Unit 5
Power Transmission

INTRODUCTION TO MECHANICAL DRIVES

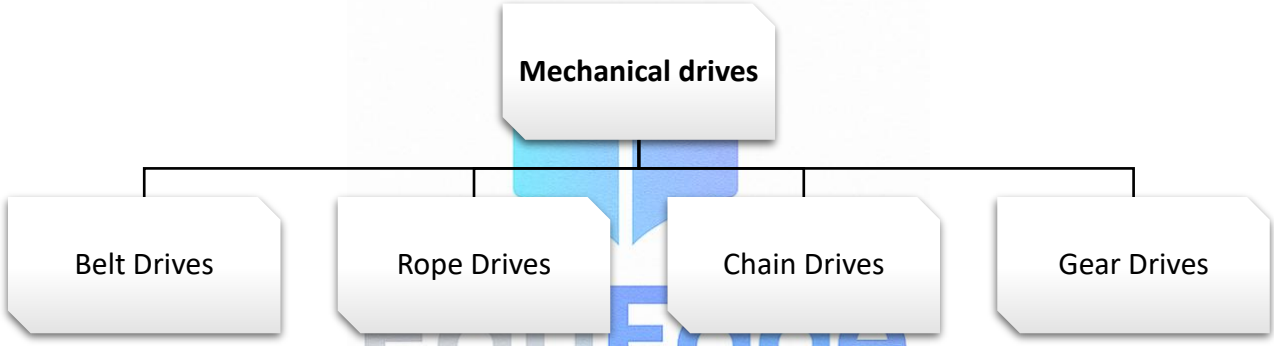
Mechanical drives are systems designed to transmit mechanical power from a power source (like a motor or engine) to a machine or application. They transfer motion, torque, and energy between components using physical contact or connection.

Importance of Mechanical Drives:

- Facilitate motion and power transfer
- Provide speed control, torque amplification
- Enable directional change in motion
- Allow distance adjustment between components
- Support energy efficiency and machine flexibility

CLASSIFICATION OF MECHANICAL DRIVES

Mechanical drives are broadly classified as:



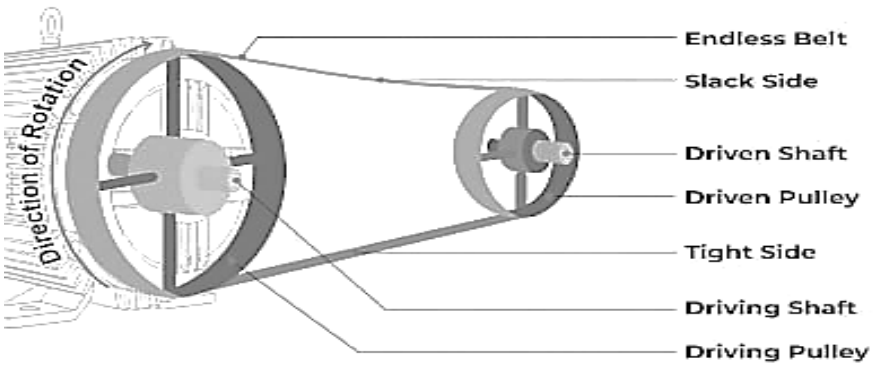
Each has its own construction, applications, pros and cons.

BELT DRIVES

Definition: A belt drive consists of a flexible belt looped over driver and driven pulleys to transmit motion and power between two rotating shafts separated by a moderate distance.

Working Principle:

- Friction between the belt and pulley transmits power.
- The driving pulley pulls the belt, which turns the driven pulley.



Types of Belt Drives:

1. Open Belt Drive
    - Shafts rotate in same direction
    - Simple and widely used
2. Cross Belt Drive
    - Shafts rotate in opposite direction
    - More contact area, more wear
3. Stepped (Cone Pulley) Drive
    - Variable speeds using multiple pulley steps
4. Compound Belt Drive
    - Multiple driver and driven pulleys
5. Fast and Loose Pulley Drive
    - Enables disengagement without stopping the motor

Belt Types Based on Cross-Section:

- Flat Belt: Used for long distance, low power
- V-Belt: Wedge-shaped, used in high power and speed
- Circular or Round Belt: Used in small machines

Materials Used:

- Leather
- Rubber
- Cotton or Fabric belts
- Synthetic (Nylon, Neoprene)

Advantages:

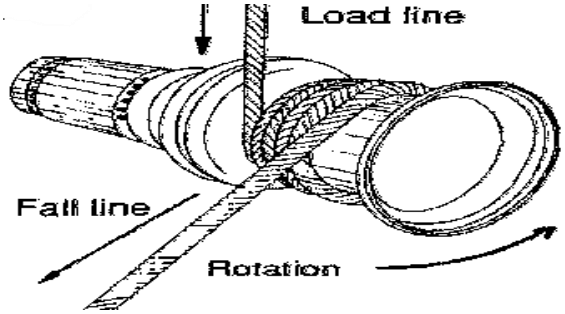
- Economical and simple
- No lubrication needed
- Shock and vibration absorbing
- Quiet operation

Disadvantages:

- Slip and creep reduce accuracy
- Power loss due to friction
- Not suitable for very high power
- Periodic maintenance required

ROPE DRIVES

Definition: Rope drives are similar to belt drives but use thick ropes made of Fiber or wire. They are used for large power transmission over long distances.



