RoboMech

Introduction To Robotics & Mechatronix

ROBOTICS CLUB

Prerequisites

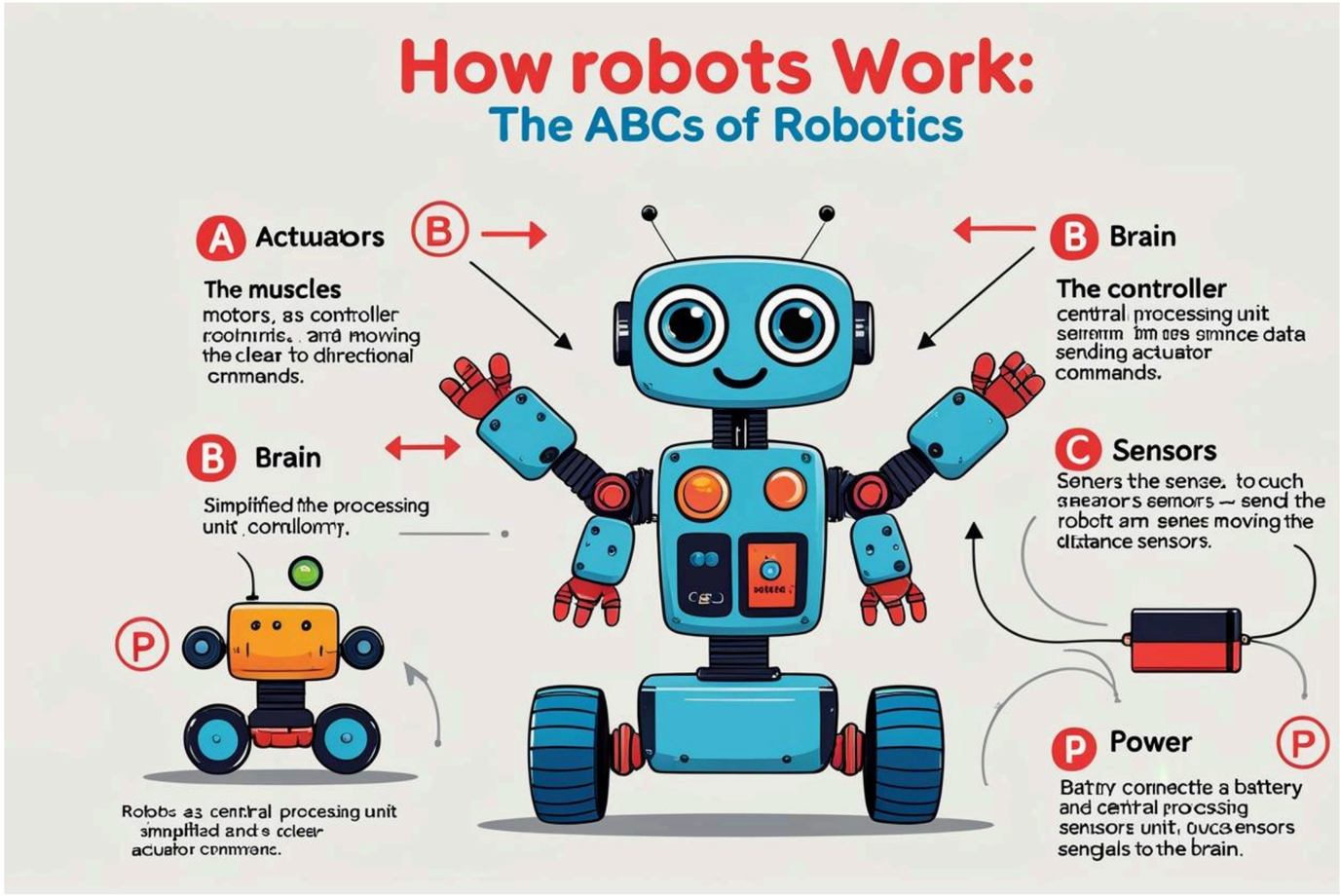
Your presence

Motivation?

Learning **Mechatronics and Robotics** helps you understand how machines work by combining mechanical parts, electronics, and programming. You learn how to design and **build smart systems like robots, drones,** or automatic machines. It improves your **problem-solving skills** and teaches you how to work with real tools like **sensors, motors,** and coding platforms. This knowledge is useful in many industries and can lead to **good career opportunities** in areas like automation, manufacturing, and research. Overall, it prepares you to create smart, useful technologies for the future.

How Do Robots Work?

