

LESSON 4 - BASIC MECHANICS

Overview of Lesson 4 - BASIC MECHANICS for AUTOMATION

Lecture 1: Pressure & Flow

Lecture 2: Load & Force

Lecture 3: Temperature & Thermal Consideration

Lecture 3 of 3 – Temperature & Environmental Considerations

Goal for this Lecture: For the student to gain an introductory understanding of basic mechanics with a focus on Temperature & Environmental Considerations and how they relate to automation.

I. Environmental Factors

A. Heat Load and Internal Temperature

1. Establish maximum internal temperatures
2. Establish minimum internal temperatures

B. External Temperature

1. Establish the range of external temperatures that are expected.
2. Consider all seasons.

C. Solar Radiation and Other Heat Sources

1. The impact of solar radiation or radiation from other hot equipment nearby, such as a furnace, is significant and must be taken into account.

D. Humidity

1. Many geographical areas experience seasonal high humidity.

E. Atmospheric Pollution

1. The vapors from corrosive chemicals may attack the metals used in electrical equipment.

F. Water, Snow and Ice

1. Industrial control panels that are situated outdoors in cool climates will be subject to rain, snow and ice and need adequate protection to prevent ingress of moisture.

II. Environmental Standards

A. NEMA - National Electrical Manufacturers Association

B. IP Ratings

1. The IP Code (or International Protection Rating, sometimes also interpreted as Ingress Protection Rating*) consists of the letters IP followed by two digits and an optional letter.
2. First Level digit 6 is for No ingress of dust; complete protection against contact.
3. Second digit 7 is for ingress of water in harmful quantity shall not be possible when the enclosure is immersed in water under defined conditions of pressure and time (up to 1 m of submersion).

1. What it is NOT

2. **Force defined:** Force is a push or pull on an object.

B. Force can cause an object to accelerate, slow down, remain in place, or change shape.

II. How we measure force

A. The unit of measure for force is the newton which is abbreviated as "N".

B. One newton is the force needed to accelerate one gram of mass by one centimeter per second squared.

III. Formula for Force

A. Formula: $f = m * a$ (Where f = force, m = mass, and a = acceleration.

B. Force is a vector because it has direction.

IV. Some common types of forces

A. Friction - Friction is a force caused when one object rubs against another. It works in the opposite direction of the main force.

B. Gravity - Gravity is a force caused by a large body, such as the Earth. Gravity pulls objects toward the Earth with an acceleration of "g" which equals 9.8 m/s².

C. Electromagnetic - Electromagnetic force is a force associated with electric and magnetic fields.

D. Nuclear - Nuclear forces are the forces that hold atoms and their particles together.

- E. Tension - A pulling force that is exerted by a string, cable, or chain on another object.
- F. Elastic - An elastic force is a force exerted by an object trying to return to its natural length.
- V. Difference between Force and Load
 - A. Force is the dynamic load [$\text{force} = \text{mass} \times \text{acceleration}$] and it can act in any direction.
 - B. Load is a static (Stationary) load { $F = mg$ } and it can act only in downward direction
 - C. Force of gravity is $F = mg$, m is the mass and where g is the acceleration due to gravity.