

**FLUID MECHANICS**
**1. FLUID MECHANICS**

- The liquids and gases together are termed as fluids, in other words, we can say that the substances which can flow are termed as fluids.
- We assume fluid to be incompressible (i.e., the density of liquid is independent of variation in pressure and remains constant) and non-viscous (i.e. the two liquid surfaces in contact are not exerting any tangential force on each other).

**1.1 Fluid Statics**
**1.1.1 Fluid Pressure**

Pressure  $p$  at every point is defined as the normal force per unit area.

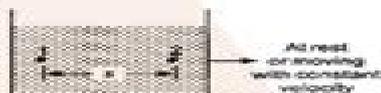
$$p = \frac{dF_{\perp}}{dA}$$

The SI unit of pressure is the Pascal and  $1 \text{ Pascal} = 1 \text{ N/m}^2$

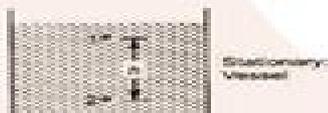
- Fluid force acts perpendicular to any surface in the fluid, no matter how that surface is oriented. Hence pressure, has no intrinsic direction of its own, it is a scalar.

**Pressure**

- (a) Pressure at two points in a horizontal plane or at same level when the fluid is at rest or moving with constant velocity is same.



- (b) Pressure at two points which are at a depth separation of  $h$  when fluid is at rest or moving with constant velocity is related by the expression



$p_2 - p_1 = \rho gh$ , where  $\rho$  is the density of liquid.

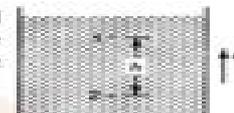
- (c) Pressure at two points in a horizontal plane when fluid container is having some constant horizontal acceleration are related by the expression



$$p_1 - p_2 = \rho a$$

and  $\tan \theta = a/g$ , where  $\theta$  is the angle which the liquid's free surface is making with horizontal.

- (d) Pressure at two points within a liquid at vertical separation of  $h$  when the liquid container is accelerating up are related by expression



$$p_2 - p_1 = \rho(g + a)h$$

If container is accelerating down, then  $p_2 - p_1 = \rho(g - a)h$ .

**1.1.2 Atmospheric Pressure**

- It is the pressure of the earth's atmosphere. Normal atmospheric pressure at sea level (an average value) is 1 atmosphere (atm) that is equal to  $1.013 \times 10^5 \text{ Pa}$ .
- The excess pressure above atmospheric pressure is called gauge pressure, and total pressure is called absolute pressure.
- Barometer is a device used to measure atmospheric pressure while U-tube manometer or simply manometer is a device used to measure the gauge pressure.

**1.1.3 Pascal's Law**

- A change in the pressure applied to an enclosed fluid is transmitted undiminished to every portion of the fluid and to the walls of the containing vessel.
- There are a lot of practical applications of Pascal's law one such application is hydraulic lift.

**1.1.4 Archimedes Principle**

- When a body is partially or fully dipped into a fluid, the fluid exerts contact force on the body. The resultant of all these contact forces is called buoyant force (upthrust).
- $F =$  weight of fluid displaced by the body.
- This force is called buoyant force and acts vertically upwards (opposite to the weight of the body) through the centre of gravity of the displaced fluid.

$$F = V\rho g$$

where,  $v =$  volume of liquid displaced

$\rho =$  density of liquid.

# Mechanical Operations Lecture Notes

**Lei Shi**



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## **Table of Contents Mechanical Operations Lecture Notes**

1. Understanding the eBook Mechanical Operations Lecture Notes
  - The Rise of Digital Reading Mechanical Operations Lecture Notes
  - Advantages of eBooks Over Traditional Books
2. Identifying Mechanical Operations Lecture Notes
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Mechanical Operations Lecture Notes
  - User-Friendly Interface
4. Exploring eBook Recommendations from Mechanical Operations Lecture Notes
  - Personalized Recommendations
  - Mechanical Operations Lecture Notes User Reviews and Ratings
  - Mechanical Operations Lecture Notes and Bestseller Lists
5. Accessing Mechanical Operations Lecture Notes Free and Paid eBooks
  - Mechanical Operations Lecture Notes Public Domain eBooks
  - Mechanical Operations Lecture Notes eBook Subscription Services
  - Mechanical Operations Lecture Notes Budget-Friendly Options

6. Navigating Mechanical Operations Lecture Notes eBook Formats
  - ePub, PDF, MOBI, and More
  - Mechanical Operations Lecture Notes Compatibility with Devices
  - Mechanical Operations Lecture Notes Enhanced eBook Features
7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Mechanical Operations Lecture Notes
  - Highlighting and Note-Taking Mechanical Operations Lecture Notes
  - Interactive Elements Mechanical Operations Lecture Notes
8. Staying Engaged with Mechanical Operations Lecture Notes
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Mechanical Operations Lecture Notes
9. Balancing eBooks and Physical Books Mechanical Operations Lecture Notes
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Mechanical Operations Lecture Notes
10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
11. Cultivating a Reading Routine Mechanical Operations Lecture Notes
  - Setting Reading Goals Mechanical Operations Lecture Notes
  - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Mechanical Operations Lecture Notes
  - Fact-Checking eBook Content of Mechanical Operations Lecture Notes
  - Distinguishing Credible Sources
13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
  - Integration of Multimedia Elements

- Interactive and Gamified eBooks

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