- A - Actuators (The Muscles): These are the parts that make the robot move, like motors, wheels, or robotic arms.
- B - Brain (The Controller): This is the computer inside the robot that tells it what to do. It processes information and sends commands. Think of it like a tiny computer!
- C - Sensors (The Senses): These are like the robot's eyes, ears, and touch. They help the robot understand its surroundings (e.g., cameras, touch sensors, distance sensors).
- P - Power (The Energy): Every robot needs energy to work! This comes from batteries or electricity. Image: A simplified diagram of a robot with arrows connecting sensors to brain, and brain to actuators, and a power source.



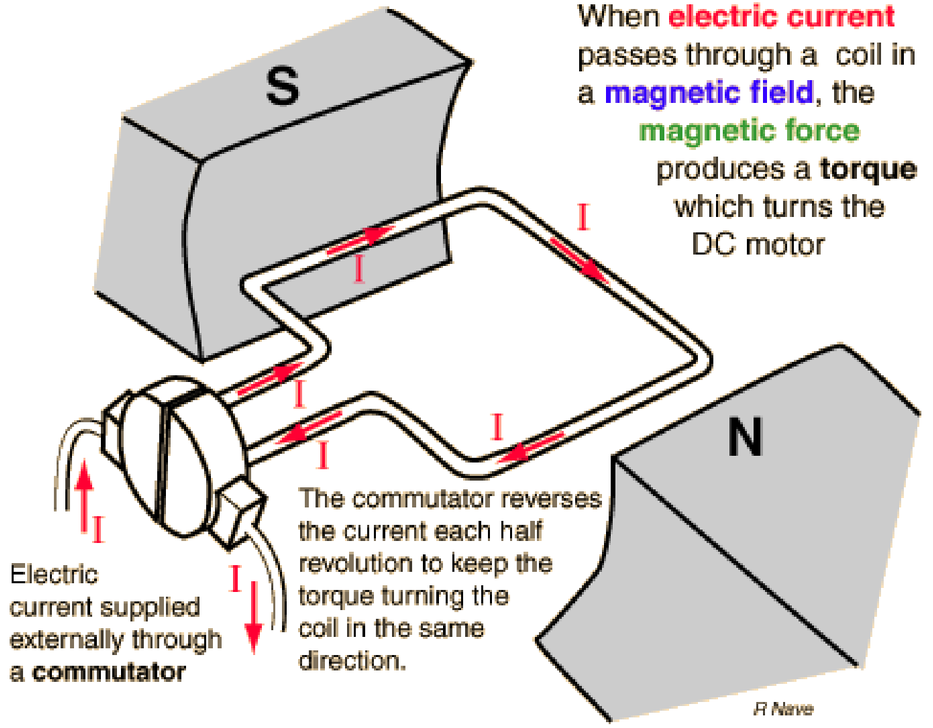
Types of Motors

We will be discussing about :-

1. DC MOTORS
2. SERVO MOTORS
3. STEPPER MOTORS
4. BLDC MOTORS

Types of Motors

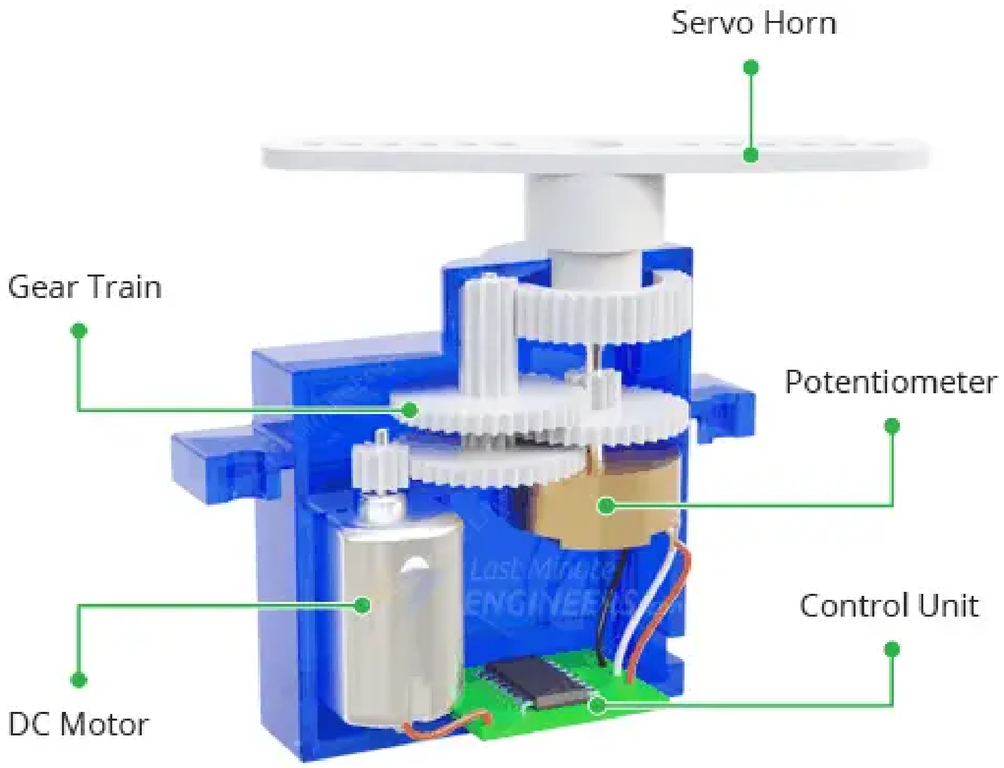
1. **DC Motors (Direct Current)**
   - **Simple, low-cost, easy to control**
   - **Good for continuous rotation (wheels, conveyors)**
   - **Speed controlled by voltage or PWM**



