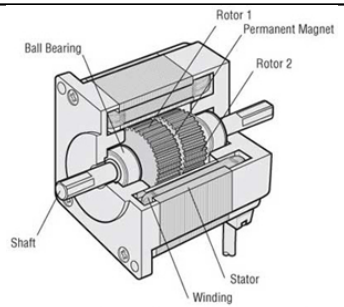
# Overview and Classification

## Common Electric Motor Types

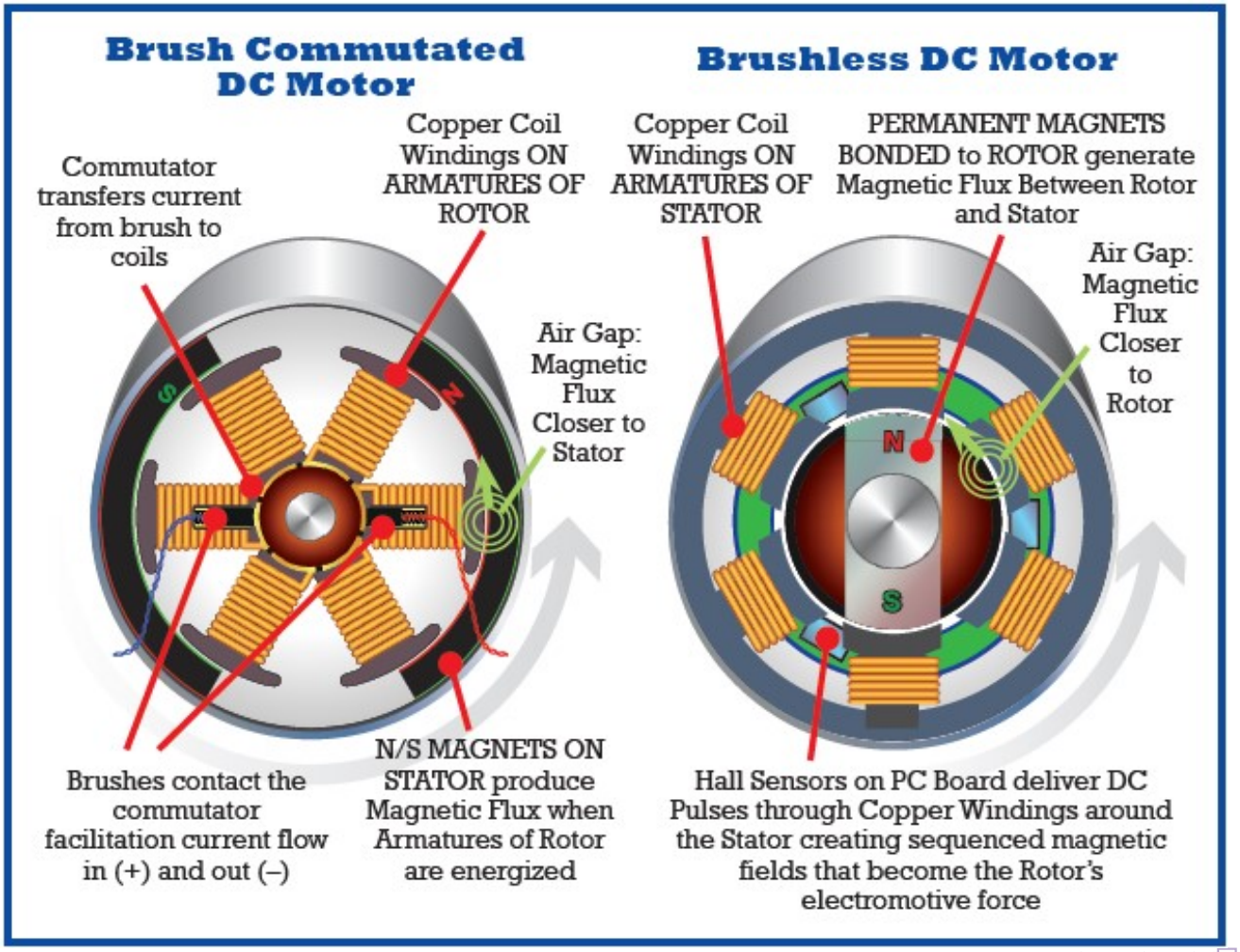
| — Type — | — Example — | — Application — |
|---|---|---|
| |  | |
| |   | |

# Overview and Classification

## Common Electric Motor Types (cont.)

| — Type — | — Example — | — Applications — |
|---|---|---|
| |  | |
| |  <br>Motor Structural Diagram: Cross-Section Parallel to Shaft | |

