

# Power Screws and Bolted Connections

ME4020 - Applied Machine Design

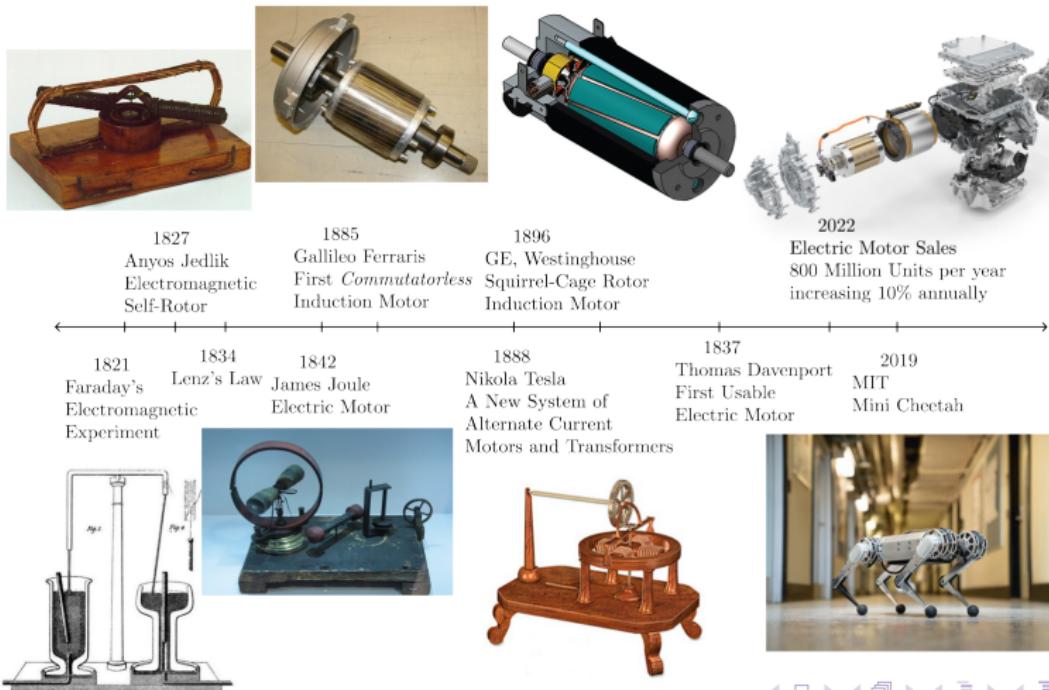
Mechanical Engineering  
Tennessee Technological University

## Motor Selection

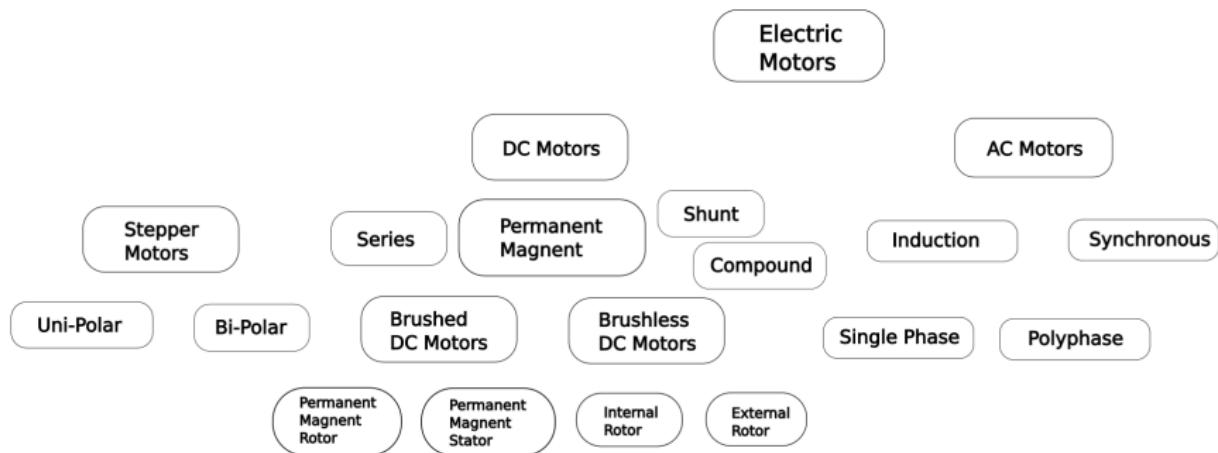
## Motor Selection

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

# Overview and Classification

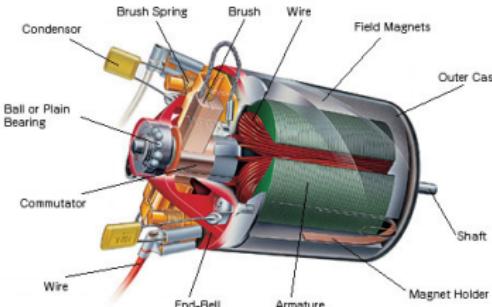


# Overview and Classification



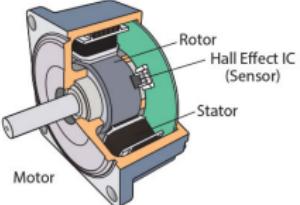
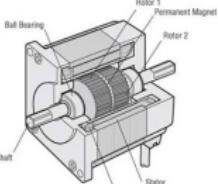
# Overview and Classification

