BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
INSTRUCTION DIVISION
FIRST SEMESTER 2017-2018
Course Handout (Part II)

Date: 02/08/2018

In addition to part – I (General Handout for all courses appended to the timetable), this portion gives further specific details regarding the course.

Course No. Course	:	**CHE F212**
title Instructor-in-	:	**Fluid Mechanics**
charge Co-	:	**DR AMIT JAIN**
Instructor	:	**Dr Pratik N Sheth**

1. Course Description

Fundamental Concepts, Fluid Statics, Integral and Differential Analysis for Fluid Motion, Dimensional Analysis, Internal and External Fluid Flow, Fluid Machinery, Flow through Packed Bed, Agitation, Introduction to Compressible Flow.

2. Scope and Objective

This course is an introduction to the field of fluid mechanics. It mainly covers the basic principles of fluid mechanics and introduces the student to the fundamental and practical aspects of basic fluid flow operations, which a practicing chemical engineer meets with regularly. The physical concepts of fluid mechanics and analysis methods, beginning from basic principles shall be dealt with in this course.

3. Text Books

T1 Fox, R.W. and A.T. McDonalds, *Introduction to Fluid Mechanics (8^{th} Ed.)*, John Wiley & Sons Inc., 2011.

T2 McCabe, W.L., J.C. Smith and P. Harriott, *Unit Operations of Chemical Engineering (7^{th} Ed.)*, McGraw Hill Inc., 2005.

4. Reference Books

R1 Bird, R.B., W.E. Stewart and E.N. Lightfoot, *Transport Phenomena (2^{nd} Ed.)*, John Wiley and Sons Inc., 2002.

R2 Welty, J.R., C.E. Wicks, R.E. Wilson, and G. Rorrer, *Fundamentals of Momentum, Heat and Mass Transfer (4^{th} Ed.)*, John Wiley and Sons Inc., 2001.

R3 Coulson, J. M. and J. F. Richardson (with J. R. Backhurst and J. H. Harker), *Coulson & Richardson's Chemical Engineering- Volume 1 (5^{th} Ed.)*, Pergamon Press.

R4 Nevers, N. de, *Fluid Mechanics for Chemical Engineers (3^{rd} Ed.)*, McGraw-Hill Higher Education, 2005.

R5 Cengel, Y. A. and Cimbala J M (Adapted by: S Bhattacharyya), *Fluid Mechanics: Fundamentals and Applications (In SI Units)*, Tata McGraw-Hill Publishing Co. Ltd., Second Reprint 2007.

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COURSE PLAN: FLUID FLOW OPERATIONS

Module No. & Objective	Lecture/Tutorial Session Contents	Reference (Text Book)	Learning Outcome
M-1 Introduction to the Fluid Mechanics	**L.1-2** Definition of a fluid, Basic equations, Dimensions and unit, Dimensionless equations and Consistent units, Dimensional equations, Method of analysis.	TB1 & TB2: Chapter 1	• Recognize the meaning and the definitions of different fluid properties such as pressure, density, temperature, viscosity and velocity fields.
M-2 Fundamental concepts of fluid mechanics	**L.3-5** Concept of fluid continuum, Velocity and stress field, Viscosity, Viscosity of gases and liquids, Surface tension, Description and classification of fluid motions.	TB1: Chapter 2	• Calculate shear stresses and viscous forces under various circumstances. • Understand the laws related to fluid properties including ideal gas law, surface tension and speed of sound.
M-3 Fluid statics [Study of the principles of fluid statics and their application for various purposes]	**L.6-8** Basic equations of fluid statics, Pressure variation in static fluids, Hydrostatic Equilibrium in a centrifugal field, Buoyancy and stability.	TB1: Chapter 3 TB2: Chapter 2	• Evaluate pressure distribution in a hydrostatic fluid and submerged surfaces for different geometries including flat and curved surfaces. • Predict Buoyancy forces on floating bodies.
M-4 Basic equations in integral form for a control volume [General mathematical formulations for a control volume using basic laws of mechanics, physics and thermodynamics]	**L.9-14** Basic laws for a system, Conservation of mass and momentum equations for integral control volumes, Angular momentum principle [fixed control volume analysis only], First and second law of thermodynamics.	TB1: Chapter 4	• Apply Reynolds transport theorem to obtain conservation laws of fluid mechanics. • Solve problems of conservation of mass using steady as well as unsteady continuity equation. • Evaluate dynamic fluid forces using the linear momentum equation (Newton's second law of motion).
M-5 Introduction to differential analysis of fluid motion	**L.15-18** Conservation of mass and momentum equation [Navier-Stokes equations: Rectangular coordinates only]	TB 1: Chapter 5	• Solve problems of conservation of mass using steady as well as unsteady continuity equation.