Types of Motors

2. Servo Motor

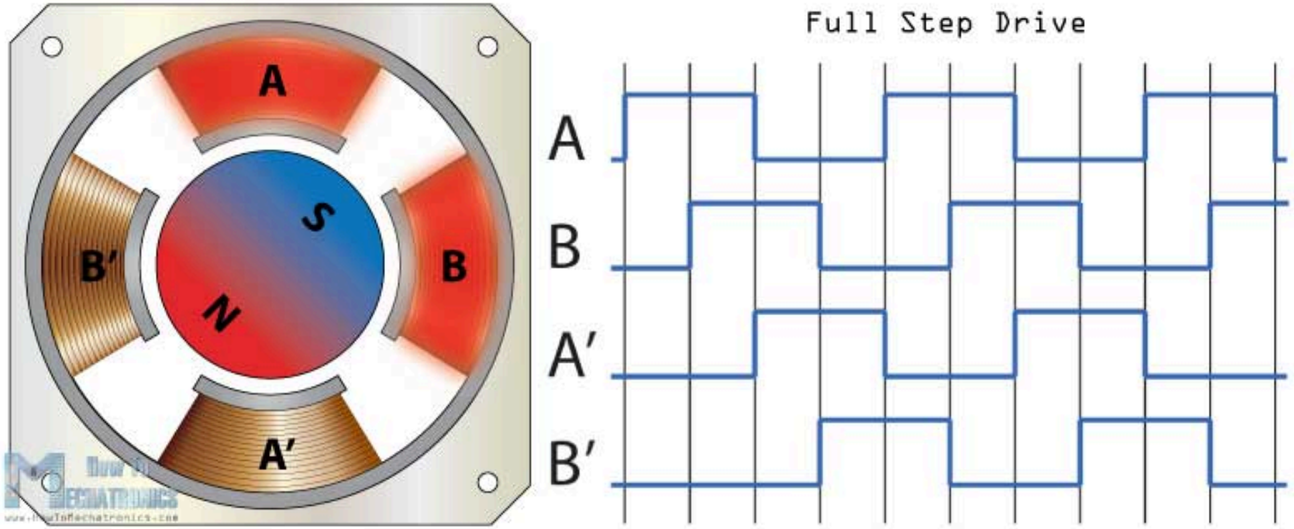
- **Provides precise angular control (0°–180° or 360°)**
- **Built-in feedback system**
- **Used in robotic arms, pan-tilt mechanisms**



