Fluid Mechanics and Hydraulics
EG 2103 CE

Year: II
Semester: I

Total: 5 Hrs. /week
Lecture: 3 Hrs./week
Tutorial: 1 Hr./week
Practical: Hrs./week
Lab: 2/2 Hrs./week

Course Description:
This course focuses on the fundamental concepts and principles of Hydraulics, measurement of flow, introduction to open channel flow and pipe flow.

Course Objectives:
After the completion of this course, students will be able to:

1. Understand the properties of fluid;
2. Analyze the behaviour of fluid at rest;
3. Analyze the behaviour of fluid in motion;
4. Apply the measurement techniques for pressure and discharge;
5. Understand the concept of head loss in pipe flow and
6. Understand the basic concept of open channel flow.

Course Contents:

Theory

Unit 1: Introduction to Fluid Mechanics and Hydraulics [3 Hrs.]

1.1 Introduction: Fluid, Fluid Mechanics and Hydraulics
1.2 Properties of fluid (Definition, formula, unit and dimension): mass density, specific weight, specific volume, specific gravity, viscosity (Dynamic and kinematic viscosity), Newton's law of viscosity, surface tension, capillarity, compressibility and Bulk Modulus.
1.3 Difference between real and ideal fluid, Newtonian and Non-Newtonian fluid, Compressible and incompressible fluid.

Unit 2: Hydrostatics: [10 Hrs.]

2.1 Introduction to fluid pressure
2.2 Derivation for Pascal's law and pressure-depth relationship (Hydrostatic law)
2.3 Relationship of atmospheric pressure, Vacuum pressure, gauge pressure and absolute pressure
2.4 Measurement of pressure by piezometer and U-tube manometer
2.5 Definition of total pressure and center of pressure
2.6 Derivation for total pressure and center of pressure on horizontal, vertical and inclined plane submerged surface
2.7 Principle of floatation
2.8 Definition of Buoyancy and Archimedes' principle
2.9 Introduction to relative equilibrium

Unit 3: Hydro kinematics: [5 Hrs.]

3.1 Types of flow: Steady and unsteady, uniform and non-uniform, laminar and turbulent, compressible and incompressible, rotational and irrotational, one, two and three dimensional
3.2 Reynold's number: Definition, equation and criteria for laminar and turbulent flow

3.3 Streamline: Definition, equation, characteristics
3.4 Conservation principles of mass, energy, momentum and continuity equation for one dimensional incompressible flow

Unit 4: Hydrodynamics: [3 Hrs.]

4.1 Energy of flowing fluid: potential or datum energy, kinetic energy, pressure energy
4.2 Concept of energy head
4.3 Bernoulli's theorem: Statements, assumptions, equation and applicability
4.4 Concept of Hydraulic gradient line (HGL) and energy gradient line (EGL)

Unit 5: Flow Measurement: [10 Hrs.]

5.1 Orifice: Definition and types, definition of vena-contracta
5.2 Derivation of equation for discharge through small orifice
5.3 Hydraulic coefficients of orifice: coefficient of discharge, velocity and contraction (definition, formula and experimental method of determination)
5.4 Concept of venturimeter, derivation of equation for discharge through venturimeter
5.5 Introduction to weir or notch and their classifications
5.6 Derivation of equation for discharge through rectangular, triangular and trapezoidal weir or notch
5.7 Area-velocity method for the discharge measurement in open channel (float and current meter): description of measurement technique, mid-section method for discharge computation

Unit 6: Pipe Flow: [6 Hrs.]

6.1 Introduction to pipe flow
6.2 Shear stress, Velocity profile for laminar and turbulent flow through pipes
6.3 Loss of head in pipes: introduction to major and minor loss such as entry, expansion, contraction, fitting, bend, obstruction, exit loss
6.4 Derivation of Loss of head in pipes in laminar (Hagen Poiseuille equation) and turbulent flow (Darcy-Weisbach equation)
6.5 Derivation of equation for expansion and contraction loss

Unit 7: Open Channel Flow: [8 Hrs.]

7.1 Difference between pipe flow and open channel flow
7.2 Types and classification of open channel flow: steady and unsteady, uniform and non-uniform, prismatic and non-prismatic, natural and artificial, (gradually varied, rapidly varied and spatially varied flow), laminar and turbulent, subcritical, critical and supercritical flow
7.3 Geometric elements of open channel (flow depth, depth of flow section flow area, top width, wetted perimeter, hydraulic radius, hydraulic depth, section factor, conveyance)
7.4 Velocity distribution in open channel flow
7.5 Chezy's equation and Manning's equation for the computation of velocity in uniform flow
7.6 Introduction to most efficient and economical section in open channel flow.
7.7 Energy equation and momentum equation in open channel flow
7.8 Specific energy: Definition, equation and diagram and Critical flow criteria, alternative depth, conjugate depth.

Tutorials: **[15 Hrs.]**

1. Numericals of fluid properties (1)
2. Pressure computation, Pressure measurement by piezometer and U-tube manometer, Total pressure and center of pressure for horizontal, vertical and inclined submerged surface, principle of floatation (3)
3. Computation of discharge by using continuity equation, computation of Reynold's number and identifying type of flow (2)
4. Application of Bernoulli's equation with and without head loss, Draw HGL, and EGL. (1)
5. Computation of hydraulic coefficients, and discharge through orifice, venturimeter, rectangular, triangular and trapezoidal weir, mid-section method for discharge computation (3)
6. Computation of Shear stress, velocity and Head loss (Major and minor) computation in pipe flow (2)
7. Computation of Cross-sectional properties, velocity, discharge and flow depth computation for uniform flow through open channel, Critical flow parameters such as depth, velocity, energy and alternative and conjugate depths. (3)

Practical (Laboratory) **[15 Hrs.]**

1. Measure major (i.e. friction) and minor (Contraction, expansion) head losses in pipe
2. Measure pressure by piezometer and manometer
3. Verify the Bernoulli's equation
4. Measure flow through orifice

Textbooks:

1. D. P. Sangroula "Fundamentals of Fluid Mechanics', Nepal Printing Support, Anamnagar, Kathmandu
2. P.N. Modi and S. M. Seth "Fluid Mechanics and Hydraulics, Standard Book House
3. D.S. Kumar "Fluid Mechanics and Fluid power Engineering', S.K. Kataria and Sons
4. S Ramamrutham 'Hydraulics fluid mechanics and fluid machines' Dhanpat Rai Publishing Company (P) Ltd. New Delhi.
5. R.K. Rajput, *"Fluid Mechanics and Hydraulic Machines"*, S. Chand & Company Ltd.

References:

1. 2. A.K. Upadhyay, *"Hydraulics and Pneumatics"*, S.K. Kataria and Sons.
2. R.K. Bansal, *"Fluid Mechanics and Hydraulic Machines"*, Laxmi Publications (P) Ltd.

Evaluation Scheme:

The question will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Unit	Title	Hrs. (L+T)	Marks Distribution
1	Introduction to Fluid Mechanics and Hydraulics	3+1=4	4
2	Hydrostatics	10+3=13	20
3	Hydro kinematics	5+2=7	8
4	Hydrodynamics	3+1=4	4
5	Flow Measurement	10+3=13	16
6	Pipe Flow	6+2=8	12
7	Open Channel Flow	8+3=11	16
	Total	60 Hrs	80