# Overview and Classification



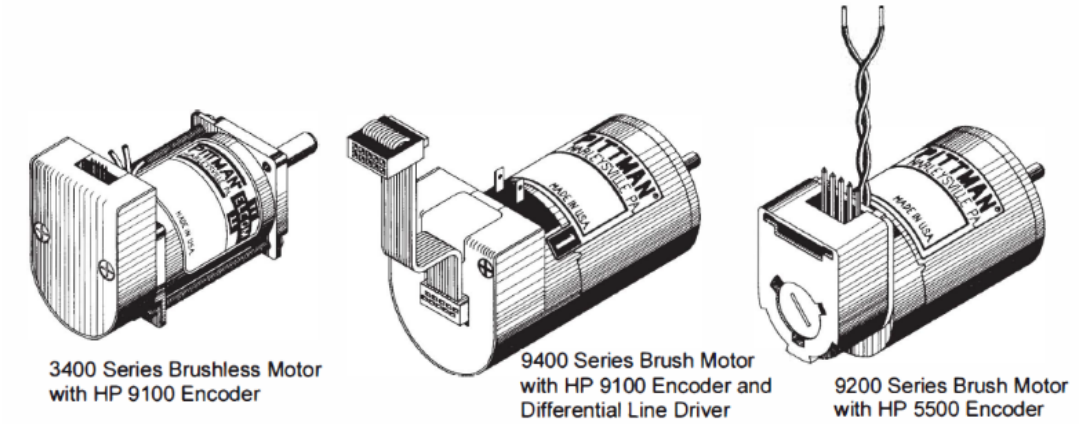
# Open Loop and Closed Loop Control

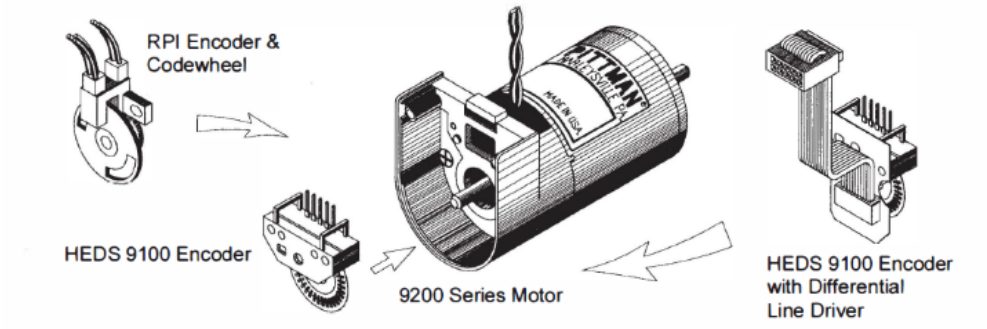
Open Loop vs Closed Loop Control

- Open Loop Control
- Bang-Bang Control
- Armature Control
- Position Control
- Velocity Control

# Open Loop and Closed Loop Control

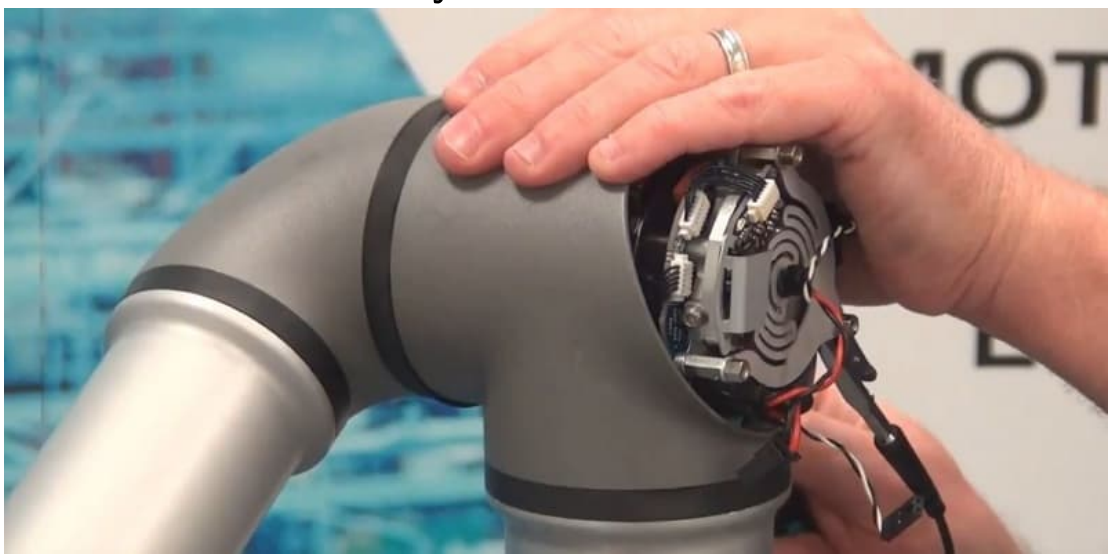
## Feedback Controlled Brushed DC Electric Motor