Module No. & Objective	Lecture/Tutorial Session Contents	Reference (Text Book)	Learning Outcome
M-6 Fundamentals of incompressible inviscid flow	**L.19-22** Euler's equations, Bernoulli's equation, Relation between first law of thermodynamics and Bernoulli's equation	TB1: Chapter 6	• Calculate energy requirements (i.e. shaft work) of fluid flow in light of potential and kinetic energies using the energy equation.
M-7 Dimensional analysis and Similitude [Significance of non-dimensionalization technique and non dimensional numbers]	**L.23-25** Buckingham PI theorem/ Reyleigh method, Significant dimensionless group in fluid mechanics	TB1: Chapter 7	• Formulate non-dimensional equations using π-Theorem. • Analyze flow simulate and model-prototype similarity using dimensional analysis.
M-8 Internal incompressible flow [Friction in pipes; Flow patterns in pipes and channels]	**L.26-33** Flow between parallel plates, Flow in pipes of various cross-sections, Energy considerations of the flow, Pumps, Flow measurement techniques (venturi and orifice meters, pitot tubes etc.)	TB1: Chapter 9-10; TB2: Chapter 8	• Analyze fully developed laminar and turbulent pipe flows. • Calculate pipe losses using Moody chart. • Evaluate pressure losses in fittings, valves and sudden enlargements/contractions.
M-9 External incompressible viscous flow (flow over immersed bodies) and associated effects.	**L.34-38** Boundary layer concept, Boundary layer thickness, Pressure gradient in boundary layer, Drag & flow through beds of solids, sedimentation, fluidized beds.	TB1: Chapter 9; TB 2: Chapter 7	• Apply the concept of boundary layer. • Calculate boundary layer thickness and pressure gradients. • Evaluate drag in bed of solids. • Analyze the characteristics of fluidized beds. • Determine minimum fluidization velocity
M-10 Transportation and metering of fluids; Agitation and Mixing	**L.39-42** Pipe, Fittings, and Valves; Pumps, Fans, Blowers and Compressors; Types of Agitators and Mixers	TB2: Chapter 8	• Understand the functioning and characteristics of Pipes, fittings and valves. • Design and select pumps based process requirement. • Understand the various working and design aspects of agitators and mixers.

EVALUATION SCHEME

Component	Duration (min)	Marks (Weightage)	Date & Time	Remarks
Class Participation	---	30 (10%)	---	In-class: quiz/surprise test (Best 3 of4)
Project (Novel-Study Presentation)	---	15 (5%)	---	Open Book
Tutorial Evaluations (Best 6 of 8)	15-20	60 (20%)	---	Closed/Open Book
Midsemester Examination	90	75 (25%)	10/10 2:00 - 3:30 PM	Closed Book
Comprehensive Examination	180	120 (40%)	14/12 FN	Closed & Open Book

- **Note: No make-up would be granted for tutorial tests.**
- **Chamber consultation hour** will be announced in the class.
- The **notices** will be displayed on the Chemical Engineering Department notice board and/or nalanda web portal only.
- **Make-up** will be granted for genuine cases only. **Prior permission of I/C is mandatory.**

Instructor-in-charge
CHE F212