Robotics & Automation – Unit 3.1

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Third Unit of the syllabus

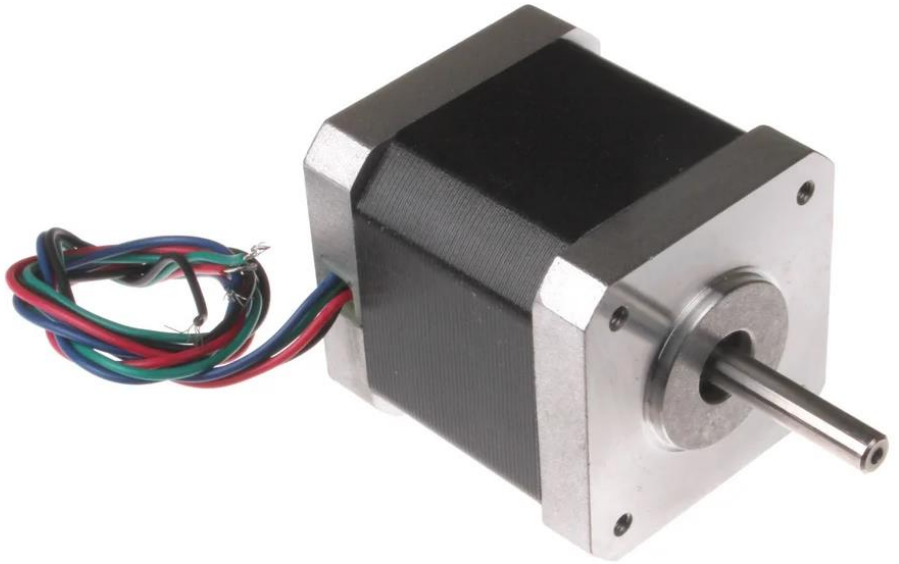
Selection of motor for automation system, sizing of servo motor for a specific application, importance of sizing, selection of mechanical components, load cycle definition, load inertia and torque calculations, selection of motors - Selection of precision motion components - LM Guide ways, Ball screws, bearings, Types, Selection, from the manufacturer’s catalogue based on the applications, fixing arrangements and assembly - Material handling systems

Selection of motors

To select a proper electric motor one has to consider many different parameters like the load that a specific motor can handle, the torque required to move the robot without being overloaded, the rotations per minute of the motor when it is loaded, etc

Power, Torque & Speed

- The power of a DC Motor is proportional to the product of its torque and its speed.
- As the speed of the motor decreases, the torque increases proportionally until maximum torque is achieved. At this point, the motor is stalled, meaning that the motor is not turning even though power is being supplied to it. This is known, appropriately, as the “Stall Torque.”



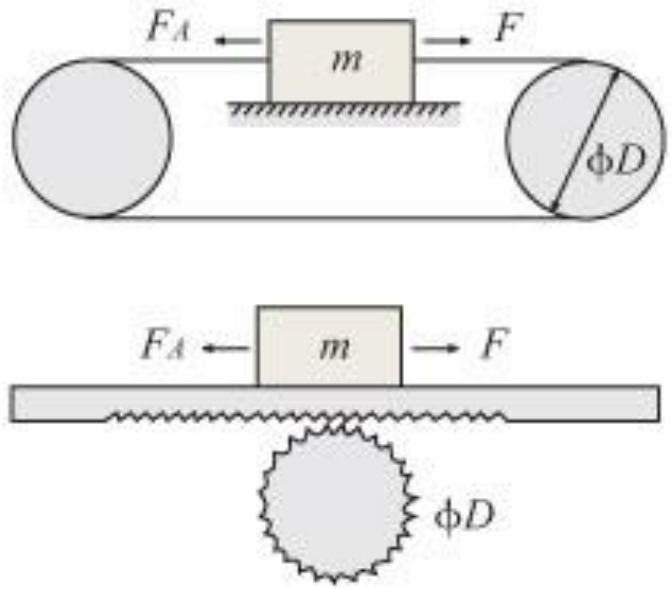
What is the meaning of motor sizing?

Motor Sizing Motor sizing refers to the process of picking the correct motor for a given load. It sis important to size a motor correctly because: a. If a motor is too small for an application it may not have sufficient torque to start the load and run it up to the correct speed.

Sizing of motors

$$T_L = \frac{F}{2\pi\eta} \times \frac{\pi D}{i} = \frac{FD}{2\eta i}$$

$$F = F_A + mg(\sin\theta + \mu\cos\theta)$$



F : Force of moving direction

μ_0 : Internal friction coefficient of preload nut (0.1~0.3)

η : Efficiency (0.85~0.95)

i : Gear ratio (This is the gear ratio of the mechanism and not the gear ratio of the Oriental Motor's gearhead you are selecting.)

