Fluid Mechanics - Web course

COURSE OUTLINE

The basic purpose of this course is to introduce 2nd year Chemical Students to the concepts of fluid mechanics.

First few lectures will review the fundamentals of fluid mechanics, while subsequent lectures will focus on its applications in chemical engineering.

Briefly the course will include microscopic & macroscopic balances, Navier-Stokes' equations.

Introduction to turbulence, concept of boundary layer, friction factor, pipe flow, pressure loss in fittings, flow past an immersed body, packed & fluidized beds, pump & compressors.

Contents:

Introduction of fluid mechanics; Fluid statics-Pressure distribution in a fluid; integral balances for a control volume - mass, energy and momentum balances.

Bernoulli equation; Differential balances (Navier-Stokes equations); viscous flow in a pipe, Friction factor, Introduction to turbulence, losses in pipe systems, Flow meters, Flow past immersed bodies, Introduction to turbulence.

Mixing and Agitation, Flow through packed and fluidized bed, Filtration, Compressible flows, Pumps and Compressors, Centrifuges & Cyclones.

COURSE DETAIL

S.No	Topics	No. of Hours
1	Introduction to Fluid Mechanics - Fluid, Fluid types, Thermodynamic properties, Introduction of Viscosity.	1

NP-TEL

NPTEL

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Chemical Engineering

Pre-requisites:

Engineering mathematics: Differential and integral calculus, ordinary differential equations, vector mathematics.

Coordinators:

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2	Fluid statics - pressure distribution in a static fluid, hydrostatic forces on plane surfaces, Illustration by examples.	2
3	Macroscopic Balances - Control Volume, Reynolds transport theorem, Conservation of mass, Energy and linear momentum balances. Kinetic energy correction factor, Bernoulli equation, illustration by examples.	5
4	Application of macroscopic balances: Losses in expansion, Force on a reducing bend, Diameter of a free jet; Jet ejector.	2
5	Differential Balances: Differential equation of mass conservation, Differential equation of linear momentum, Navier-Stokes equations. Applications to Couette flow between a fixed and a moving plate, flow due to pressure gradient between two fixed plates, Fully developed laminar pipe flow.	4
6	Dimensional analysis and similarity: Buckingham Pi theorem, Nondimensionalization of continuity and Navier-Stokes equations, Introduction of dimensionless numbers.	2
7	Introduction to turbulence.	1
8	Viscous flow in a pipe/duct: Head loss, friction factor, frictional loss in high Reynolds no. flow, Effect of wall roughness, the Moody chart, illustration by examples.	3
9	Losses in pipe systems: pipe entrance/exit, expansion/contraction, Fittings, valves.	2
10	Fluid Meters: Local velocity measurement, Volume flow measurement, Thin- Plate orifice, flow nozzle, venture meter.	2

11	Flow past immersed bodies: Introduction to boundary layer, boundary layer thickness, Karman's momentum integral theory, Drag on a flat plate for laminar and turbulent flow, Drag on immersed bodies.	5
12	Flow through packed and fluidized beds: Flow through beds of solids, motion of particles through the fluid, Particle settling, Fluidization, minimum fluidization velocity.	2
13	Mixing and Agitation- power consumption, mixing times, scale up.	2
14	Filtration: Governing equations, constant pressure operation, constant flow operation, cycle time, types of filters.	1
15	Compressible flow: Isothermal flow, Adiabatic flow, Choked flow.	1
16	Pumps and Compressors:Pump types and characteristics, Required head, Cavitation and NPSH, isothermal compression, isentropic compression, Staged operation, Efficiency.	3
17	Centrifuges and Cyclones: Gravity settling, centrifugal separation, cyclone separations, separation efficiency, pressure loss.	2
	Total	40

References:

1. Frank M. White, Fluid Mechanics (Sixth Edition), Tata McGraw-Hill, New Delhi (2008).
2. J. O. Wilkes, Fluid Mechanics for Chemical Engineers, Prentice Hall (1999).

3. W. L. McCabe, W. L. Smith, and P. Harriot, Unit Operations of Chemical Engineering, McGraw-Hill International Edition (Sixth edition) (2001).

4. R. B. Bird, W. L. Stewart and E. L. Lightfoot, Transport Phenomena (Secondedition), Wiley Singapore (2002).

5. M. M. Denn, Process Fluid Mechanics, Prentice Hall (1980).

6. Ron Darby, Chemical Engineering fluid Mechanics, Marcel Dekker Inc, NY (1996).