Types of Motors

3. Stepper Motors

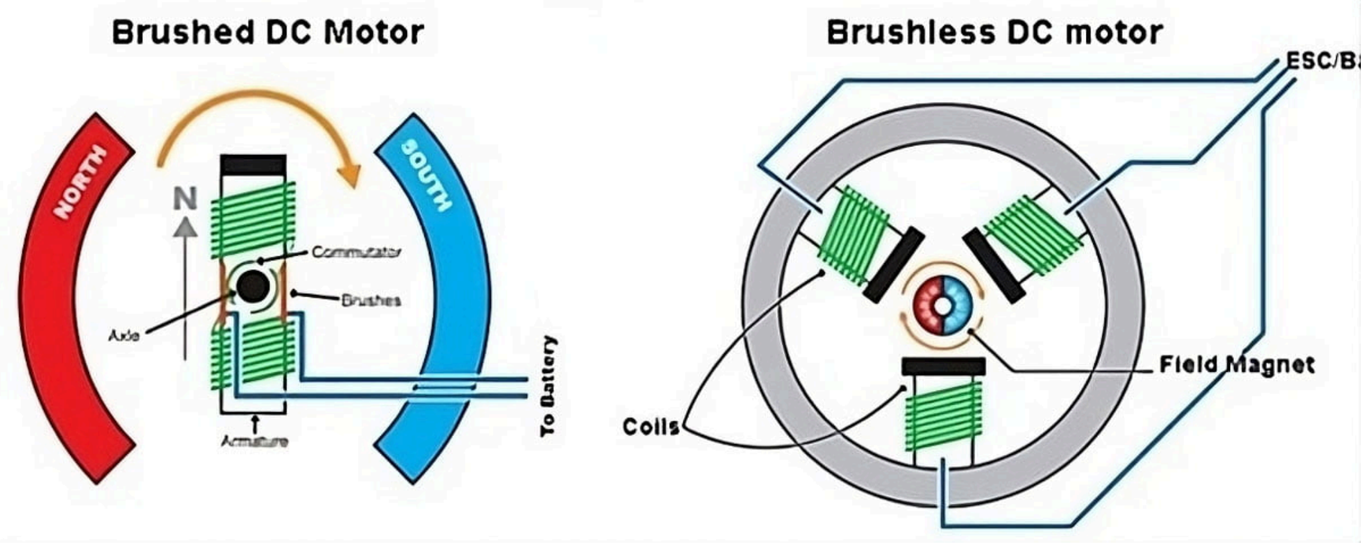
- Rotates in precise steps (1.8°, 0.9°, etc.)
- Ideal for open-loop positioning
- Common in 3D printers, CNC machines



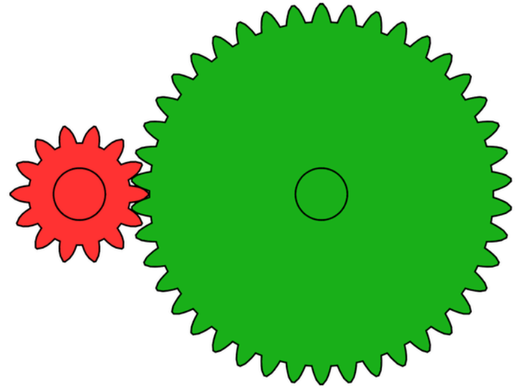
Types of Motors

4. Brushless DC Motors (BLDC)

- High efficiency, low maintenance
- Used in drones, e-bikes, RC vehicles
- Requires ESC (electronic speed controller)



Gears :

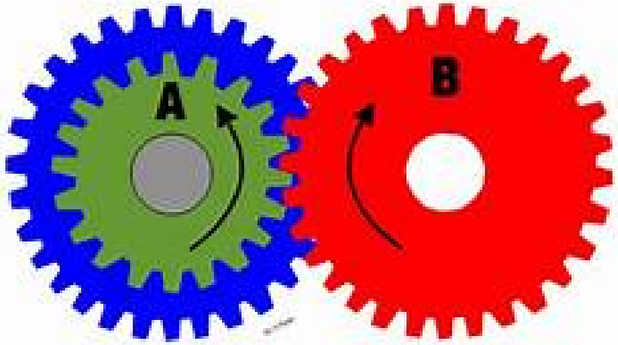


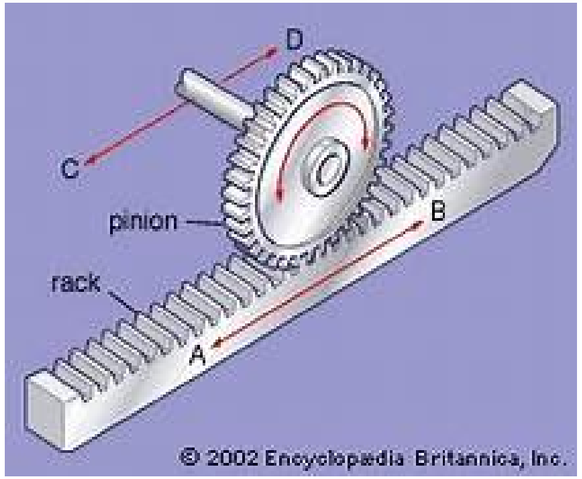
In mechanical engineering, a gear is a rotating machine part, typically a wheel, that has cut teeth around its circumference. These teeth are designed to mesh with the compatible teeth of another gear or a toothed component (like a rack) to transmit rotational motion and/or torque.

Applications:

- **Change Speed:** Gears alter rotational speed, either increasing (with decreased torque) or, more commonly, decreasing it (with increased torque) to match application requirements.
- **Transmit Power:** They efficiently transfer rotational force and power between shafts, ensuring a positive, slip-free drive.

