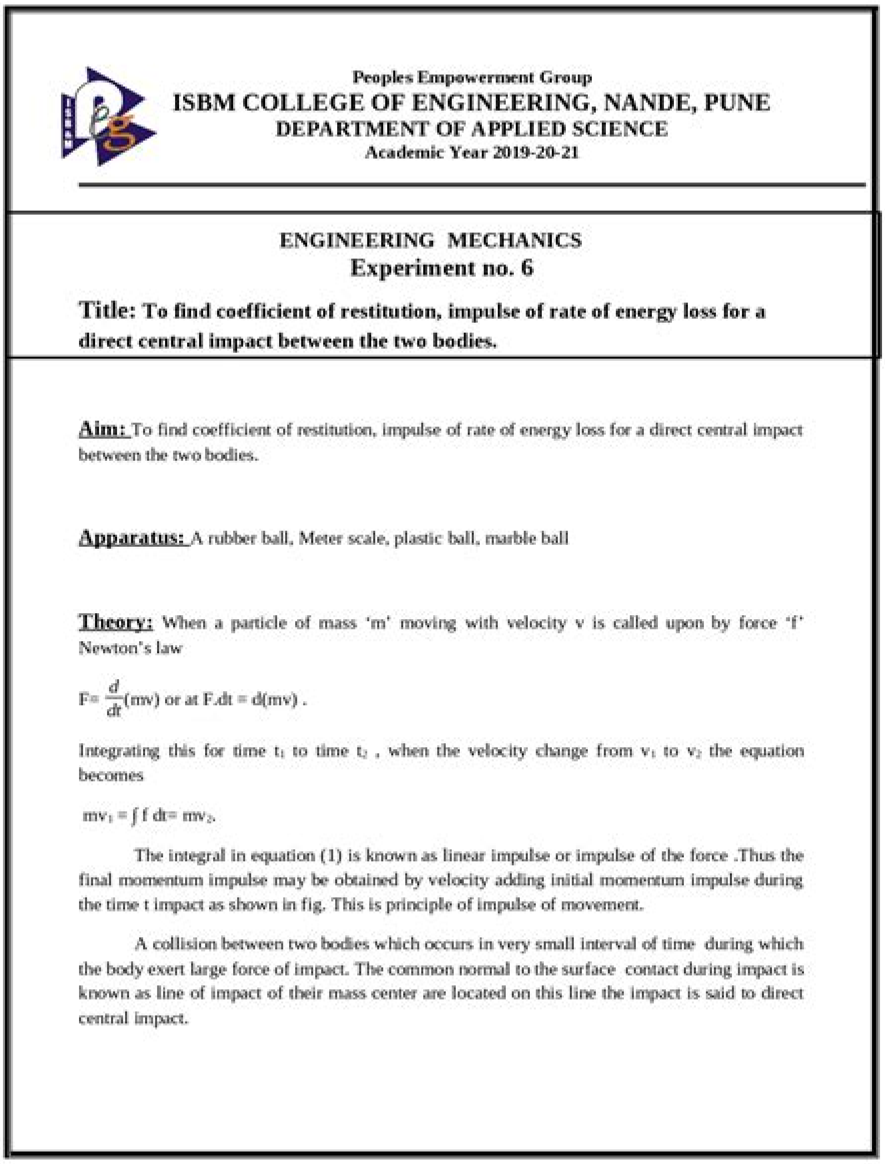
First Year Engineering Mechanics Notes



Peoples Empowerment Group
ISBM COLLEGE OF ENGINEERING, NANDE, PUNE
DEPARTMENT OF APPLIED SCIENCE
Academic Year 2019-20-21

ENGINEERING MECHANICS
Experiment no. 6

Title: To find coefficient of restitution, impulse of rate of energy loss for a direct central impact between the two bodies.

Aim: To find coefficient of restitution, impulse of rate of energy loss for a direct central impact between the two bodies.

Apparatus: A rubber ball, Meter scale, plastic ball, marble ball

Theory: When a particle of mass 'm' moving with velocity v is called upon by force 'f' Newton's law

$F= \frac{d}{dt}(mv)$ or at $F.dt = d(mv)$.

Integrating this for time t_1 to time t_2 , when the velocity change from v_1 to v_2 the equation becomes

$mv_1 = \int f\,dt= mv_2.$

The integral in equation (1) is known as linear impulse or impulse of the force .Thus the final momentum impulse may be obtained by velocity adding initial momentum impulse during the time t impact as shown in fig. This is principle of impulse of movement.

A collision between two bodies which occurs in very small interval of time during which the body exert large force of impact. The common normal to the surface contact during impact is known as line of impact of their mass center are located on this line the impact is said to direct central impact.

First year engineering mechanics notes are crucial for students embarking on their engineering journey. Engineering mechanics serves as the foundation for understanding the principles of physics and their application in engineering problems. The subject covers a range of topics that help students analyze forces and motion, ultimately preparing them for more complex concepts in later engineering courses. This article aims to provide comprehensive notes on the essential topics covered in first-year engineering mechanics, including fundamental concepts, key principles, and practical applications.

Introduction to Engineering Mechanics

Engineering mechanics is a branch of physical science that deals with the behavior of solid objects when subjected to forces or displacements. The main goal is to understand how and why objects move or remain at rest under various conditions. This field can be divided into two primary categories:

1. Statics

Statics is the study of bodies at rest or in equilibrium. It involves analyzing forces acting on objects that are not moving. Key concepts in statics include:

- Equilibrium: An object is in equilibrium when the sum of forces and the sum of moments acting on it are zero.
- Free Body Diagrams (FBD): Visual representations of an object and all the forces acting on it.
- Support Reactions: Understanding how different supports (hinges, rollers, fixed) can affect an object's equilibrium.

