

# 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.

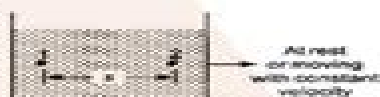
$$p = \frac{dF_{\perp}}{dA}$$

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

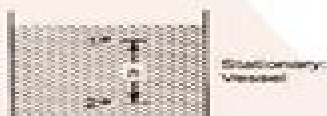
- Fluid force acts perpendicular to any surface in the fluid, no matter how that surface is oriented. Hence pressure, has no intrinsic direction of its own, it is a scalar.

#### 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.

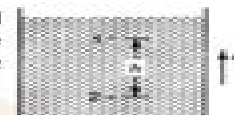
- (c) Pressure at two points in a horizontal plane when fluid container is having some constant horizontal acceleration are related by the expression



$p_1 - p_2 = \rho a$

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

**William Arnold Anthony**



## **Mechanical Operations Lecture Notes:**

Smart Innovations in Energy and Mechanical Systems Dmytro Pavlenko, Pavlo Tryshyn, Natalia Honchar, Olena Kozlova, 2025-07-15 This book appeals to researchers and professionals working in the field of artificial neural networks. It offers insights into the application of neural networks in engineering contexts, providing valuable case studies and methodologies for those looking to bridge the gap between AI theory and practical engineering solutions. Engineers and technicians involved in additive manufacturing will find relevant content in this book. It covers advanced techniques and applications of 3D printing in aerospace and mechanical engineering, offering a unique perspective on how these technologies are shaping the future of manufacturing. The book caters to professionals and students focusing on machine learning and artificial intelligence, particularly in industrial applications. It demonstrates how these technologies are being integrated into energy systems and mechanical engineering, providing real-world examples and potential future directions. Robotics enthusiasts and engineers will benefit from the book's coverage of cutting-edge developments in industrial and aerospace robotics. It offers insights into autonomous systems, control algorithms, and the integration of robotics in smart manufacturing environments. Graduate and undergraduate students in STEM fields, beyond traditional engineering such as computer science or data science, will find value in the book's interdisciplinary approach. It showcases how advanced computational methods are applied to solve complex engineering problems. This book is of interest to enterprises that are involved in the implementation of green energy technologies, resource-saving technologies, and support the concept of decarbonization of the energy system.

**Recent Advances in Operations Management and Optimization** Anish Sachdeva, Kapil Kumar Goyal, Rajiv Kumar Garg, J. Paulo Davim, 2024-03-19 The book presents the select proceedings of International Conference on Production and Industrial Engineering (CPIE 2023). It covers the current and latest research methods for development and implementation of operations. Various topics covered include selection of designing parameters, decisions related to conditions of optimum process operation, parameters, facilities planning and management, transportation and supply chain management, quality engineering, reliability and maintenance, product design and development, human factors and ergonomics, project management, service system and service management, waste management, sustainable manufacturing and operations. The book is useful for researchers and professionals working in manufacturing, industrial engineering systems, engineering and production engineering.

**Advances in Condition Monitoring of Machinery in Non-Stationary Operations** Giorgio Dalpiaz, Riccardo Rubini, Gianluca D'Elia, Marco Cocconcelli, Fakher Chaari, Radoslaw Zimroz, Walter Bartelmeus, Mohamed Haddar, 2013-10-05 This book presents the proceedings of the third edition of the Condition Monitoring of Machinery in Non-Stationary Operations (CMMNO13) which was held in Ferrara, Italy. This yearly event merges an international community of researchers who met in 2011 in Wroclaw, Poland and in 2012 in Hammamet, Tunisia to discuss issues of diagnostics of rotating machines operating in complex motion and/or load conditions. The growing interest of the industrial world on the

topics covered by the CMMNO13 involves the fields of packaging automotive agricultural mining processing and wind machines in addition to that of the systems for data acquisition The participation of speakers and visitors from industry makes the event an opportunity for immediate assessment of the potential applications of advanced methodologies for the signal analysis Signals acquired from machines often contain contributions from several different components as well as noise Therefore the major challenge of condition monitoring is to point out the signal content that is related to the state of the monitored component particularly in non stationary conditions *Notes in mechanical engineering* Henry Adams,1883

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Advances in Condition Monitoring of Machinery in Non-Stationary Operations Fakher Chaari,Radoslaw Zimroz,Walter Bartelmus,Mohamed Haddar,2015-07-16 The book provides readers with a snapshot of recent research and technological trends in the field of condition monitoring of machinery working under a broad range of operating conditions Each chapter accepted after a rigorous peer review process reports on an original piece of work presented and discussed at the 4th International Conference on Condition Monitoring of Machinery in Non stationary Operations CMMNO 2014 held on

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