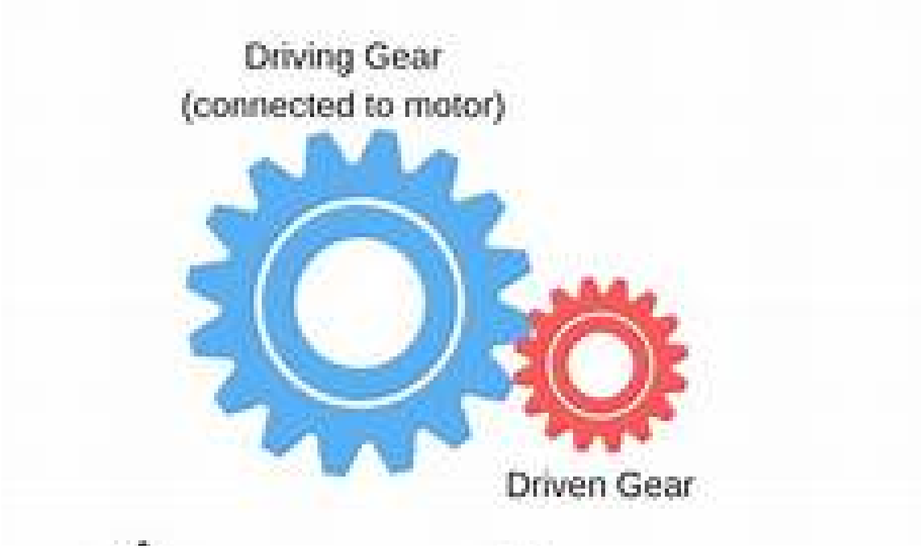
- Change Direction: Gears can reverse the direction of rotation between shafts, a fundamental capability in many mechanical systems.
- Convert Motion: A rack and pinion setup transforms rotational motion into linear motion, essential for steering and precise positioning.
- Provide Mechanical Advantage: By leveraging different gear sizes, they effectively multiply torque, enabling systems to move heavier loads with less input force.
- Synchronize Movement: Gears ensure precise, coordinated motion between different parts of a machine, critical for timing and consistent operation.
- Ensure Precision: In applications requiring high accuracy, such as robotics or measurement instruments, gears provide reliable and exact positioning.





Here are some of the most fundamental gear formulas:

1. Gear Ratio (i or GR):The gear ratio defines the relationship between the speeds and torques of two meshing gears.



Using Number of Teeth:

i : Zdriver / Zdriven = Ndriven / Ndriver

Zdriven = Number of teeth on the driven (output) gear

Zdriver = Number of teeth on the driving (input) gear

Ndriver = Speed of the driving gear (e.g., RPM)

Ndriven = Speed of the driven gear (e.g., RPM)

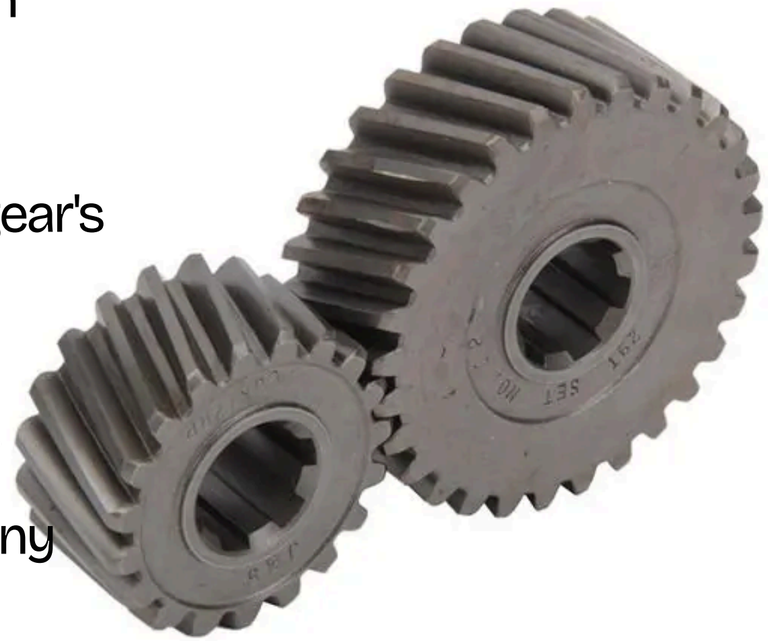
Different types of Gears

1. Spur gear

- Straight Teeth, Parallel Shafts: They have straight teeth parallel to the axle and connect parallel shafts.
- Simple & Economical: Easiest and cheapest to manufacture, install, and maintain.
- Positive Drive: They provide a precise, slip-free transfer of motion, ensuring a constant velocity ratio between the driving and driven gears.