P_B : Ball screw lead

F_A : External force

m : Total mass of the table and load

μ : Friction coefficient of sliding surface (0.05)

θ : Tilt angle [deg]

D : Final pulley diameter

g : Gravitational acceleration

Sizing of motors

Proper sizing and selection of a motor for your equipment is key to ensuring performance, reliability and cost of the equipment.

Proper sizing is a crucial aspect of motor selection. If a motor is undersized, it will not be able to control the load, leading to overshoot and ringing. If the motor is oversized, it may control the load but it will also be larger and heavier, as well as more expensive in terms of price and cost of operations.

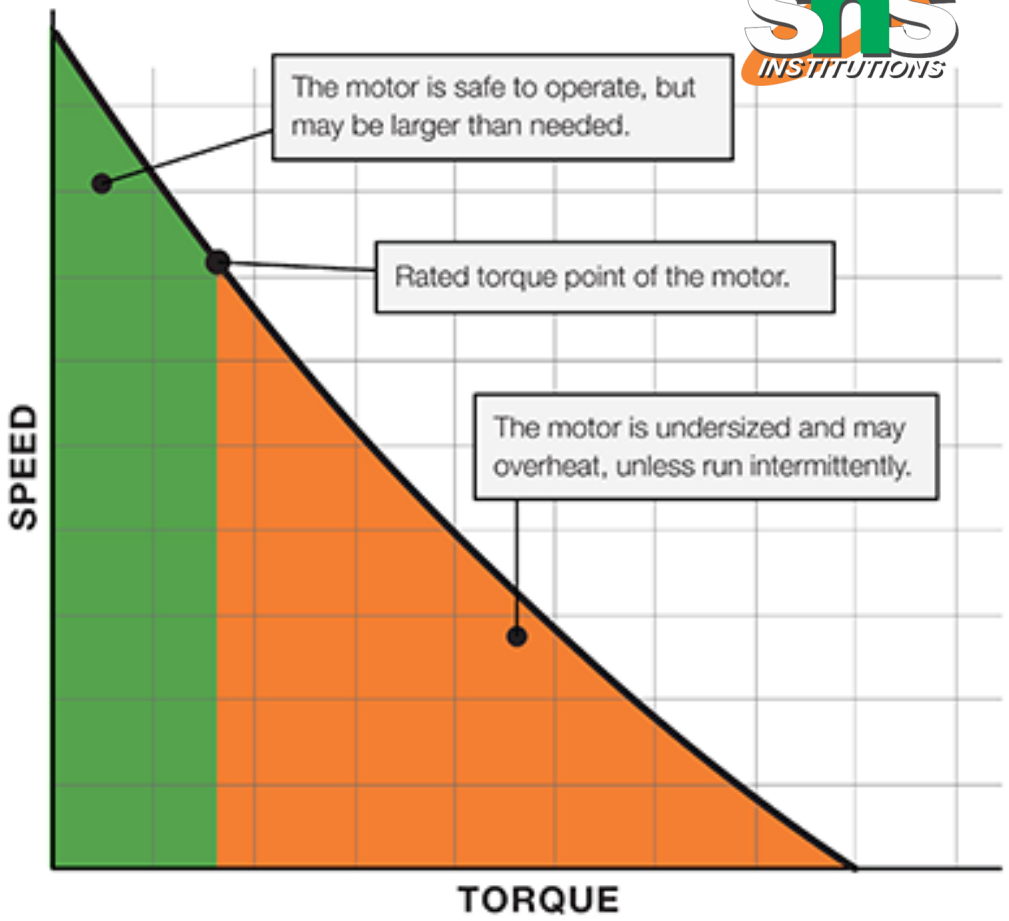
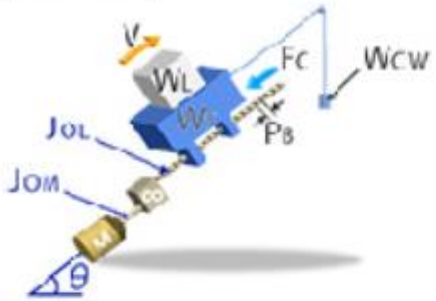
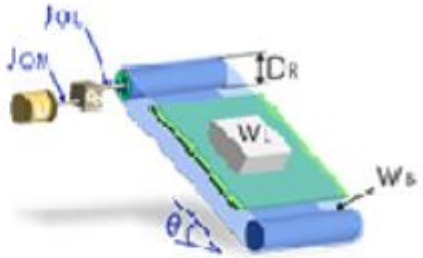


Figure 2: Speed-torque shows the rated torque point of the motor. At the low end of the torque curve, the motor is safe to operate but may be oversized (green) while on the high end of the torque curve, the motor would be undersized and vulnerable to failure if operated continuously in this regime (orange). (Courtesy of Groschopp)

