CHE-221: Fluid Mechanics-I

Credit Hours: 3-0

Pre-requisites. None

Course Objectives

- To introduce with the principles of force balances applied to fluid motion.
- It gives the introduction to the concepts and applications of fluid mechanics and dimensional analysis with an emphasis on fluid behavior, internal and external flows, analysis of engineering applications of incompressible pipe systems. Fluids have the ability to transport matter and its properties as well as transmit force, therefore fluid mechanics is a subject that is particularly open to cross fertilization with other sciences and disciplines of engineering.

Course Contents

i. Introduction to fluid statics and fluid Mechanics:
   a. Pressure forces on surfaces, Pressure distribution, Pressure measuring devices.
   b. Difference between fluid statics and fluid mechanics
   c. Applications of fluid mechanics in daily life and process industry

ii. Stress in Fluids:
   a. Concept of Viscosity, Newton's Law of Viscosity
   b. Shear Stress Components
   c. Velocity profile
   d. Newtonian and non-Newtonian flow, Reynolds number

iii. Nature of Flow:
   a. Different types of flow such as Compressible & Non-Compressible, uniform & non-uniform, steady and unsteady etc.
   b. Types of flow based on Reynolds number
   c. Nature of Laminar & Turbulent Flow

iv. Concept of boundary layer, Boundary layer formation and applications

v. Basic equations for fluid flow:
   a. Bernoulli's equation and its applications
   b. Equation of continuity and its application

vi. Momentum of a Flowing Fluid:
   a. Newton's 2nd law of motion & Momentum Balance,
   b. Velocity and pressure calculations for Laminar & Turbulent flow in a circular pipe.

vii. Flow of Incompressible Newtonian Fluids in Pipes & Channels, Shear stress, velocity, and pressure distribution in a pipe

viii. Flow of Compressible Newtonian Fluids

ix. Piping network analysis:
   a. Types of pipes and pipes fittings
   b. Calculations of pressure losses and friction factor for different pipe fitting (bend, sudden enlargements and sudden contractions, friction in non-circular channels)

x. Introduction to Flow measuring devices:
   a. Construction, working principal and selection criteria (Orifice meter, Venturi meter, Rota meter, Nozzle. Notch and Wier, Electromagnetic flow meter)
   b. Calculations of pressure drops across different flow measuring device, Flow of Compressible Newtonian Fluids

Course Outcomes

The student, upon completion of this course, will be able to:

- Formulate the principles of conservations of mass, momentum, and energy as applied to a variety of internal and external flows.
- Formulate solutions to flow problems, including those based on differential analysis, using appropriate fluid properties, flow conditions (i.e., laminar or turbulent)
- Solve conservation equations using a systematic approach based on different and/or integral analyses of conservation equations. The analyses will include concepts of fluid friction, momentum-force relationships, lift and drag, boundary layer theory, and pipe networks.
- Apply the principles of dimensional analysis and similitude to establish functional relations between important relevant parameters, and apply these to design.

Recommended Books:

- McCabe, Warren L., Smith, Julian C., and Harriott, Peter. (2001). Unit Operations of Chemical Engineering. 6th Edition. McGraw Hill Inc.

- Coulson, J.M. and Richardson, J.F. (1985). Chemical Engineering, Volume I. The English Book Society and Pergamon Press.
- Holland, F.A. and Bragg, R. (1995). Fluid Flow for Chemical Engineers, 2nd Edition. Butterworth & Heinemann.
- White, F.M. (1999). Fluid Mechanics, 4th Edition. McGraw-Hill.
- Noel-de-Nevers. Fluid Mechanics for Chemical Engineers. McGraw Hill.