Helical Gears

Think of a spur gear, but instead of straight teeth, the teeth are cut at an angle, spiraling around the gear's body. When two helical gears mesh, their angled teeth engage gradually, starting at one end and smoothly rolling across the face.



- Angled Teeth, Parallel Shafts: Helical gears have teeth cut at an angle to the gear's axis and are primarily used for transmitting power between parallel shafts.
- Quiet & Smooth Operation: Due to gradual tooth engagement, they operate much more quietly and smoothly than spur gears, especially at high speeds.
- Higher Load Capacity: The increased contact ratio (more teeth in mesh at any given time) allows helical gears to transmit heavier loads and handle higher torque.
- Axial Thrust Generated: A disadvantage is that the angled teeth generate axial (endways) thrust force, which requires thrust bearings to manage

3. Bevel Gears

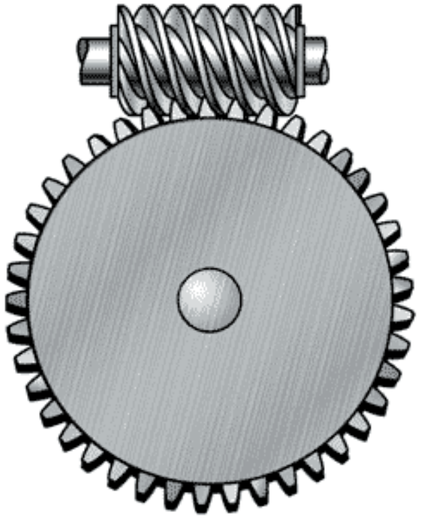
Imagine two cone-shaped wheels with teeth cut into their sloped surfaces. When these two cones are placed so their tips meet and their teeth mesh, you have bevel gears. They are specifically designed to transfer power and motion between shafts that intersect, typically at a 90-degree angle, but other angles are possible.

- Intersecting Shafts: Bevel gears are designed to transmit power between shafts that intersect, commonly at a 90◦ angle.
- Cone-Shaped Profile: Their teeth are cut on conical surfaces, allowing them to change the axis of rotation of power transmission.
- Direction Change & Speed Ratio: Primarily used to change the direction of rotation, they can also provide speed reduction or increase depending on the gear ratio.
- Applications: Found in automotive differentials, hand drills, printing presses, and any machinery needing a change in rotational axis.

4. Worm Gears

A worm gear set consists of two parts: a "worm" which looks like a screw (a cylindrical shaft with a helical thread), and a "worm wheel" which looks like a spur gear but with a curved face designed to perfectly match the worm. When the worm rotates, its thread pushes the teeth of the worm wheel, making it turn.

1. Perpendicular, Non-Intersecting Shafts: Worm gears are used to transmit power between shafts that are at 90° to each other and do not intersect.
2. High Speed Reduction in Compact Space: They offer very high speed reduction ratios (and thus high torque multiplication) in a very compact footprint, often requiring only a single reduction stage.
3. Self-Locking Feature: Due to the high friction and angle of the worm thread, the worm wheel typically cannot drive the worm, providing a "self-locking" safety feature (e.g., in hoists).
4. Low Efficiency & Heat: The primary mode of contact is sliding rather than rolling, leading to lower efficiency and generating more heat, which requires good lubrication.



Project Ideas

Gearbox Comparison Rig

Set up 2 or 3 identical motors with different gearboxes (e.g., 10:1, 20:1, 50:1)
Attach identical loads to each
Compare rotation speed vs. torque

Mechanical Claw (Gripper)

Use gears to open/close the claw using one motor
Learn how gear rotation translates into finger motion
Manual or battery-powered

Mini Windshield Wiper Mechanism

Use a DC motor + gear + crank-slider
Simulate a real wiper with gear-converted oscillation
Good for understanding motion conversion (rotary to linear)

Career Prospects

- **Manufacturing & Automation:** This is a core industry for mechatronics, focusing on designing, optimizing, and implementing automated production lines, robotics, and smart factories (Industry 4.0) to enhance efficiency and precision.

- **Automotive**: Mechatronics engineers are crucial for developing electric vehicles (EVs), autonomous driving systems (ADAS), advanced engine controls, and other intelligent vehicle features.

- **Robotics:** This industry directly leverages mechatronics expertise for designing, building, and programming various types of robots, including industrial, service, and collaborative robots, for applications ranging from assembly to healthcare.

