Fluid Mechanics

Course Objective:

A proper understanding of fluid mechanics is extremely important in many areas of civil engineering. This course has been designed to provide basic knowledge of fluid mechanics to the students of civil engineering so that it would be helpful them to understand the basic phenomena of this science. This course shall be considered as an introduction: common for all civil engineering faculties of Tribhuvan University in the second year first part of undergraduate.

1. Fluid and its physical properties (3 hours)
    a. Basic concept and definition of fluid. Application in civil engineering
    b. Shear stress in a moving fluid, Difference between solids and fluids
    c. Concept of control volume and continuum in fluid mechanics
    d. Mass density, specific weight, specific gravity, specific volume, viscosity, compressibility, capillarity, surface tension, cavitation and vapour pressure (relations, their dimension, units as well as values for different materials).
    e. Newton's law of viscosity causes of viscosity in liquid and gases.
    f. Variation of viscosity with temperature for different fluids
    g. Different methods for finding viscosity of fluids like viscometer etc.
    h. Ideal and Real fluid, Newtonian and non Newtonian, compressible and incompressible fluid with examples

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2. Pressure and Head (4 hours)
    a. Introduction, application in civil engineering. Concept about the absolute and relative equilibrium.
    b. Atmospheric, gauge and absolute pressure
    c. Hydrostatics law of pressure distribution (pressure depth relationship)
    d. Pascal's law
    e. Measurement of pressure, simple manometer as piezometer, U-tube manometer, single column vertical and inclined manometers, differential manometer, inverted U-tube differential manometer, bourden gauge

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3. Hydrostatics (10 hours)
    a. Pressure force and centre of pressure on submerged bodies (plane and curve Surfaces)
    b. Computation of pressure forces on gates (plane and curve), dams, retainingstructures and other hydraulic structures, pressure diagrams
    c. Buoyancy, flotation concept, thrust on submerged and floating bodies, hydrometer
    d. The stability of floating and submerged bodies.
    e. Metacentre, determination of metacentric height.
    f. Liquid in relative equilibrium (pressure variation in the case of uniform linear and radial acceleration)
    g. Computer programme coding for simple problems

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4. Hydrokinematics (4 hours)
    a. Lagragian and Eulerain approaches of describing fluid flow
    b. One, two and three dimensional of flow
    c. Classification of fluid motion (uniform and non-uniform, steady and unsteady, laminar and turbulent flows)
    d. Rotational and Irrotational motion, stream function and potential function.

e. Description of streamline, streak line, path line and stream tube and their drawing procedures
f. Conservation principle of mass and continuity equation in Cartesian and cylindrical polar coordinates (one , two and three dimensional)

5. Hydrodynamics (2 hours)
   a. Forces acting on a fluid in motion (gravitational, pressure, viscous, turbulent, surface tension, and compression forces)
   b. Reynolds's, Euler's and Navier-Stoke's equation of motions
   c. Development of the Euler's Equation of motion
   d. Bernoulli's equation and its physical meaning

6. Flow measurement (7 hours)
   a. Venturimeter, orifice meter nozzle meter and Pitot tube
   b. Flow through orifice (small orifice, large orifice, partially submerged orifice as well as submerged orifice)
   c. Different hydraulic coefficients Cv, Cc and Cd) and their determination
   d. Notches and Weir (classification, discharge through rectangular, triangular trapezoidal , and Cipoletti notches, Sharp crested weir, narrow crested weir, broad crested as well as ogee shaped weirs)
   e. Emptying and filling of reservoirs without inflow (cylindrical, hemispherical and conical). Emptying and filling of reservoir with inflow (cylindrical case).
   f. Computer programme coding for simple problems

7. Momentum principle and flow analysis (6 hours)
   a. Momentum principle and equations
   b. Application of equation of calculate forces (pipe in bends, enlargements and reducer)
   c. Forces exerted by the jet on stationary and moving vanes of different shapes
   d. Concept of angular momentum with examples.

8. Boundary Layer theory (3 hours)
   a. Boundary layer concept and definition.
   b. Boundary layer concept along a thin plate (laminar zone, turbulent zone, transition zone as well as laminar sub layer)
   c. Application of this concept (hydraulically smooth and rough boundary)
   d. Boundary layer thickness (Boundary layer thickness, momentum thickness, and is placement thickness)

9. Flow past through submerged bodies (3 hours)
   a. Introduction to the drag and lift forces acting on a body
   b. Expression for drag and lift forces
   c. Pressure and friction drag; drag coefficients
   d. Drag on a flat plate, cylinder and sphere
   e. Concept of aerofoil.

10. Similitude and physical modeling (3 hours)
   a. Introduction to dimensional analysis (physical quantities and their dimensions)
   b. Methods of dimensional analysis (Rayleigh and Buckingham theorem)
   c. Similitude, laws of similarity, distorted and undistorted model Physical model and modeling criteria (Reynolds, Froude, Euler, Weber and Mach's model laws with some examples.)