## Common Electric Motor Types

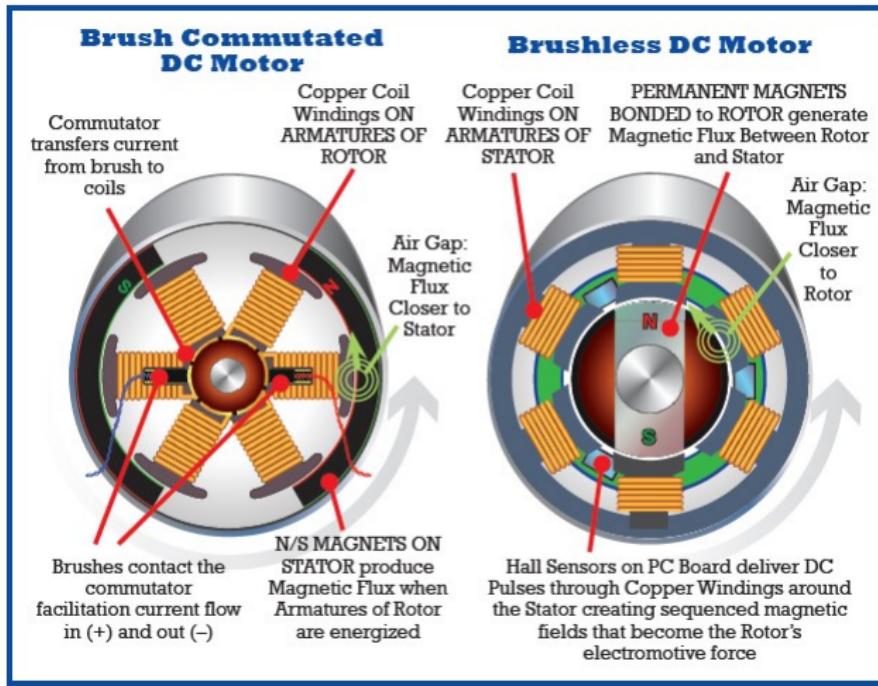
— Type —	— Example —	— Application —
		
		

# Overview and Classification

## Common Electric Motor Types (cont.)

— Type —	— Example —	— Applications —
		
	 Motor Structural Diagram: Cross-Section Parallel to Shaft	

# Overview and Classification



# Open Loop and Closed Loop Control

## Open Loop Control

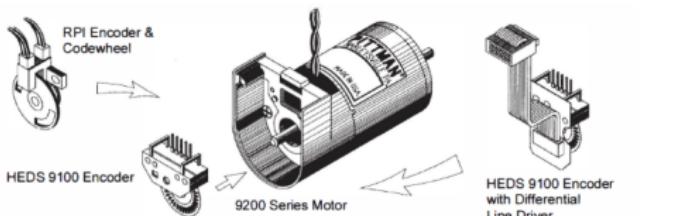
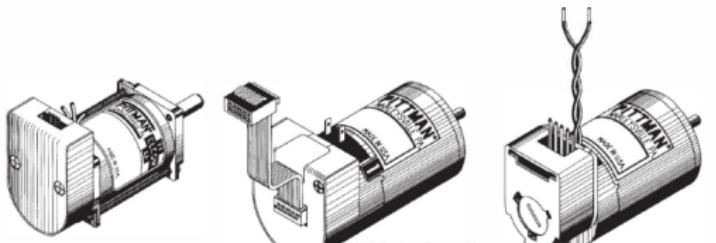
- aka feed-forward controller
- sensorless operation

## Closed Loop Control

- aka feedback control
- Bang-Bang Control
- Current, Velocity, Position Control
- Preferred Strategy: PID  
(alternatives: Model Predictive, Fuzzy Logic)

# 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

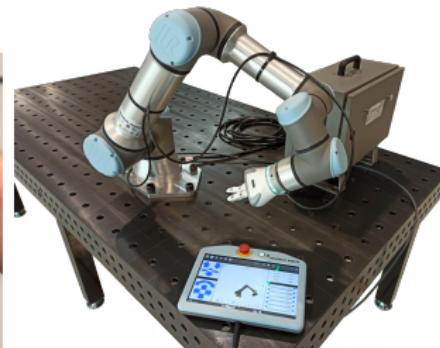


image: [wikimedia commons](#)