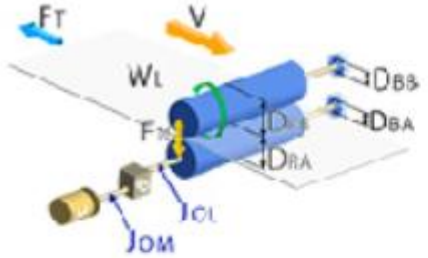
[Ball screw]



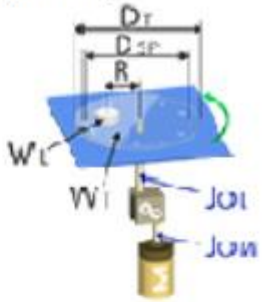
[Rack and pinion]



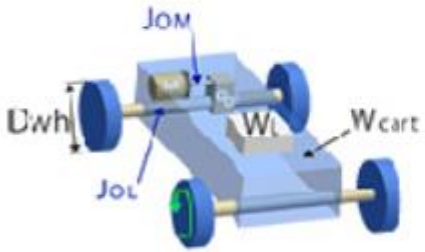
[Roll feed]



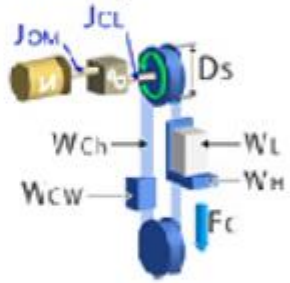
[Rotary table]



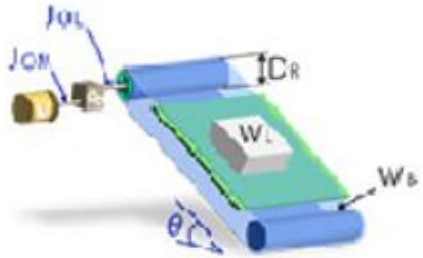
[Cart]



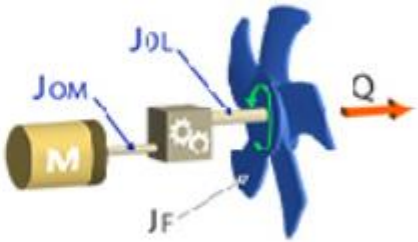
[Elevator/hoist]



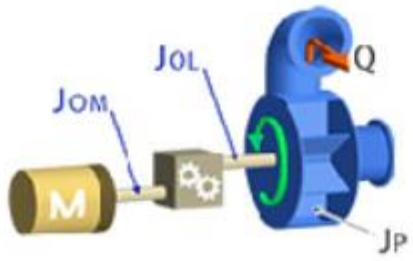
[Conveyor]



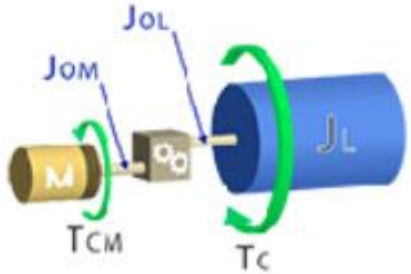
[Fan]



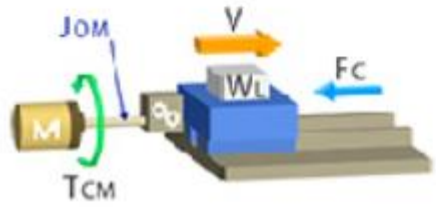
[Pump]



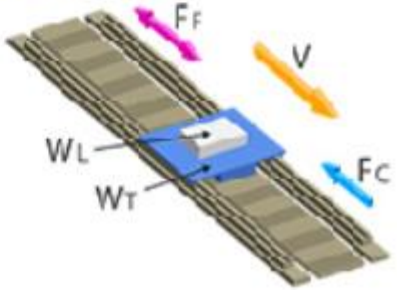
[Generic (rotary)]



[Generic (linear)]