2. Dynamics

Dynamics focuses on objects in motion and the forces that cause this motion. It encompasses:

- Kinematics: The study of motion without considering the forces involved. It involves concepts such as velocity, acceleration, and displacement.
- Kinetics: The study of the relationship between the motion of an object and the forces acting on it.

Fundamental Concepts

Understanding the fundamental concepts of engineering mechanics is vital for grasping more complex topics. Here are some of the key concepts:

1. Forces

A force is a vector quantity that causes an object to accelerate. It can be represented as:

- Magnitude: The strength of the force (measured in Newtons).
- Direction: The line along which the force acts.

Types of forces include:

- Contact Forces: Forces that occur when objects are in physical contact (e.g., friction, tension).
- Non-Contact Forces: Forces that act at a distance (e.g., gravitational, magnetic).

2. Moments and Torques

The moment of a force about a point is the measure of its tendency to cause rotation about that point. It is calculated using:

$$
\text{Moment} = \text{Force} \times \text{Distance}
$$

Torque is the rotational equivalent of linear force. It is crucial for analyzing rotational motion in various engineering applications.

3. Equilibrium Conditions

For a body to be in static equilibrium, the following conditions must be satisfied:

- The sum of horizontal forces must equal zero:
$$
\sum F_x = 0
$$
- The sum of vertical forces must equal zero:
$$
\sum F_y = 0
$$
- The sum of moments about any point must equal zero:
$$
\sum M = 0
$$

Applications of Engineering Mechanics

The principles of engineering mechanics have numerous applications across various fields. Some notable applications include:

1. Structural Engineering

Understanding forces and moments is essential for designing buildings, bridges, and other structures. Engineers must ensure that structures can withstand loads without collapsing.

2. Mechanical Engineering

Mechanical systems, such as gears and levers, rely on the principles of mechanics to function efficiently. Analyzing forces and torques helps in designing machinery and mechanical components.

3. Aerospace Engineering

In aerospace applications, mechanics is vital for analyzing forces acting on aircraft and spacecraft. Engineers must consider aerodynamic forces, gravitational forces, and thrust to ensure safe and efficient operation.

Key Equations in Engineering Mechanics

Several key equations are fundamental to solving problems in engineering mechanics:

1. Newton's Laws of Motion

- First Law (Inertia): An object at rest stays at rest, and an object in motion remains in motion unless acted upon by a net external force.
- Second Law (F=ma): The acceleration of an object is directly proportional to the net force acting on it and inversely proportional to its mass.
- Third Law (Action-Reaction): For every action, there is an equal and opposite reaction.

2. Equations of Kinematics

For uniformly accelerated motion, the following equations are used:

1. $v = u + at$
2. $s = ut + \frac{1}{2}at^2$
3. $v^2 = u^2 + 2as$

Where:
- u = initial velocity
- v = final velocity
- a = acceleration
- s = displacement
- t = time

3. Work and Energy Principles

- Work: Work done by a force is defined as the product of the force and the displacement in the direction of the force:

$$
W = F \cdot d \cdot \cos(\theta)
$$

- Kinetic Energy (KE): The energy of an object due to its motion:

$$
KE = \frac{1}{2}mv^2
$$

- Potential Energy (PE): The energy stored in an object due to its position in a gravitational field:
\[
PE = mgh
\]

Study Tips for Engineering Mechanics

Here are some study tips to help first-year engineering students excel in mechanics:

1. Practice Problem-Solving: Regularly solve practice problems to develop a strong understanding of concepts.
2. Use Visual Aids: Draw free body diagrams to visualize forces and moments acting on objects.
3. Group Study: Collaborate with classmates to discuss complex topics and solve problems together.
4. Utilize Resources: Make use of textbooks, online tutorials, and videos to reinforce learning.
5. Stay Organized: Keep notes well-organized and review them regularly to keep concepts fresh in your mind.

Conclusion

First year engineering mechanics provides students with the foundational knowledge necessary for understanding and analyzing real-world engineering problems. By mastering the concepts of forces, moments, equilibrium, and motion, students prepare themselves for advanced studies in various engineering fields. The principles learned in mechanics will serve as essential tools throughout their academic and professional careers, enabling them to approach complex engineering challenges with confidence and clarity.

Frequently Asked Questions

What are the key topics covered in first year engineering mechanics notes?

Key topics typically include statics, dynamics, kinematics, force systems, equilibrium, and the laws of motion.

How can I effectively use first year engineering mechanics notes for exam preparation?

To prepare effectively, review the concepts regularly, practice problems, create flashcards for key terms, and summarize each chapter.

Are there any recommended textbooks to supplement first year engineering mechanics notes?

Recommended textbooks include 'Engineering Mechanics: Statics' and 'Engineering Mechanics: Dynamics' by J.L. Meriam and L.G. Kraige.

What resources are available for additional practice in engineering mechanics?

Resources include online platforms like Khan Academy, Coursera, and various engineering forums with practice problems and solutions.

How important is understanding vector analysis in first year engineering mechanics?

Understanding vector analysis is crucial as it is fundamental to solving problems related to forces and motion in engineering mechanics.

What are common mistakes to avoid when studying engineering mechanics?

Common mistakes include neglecting to understand the concepts before solving problems, skipping practice, and not reviewing errors made in previous exercises.

How can study groups enhance learning in engineering mechanics?

Study groups can enhance learning by providing diverse perspectives, allowing for collaborative problem-solving, and offering mutual support in understanding difficult concepts.

What role do free body diagrams play in engineering mechanics?

Free body diagrams are essential as they visually represent all forces acting on a body, helping to analyze the mechanics of the situation effectively.

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