Basic Mechanical Engineering Unit–3 Notes Fluids

UNIT–3 TOPICS

• Fluid Properties
• Pressure, Density and Viscosity
• Types of Fluids
• Newton’s Law of Viscosity
• Pascal’s Law
• Bernoulli’s Equation
• Hydraulic Machines
• Pumps
• Turbines
• Reciprocating Pumps

1. INTRODUCTION TO FLUIDS

A fluid is a substance which flows continuously when subjected to external force.

Examples:
• Water
• Oil
• Air

Fluid mechanics deals with behavior of fluids at rest and in motion.

2. FLUID PROPERTIES

(a) Density

Density is mass per unit volume of fluid.

Formula:

$\rho = m / V$

Where:
ρ = density
m = mass
V = volume

Units:
kg/m^3

(b) Pressure

Pressure is force acting per unit area.

Formula:

$P = F / A$

Where:
P = pressure
F = force
A = area

Units:
N/m^2 or Pascal

(c) Viscosity

Viscosity is property of fluid which resists motion between layers of fluid.

Higher viscosity means more resistance to flow.

Examples:
• Honey has high viscosity.
• Water has low viscosity.

3. TYPES OF FLUIDS

(a) Ideal Fluid
Fluid having no viscosity and incompressible nature.

(b) Real Fluid
Fluid having viscosity.

(c) Newtonian Fluid
Fluid obeying Newton's law of viscosity.

Examples:
• Water
• Air

(d) Non-Newtonian Fluid
Fluid not obeying Newton's law of viscosity.

Examples:
• Paint
• Toothpaste

4. NEWTON'S LAW OF VISCOSITY

Newton's law states that shear stress is directly proportional to velocity gradient.

Expression:

$\tau = \mu \, (du/dy)$

Where:
τ = shear stress
μ = coefficient of viscosity
du/dy = velocity gradient

Applications:
• Lubrication systems
• Fluid flow analysis

5. PASCAL'S LAW

Pascal's law states that pressure applied at any point of confined fluid is transmitted equally in all directions.

Applications:
• Hydraulic press
• Hydraulic lift
• Hydraulic brakes

6. BERNOULLI'S EQUATION

Bernoulli's theorem states that total energy of flowing incompressible fluid remains constant.

Expression:

$P/\rho g + V^2/2g + z = \text{Constant}$

Where:
P = pressure energy
V = velocity
z = height

Assumptions:
• Fluid is incompressible
• Flow is steady
• No friction losses

Applications:
• Venturimeter
• Aircraft wings
• Carburetors

7. HYDRAULIC MACHINES

Hydraulic machines convert hydraulic energy into mechanical energy or vice versa.

Types:
• Pumps
• Turbines

Applications:
• Power plants
• Irrigation systems
• Hydraulic systems

8. PUMPS

Pump is hydraulic machine used to convert mechanical energy into hydraulic energy.

Types of Pumps:
1. Centrifugal pump
2. Reciprocating pump

Applications:
• Water supply systems
• Irrigation
• Industries

9. TURBINES

Turbine is machine used to convert hydraulic energy into mechanical energy.

Types of Turbines:
• Pelton wheel turbine
• Francis turbine
• Kaplan turbine

Applications:
• Hydroelectric power plants

10. RECIPROCATING PUMP

Reciprocating pump is positive displacement pump in which piston moves back and forth inside cylinder.

Main Parts:

• Cylinder
• Piston
• Suction valve
• Delivery valve

Working Principle:
During suction stroke, fluid enters cylinder. During delivery stroke, fluid is discharged through delivery valve.

Advantages:
• High efficiency
• Suitable for high pressure

Disadvantages:
• Complex construction
• High maintenance

Applications:
• Water pumping
• Oil pumping

MOST IMPORTANT 14 MARK QUESTIONS

1. Explain fluid properties with examples.

2. Explain density, pressure and viscosity.

3. Explain types of fluids with examples.

4. State and explain Newton’s law of viscosity.

5. State and explain Pascal’s law with applications.

6. Derive Bernoulli’s equation for incompressible fluids.

7. Explain hydraulic machines and their applications.

8. Explain working principle of pumps and turbines.

9. Explain reciprocating pump with neat diagram and working.

10. Differentiate pumps and turbines.

IMPORTANT 7 MARK QUESTIONS

1. Define density and pressure.

2. Explain viscosity.

3. Explain ideal and real fluids.

4. Explain Newtonian fluids.

5. Explain Pascal’s law applications.

6. Explain hydraulic machines.

7. Explain reciprocating pump applications.

IMPORTANT NUMERICALS

1. Pressure calculation problems.

2. Density numerical problems.

3. Bernoulli equation numerical.

4. Fluid flow numerical problems.

EXAM TIPS

- Draw neat diagrams of pumps and turbines.
- Learn Bernoulli equation carefully.
- Practice fluid property numericals regularly.
- Revise hydraulic machine applications.
- Write definitions with units properly.