



MECHANICAL ENGINEERING

Fluid Mechanics

Hand Notes For GATE, IES, PSUs & Competitive Exam

Hand Notes

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Note : We also providing GATE, IES, PSUs & Competitive Exam Materials [Handnotes, Shortnotes & Books], All Reports [Seminar Reports & PPT]

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FM is branch of science which deals with property of fluids (liquids and gases), behaviour of fluids at rest, under motion with and without forces causing motion.

App of FM

1. Hydraulic Analysis of turbine, pumps, hydraulic equipment
- Flow Analysis in pipes and hydraulic losses in pipes for optimisation of the pipe size etc.

unit 1

1. Properties of Fluids
2. Fluid statics
3. Fluid kinematics
4. Fluid dynamics
5. Laminar ^{Flow of} Incompressible fluids through pipes and in between plates
6. Turbulent flow thru pipes
7. Boundary Layer theory concepts
8. Turbo machinery (Hydraulic turbines)

PROPERTIES OF FLUIDS

- Property of fluids
- Newton's law of viscosity
- Compressibility and Bulk modulus

Pressure intensity of fluid and vapour pressure

→ classification of fluid Based on fluid power Law

[Rheological eqn of Fluids]

PROPERTIES

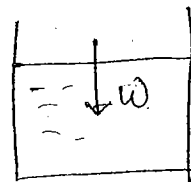
there are 4 properties

1. Mass of the matter
2. weight of the fluid
3. Area
4. volume -
5. Specific mass [mass density]
6. weight density [unit weight or sp weight]
7. Specific Gravity or relative density
8. Specific volume
9. Dynamic viscosity
10. Kinematic viscosity
11. compressibility of liquids [Bulk Modulus]
12. Surface Tension [surface Energy]
13. Pressure Intensity
14. Vapour pressure

Weight

A force due to gravitational pull.

$$W = mg$$



Newton's 2nd Law

2

$$F = ma$$

$$1N = 1kg \times \frac{1m}{sec^2}$$

$$N = kg \cdot m/sec^2$$

$$W = mg$$

$$kg \cdot f = m \times 9.81$$

$$kg \left[\frac{m}{sec^2} \right]$$

$$\boxed{kgf = 9.81 N}$$

$$= \underline{\underline{10 N}}$$

③

Area

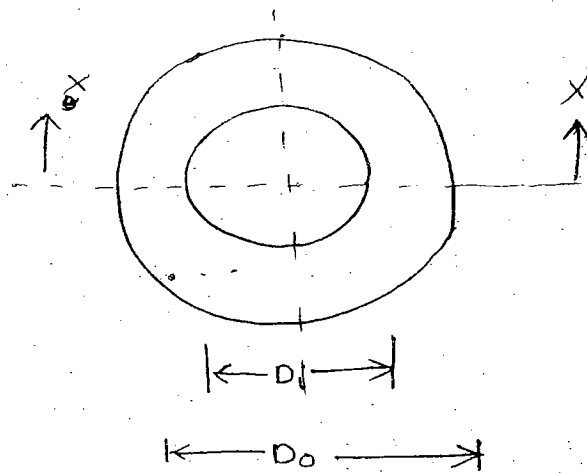
Area is the space occupied by the matter in 2D.

- Normal Area ✓
- cls Area
- plane Area ✓
- Resisting Area
- surface Area ✓
- shear Area
- crushing Area
- tearing Area
- projected Area ✓
- Flow Area ✓
- ~~for FM~~

Normal Area

without touching the body

2 dimensions visible



$$A_n = \frac{\pi}{4} [D_o^2 - D_i^2]$$



$$A_{cls} = \frac{\pi \times d^2 \times 2}{4}$$

Flow Area

Depending on the fluid touching the sides

Volume

It is the space occupied by the matter in 3D

units

m^3 , mm^3 , cm^3

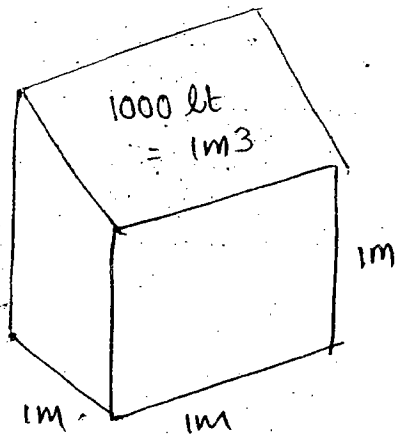
$$V = (A \times l)$$

$$V = l \times b \times h$$

→ litres (lt)