# Open Loop and Closed Loop Control

Feedback Controlled Brushless DC Electric Motor
Modern Case Study: Universal Robotics - Cobot Arm Joint



# Open Loop and Closed Loop Control

Applications:

- 
- 
- 

Pros

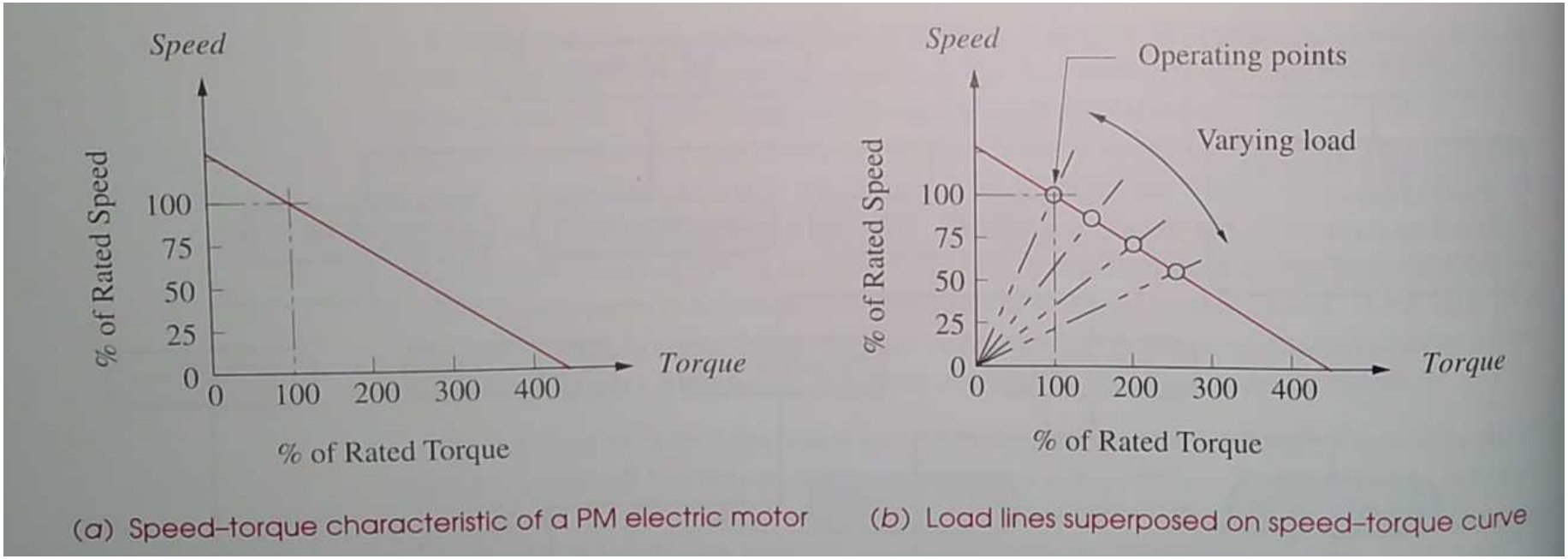
- 
- 
- 

Cons

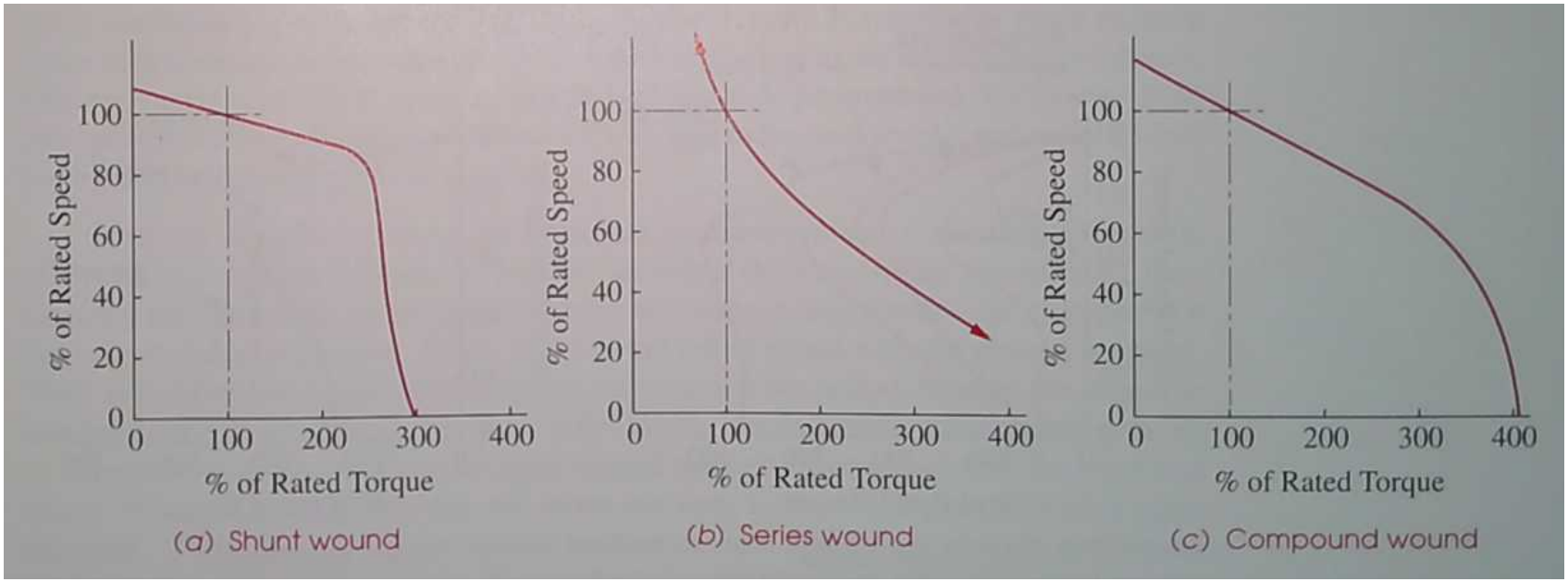
- 
- 
- 

# Open Loop and Closed Loop Control

# Motor Torque-Speed Curves



# Motor Torque-Speed Curves