- **Healthcare & Biomedical:** Mechatronics plays a vital role in developing advanced medical devices, surgical robots, prosthetics, and automated diagnostic equipment that improve patient care and surgical precision.

- **Logistics & Supply Chain:** Automation is transforming warehouses and distribution centers. Mechatronics engineers design and implement automated guided vehicles (AGVs), robotic sorting systems, and intelligent inventory management solutions.

QnA

Resources

What is a GearBox?

How Stuff Works

Complete Guide on Gear Ratio

MIT

All about Motors

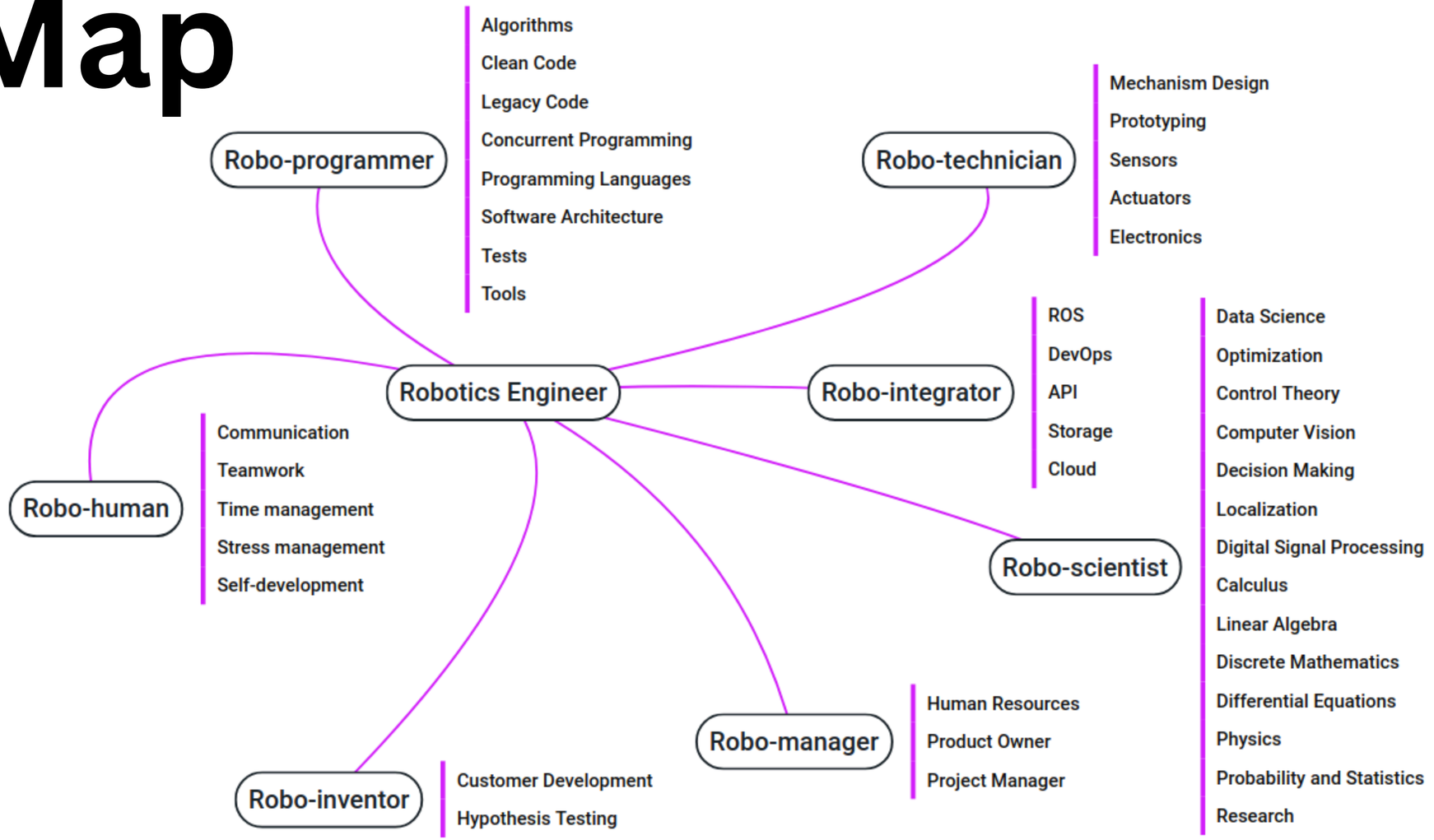
electronoobs

A Beginner's Guide to Choosing Motors

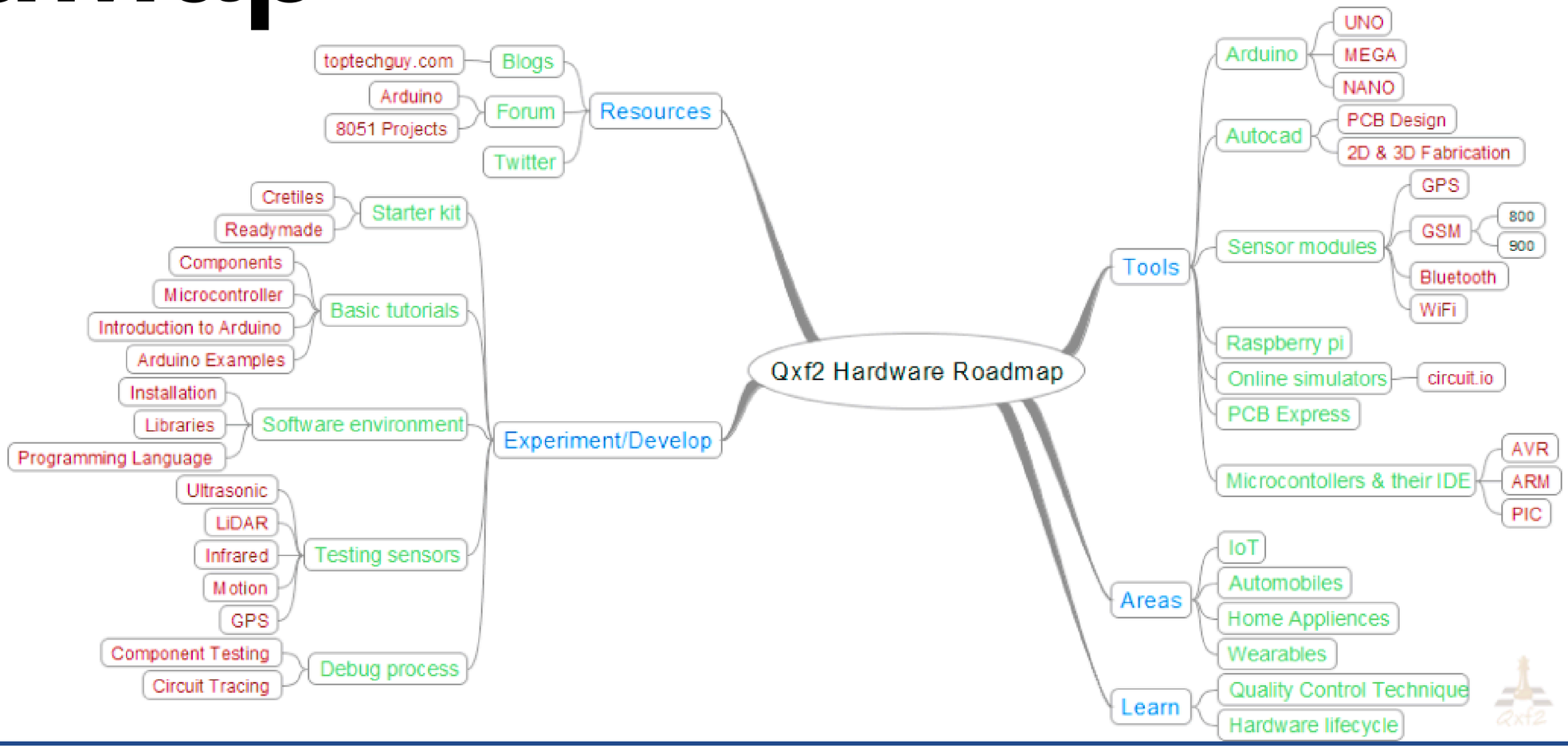
core electronics

QUT Robot Academy

RoadMap


Robotics Engineer
Robo-programmer
Algorithms
Clean Code
Legacy Code
Concurrent Programming
Programming Languages
Software Architecture
Tests
Tools
Robo-technician
Mechanism Design
Prototyping
Sensors
Actuators
Electronics
Robo-integrator
ROS
DevOps
API
Storage
Cloud
Robo-human
Communication
Teamwork
Time management
Stress management
Self-development
Robo-scientist
Data Science
Optimization
Control Theory
Computer Vision
Decision Making
Localization
Digital Signal Processing
Calculus
Linear Algebra
Discrete Mathematics
Differential Equations
Physics
Probability and Statistics
Research
Robo-manager
Human Resources
Product Owner
Project Manager
Robo-inventor
Customer Development
Hypothesis Testing

RoadMap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Cretiles
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Components
Microcontroller
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Programming Language
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GPS
Debug process
Component Testing
Circuit Tracing
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Thank You

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