# Open Loop and Closed Loop Control

## **Open-Loop Control**

Applications:

- 
- 
- 

### Pros

- 
- 
- 

### Cons

- 
- 
-

# Open Loop and Closed Loop Control

## Closed-Loop Control

Applications:

- 
- 
- 

### Pros

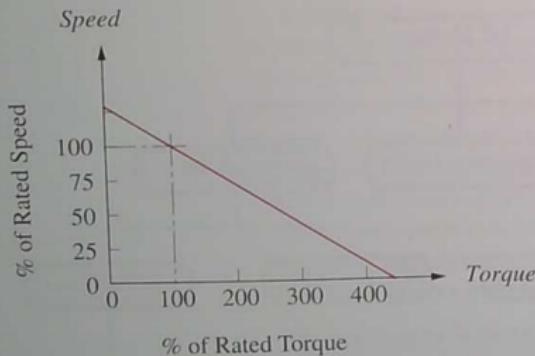
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### Cons

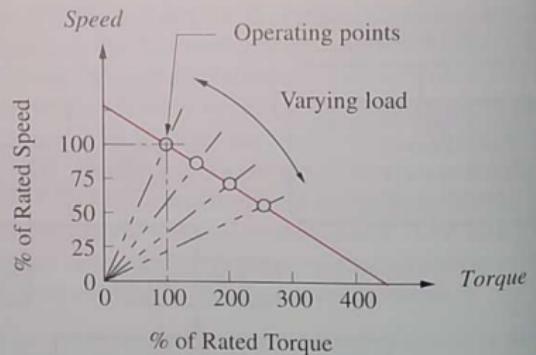
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# Open Loop and Closed Loop Control

# Motor Torque-Speed Curves

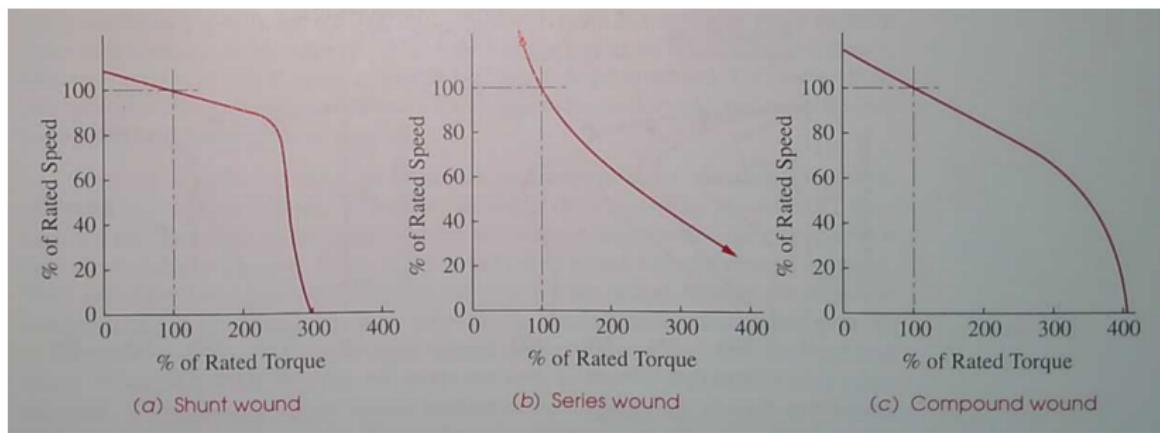


(a) Speed-torque characteristic of a PM electric motor

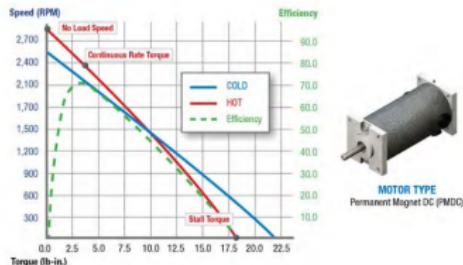


(b) Load lines superposed on speed-torque curve

# Motor Torque-Speed Curves



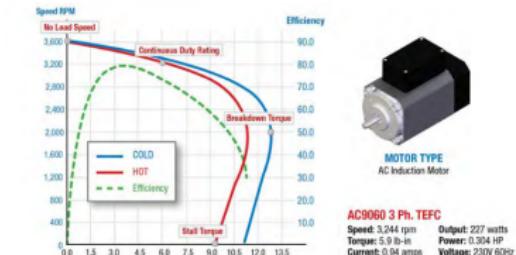
## Motor Torque-Speed Curves



**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**

duty rating

# 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 interface
- 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