For water

$$1m^3 = 1000 \text{ lit}$$



$$1000 \text{ cm}^3 = 1 \text{ lit}$$

$$\text{cm}^3 = \frac{.1}{1000} \text{ lit}$$

$$= 10^{-3} \text{ lit}$$

$$= \text{milli lit}$$

$$\boxed{\text{cm}^3 = \text{ml}}$$

Specific Mass or Mass density

— Property of matter

— matter occupied
1 volume

$$\rho = \frac{m}{v} \left[\frac{\text{kg}}{\text{m}^3} \right]$$

Ex:

$$\begin{aligned} \rho_{\text{air}} &= 1.2 \text{ kg/m}^3 \\ \rho_{\text{water}} &= 1000 \text{ kg/m}^3 \\ \rho_{\text{Hg}} &= 13600 \text{ kg/m}^3 \end{aligned}$$

$$\rho_{\text{gold}} = 19200 \text{ kg/m}^3$$

$$\rho_{\text{Pt}} = 22500 \text{ kg/m}^3$$

↘ Highest

$$\rho_{\text{oil}} < \rho$$

1) A steel plate 10 mm thick, 1 m width and length 2 m. cost of 1 tonne steel is Rs 30,000. Estimate cost of plate.

$$\begin{aligned}\text{Volume} &= 0.01 \times 1 \times 2 \\ &= 0.02 \text{ m}^3 \\ &= \cancel{20} \text{ m}^3\end{aligned}$$

$$\rho = \frac{m}{V}$$

$$7850 \left(\frac{\text{kg}}{\text{m}^3} \right) = \frac{m \text{ (kg)}}{\cancel{20} 0.02}$$

$$\begin{aligned}m &= 7850 \times \cancel{20} 0.02 \\ &= \underline{157 \text{ kg}}\end{aligned}$$

$$1 \text{ Ton} = 1000 \text{ kg}$$

$$\cancel{1 \text{ kg} = 30}$$

$$1000 \text{ kg} = 30,000$$

$$\underline{1 \text{ kg} = 30 \text{ Rs}}$$

$$\begin{aligned}\text{Cost} &= 157 \times 30 \\ &= \underline{4710 \text{ Rs}}\end{aligned}$$

2) A water ~~pot~~ sump of inner dimensions 6 ft, 10 ft, 5 ft, Estimate how many lit of

~~Volume~~ = 10A family consists 4 people and
Consumption per Head 150 lit/day. How many day
the sump can serve 3

Volume

$$\rho_w = \frac{m_w}{\text{Volume}}$$

$$1000 = \frac{m}{5\text{ft} \times 6\text{ft} \times 10\text{ft}}$$

$$m = \frac{1000 \times (5 \times 6 \times 10) \text{ft}^3}{35} = 1000 \times \frac{300}{35} \left(\frac{\text{kg}}{\text{m}^3}\right)$$

$$m = 304.8 \text{ kg}$$

$$8570 \text{ kg} = 8750 \text{ lb}$$

Volume =

$$1\text{ft} = 12\text{in}$$

$$\text{Inch} = 25.4\text{mm}$$

$$= 12 \times 25.4\text{mm}$$

$$= \frac{12 \times 25.4}{1000}$$

$$= 0.3048$$

$$35\text{ft}^3 = 1\text{m}^3$$

$$\text{kg} \rightarrow$$

$$\frac{8750}{600} = \underline{\underline{15 \text{ days}}}$$

weight density or sp weight

It is the weight of the matter occupied per unit volume.

$$\frac{\text{weight}}{\text{volume}} = \frac{w}{V} = \frac{N}{\text{m}^3}$$

$$\boxed{w = \gamma = \rho g \text{ (N/m}^3\text{)}}$$

$$\gamma_{\text{water}} = \rho_{\text{water}} \times g$$

$$= 1000 \times 9.81$$

$$= 9810 \frac{\text{N}}{\text{m}^3}$$

$$= 9.81 \frac{\text{kN}}{\text{m}^3}$$

Relative density or Sp gravity [S]

It is the Ratio of mass density of any matter

" " " std fluid -

water

$$\boxed{S = R.D = \frac{\rho_x}{\rho_{\text{water}}}}$$

$$S_{\text{steel}} = \frac{\rho_{\text{steel}}}{\rho_{\text{water}}} = \frac{7850}{1000} = \underline{\underline{7.85}}$$

$$\text{ex: } S_{\text{mercury}} = \frac{\rho_{\text{mercury}}}{\rho_{\text{water}}} = \frac{13600}{1000} = \underline{\underline{13.6}}$$

$$S_{\text{air}} = \frac{\rho_{\text{air}}}{\rho} = \frac{1.2}{1000} = \underline{\underline{0.001}}$$