# Motor Torque-Speed Curves

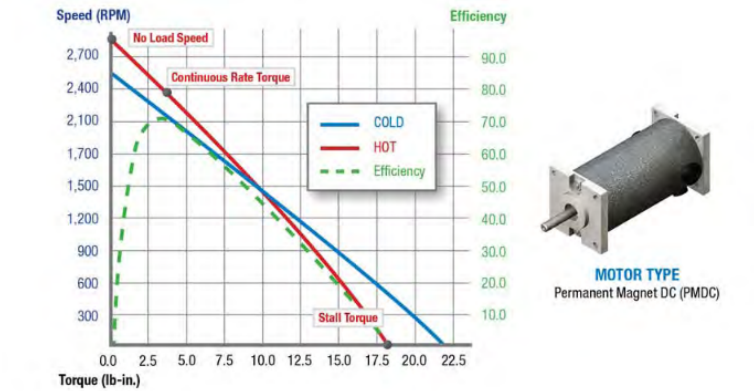



**Figure 7:** *Speed, Torque, Efficiency Curves of a PMDC motor*

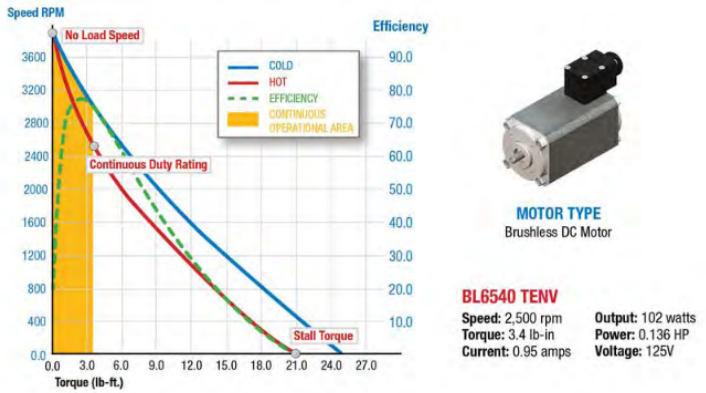



**Figure 10:** *Speed, Torque, Efficiency Curves of a BLDC motor*

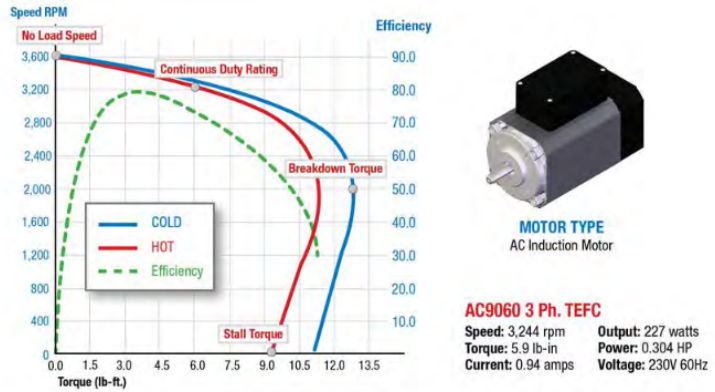



*Figure 9: Speed, Torque & Efficiency Curves of an AC Induction Motor*

# 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