Types:

- Fiber Rope Drives: Made from hemp, cotton
- Wire Rope Drives: Made from steel wires twisted into strands

Applications:

- Lifting mechanisms (cranes, hoists)
- Mines and elevators
- Overhead transport

Advantages:

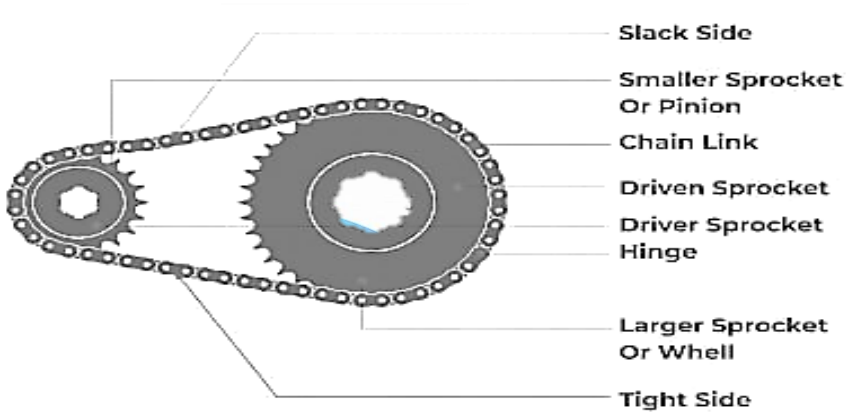
- Strong and durable
- Suitable for long-distance and heavy loads
- High speed ratios possible

Disadvantages:

- Heavier and more expensive than belts
- More complicated installation
- Higher maintenance for wire ropes

CHAIN DRIVES

Definition: Chain drives use linked metal chains running over toothed wheels called sprockets to transmit motion without slip.



Construction:

- Consists of roller chain, sprockets, and tensioners
- Chains are made from steel

Advantages:

- No slip – perfect speed ratio
- Long life
- Can work in oily or dirty environments
- More compact than belts

Disadvantages:

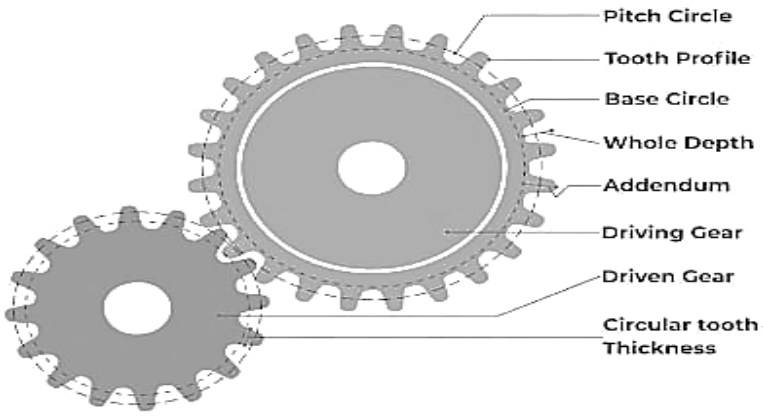
- Noisy
- Requires lubrication
- Initial cost is higher than belt drives

Applications:

- Bicycles, motorcycles
- Conveyor systems
- Agricultural and industrial machinery

GEAR DRIVES

Definition: Gears are toothed wheels that mesh together to transmit torque between shafts. Gear drives are positive drives with no slip, used when precise motion control is needed.



Types of Gears:

1. Spur Gears – Straight teeth, parallel shafts
2. Helical Gears – Angled teeth, smoother, used in high speed
3. Bevel Gears – Shafts at 90° angle
4. Worm Gears – Screw-like worm meshes with gear, large speed reduction

Note: Epicyclic (planetary) gear trains are excluded from BTU syllabus.

Advantages:

- Accurate transmission
- Compact and efficient
- Can handle high load and speed

Disadvantages:

- Expensive and complex
- Needs lubrication and precise alignment
- More noise and vibration at high speed

VELOCITY RATIO (V.R.)

Definition: Velocity ratio is the ratio of speed of driver (input) to speed of driven (output) component.

For belt drives:

$$V.R. = \frac{N_2}{N_1} = \frac{D_1}{D_2}$$

Where:

- N_1 = Speed of driver pulley
- N_2 = Speed of driven pulley
- D_1 = Diameter of driver pulley
- D_2 = Diameter of driven pulley

If belt thickness is significant:

$$V.R. = \frac{\mathrm{D1} + \mathrm{t}}{\mathrm{D2} + \mathrm{t}}$$

RATIO OF TENSIONS IN BELTS

When transmitting power, a belt experiences two tensions:

- T_1: Tension on the tight side
- T_2: Tension on the slack side

Formula:

$$\frac{T_1}{T_2} = e^{\mu\theta}$$

Where:

- μ = Coefficient of friction
- θ = Angle of lap/contact in radians

This equation is essential in designing belt drive systems, calculating power, and understanding friction loss.

APPLICATIONS OF MECHANICAL DRIVES

Drive Type	Applications
Belt Drives	Fans, blowers, textile looms, lathe machines
Rope Drives	Elevators, cranes, ropeways
Chain Drives	Motorcycles, bicycles, conveyor belts
Gear Drives	Gearboxes, clocks, wind turbines, machine tools

COMPARISON TABLE

Feature	Belt Drive	Rope Drive	Chain Drive	Gear Drive
Slip	Yes	Yes	No	No
Maintenance	Low	Medium	Medium	High
Speed Ratio	Moderate	High	Accurate	Most Accurate
Power Transfer	Moderate	High	High	Very High
Cost	Low	Medium	High	High