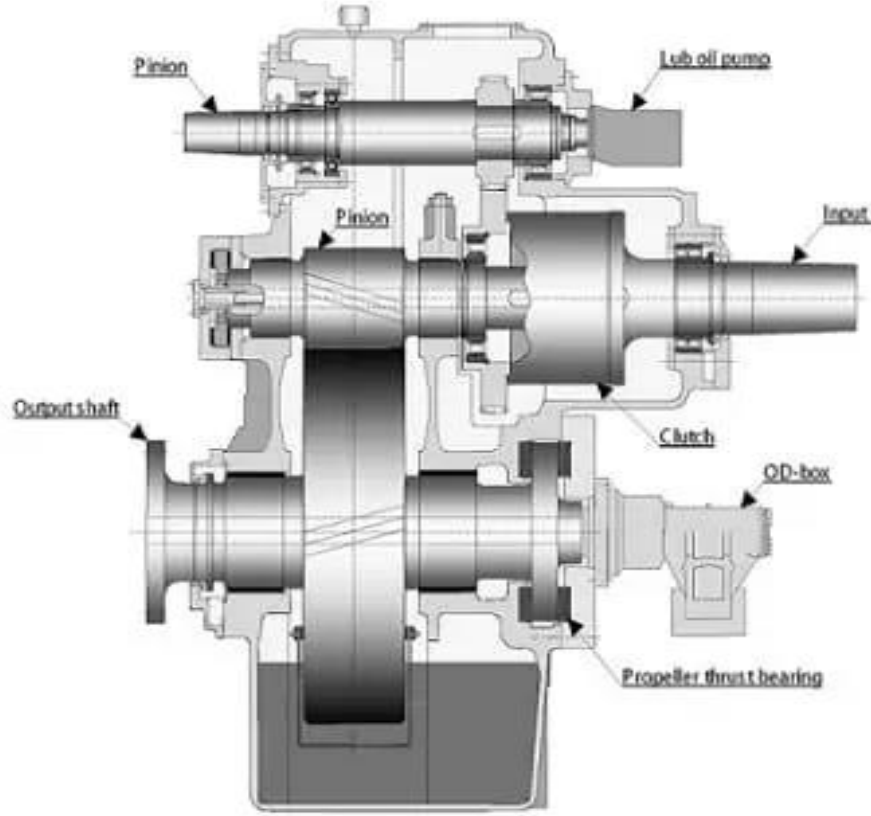
[Linear servo]



Selection of Mechanical components

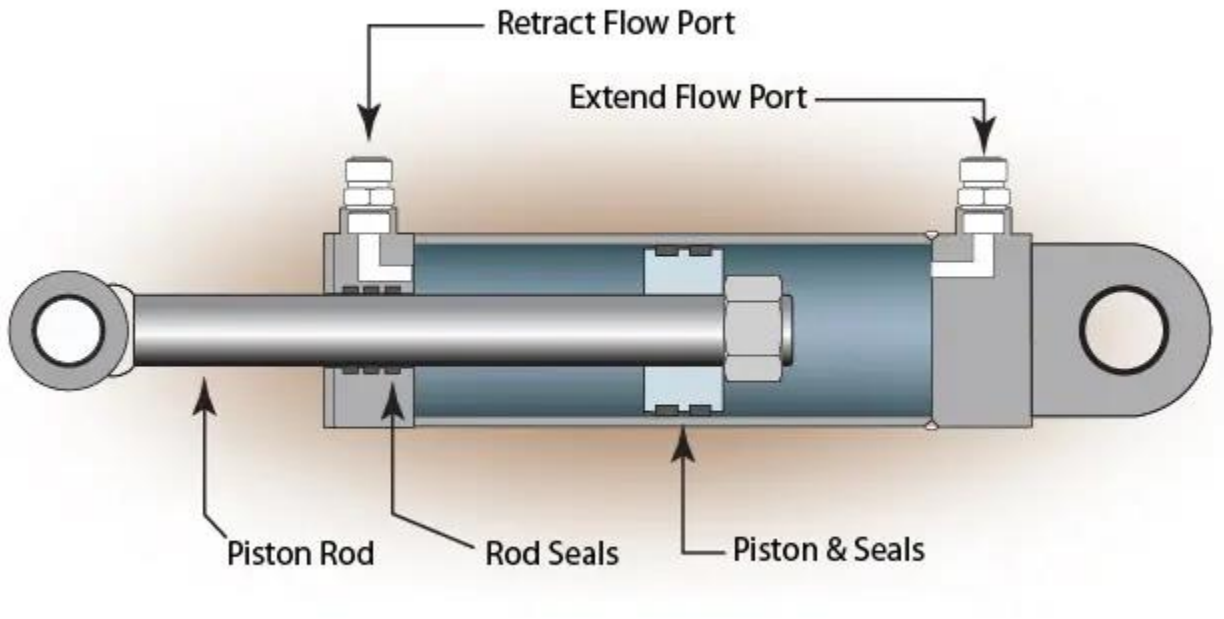
There are four main mechanical components o industrial robots;

1. actuators,
2. reduction gears,
3. encoders,
4. and the transmission.



What is an Actuator?

An actuator is a device that produces motion by converting energy and signals going into the system. The motion it produces can be either rotar or linear.



Types of Actuators

1. Electrical actuators
   - Electric motors
     - DC servomotors
     - AC motors
     - Stepper motors
   - Solenoids

1. Hydraulic actuators
   - Use hydraulic fluid to amplify the controlle command signal

1. Pneumatic actuators
   - Use compressed air as the driving force