Birla Institute of Technology & Science, Pilani
Hyderabad Campus

FIRST SEMESTER 2020-2021

Course Handout Part II

Date: 17-08-2020

In addition to Part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. : **CHE F212**
Course Title : **Fluid Mechanics**
Instructor-in-Charge : **Prof. Ved Prakash Mishra**

Scope and Objective of the Course:

This course is an introduction to the field of fluid mechanics. It covers the basic physical concepts, analytical treatments beginning from fundamental principles along with examples and practical exercise problems. The objective of the course is to equip the students with a strong understanding of the fundamental and practical aspects fluid flow operations which a practicing chemical engineer meets with regularly, along with a flavor of current research.

Course Outcomes:

1. Understanding the basic properties of fluid and principles of fluid flow.
2. Understanding simple pipe flows as well as fluid machinery and flow measuring devices
3. Ability to solve different fluid flow problems using first principles i.e. mass, momentum and energy conservation equations.

Textbooks:

T1. Fox, R. W.; McDonald, A. T.; Pritchard P.J. and Mitchell J.W., *Fluid Mechanics* , John Wiley & Sons Inc., 2015. [ISBN: 978-81-265-5856-8]

T2. McCabe, W. L.; Smith, J. C. and Harriott, P. *Unit Operations of Chemical Engineering (7th Ed.)*, McGraw Hill Inc., 2005. [ISBN 007-124710-6]

Reference books

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

R2. Coulson, J. M. and Richardson, J. F. (with Backhurst J. R. and Harker J. H.), *Coulson & Richardson's Chemical Engineering- Volume 1 (5th Ed.)*, Pergamon Press.

R3. Som, S.K.; Biswas, G.; Chakraborty, S. *Introduction to Fluid Mechanics and Fluid Machines (3rd Ed.)*, McGraw Hill Edu., 2012.

R4. White, F. M.; *Fluid Mechanics (8th Ed.)*, McGraw Hill Edu., 2017.

Course Plan:

Lecture No.	Learning objectives	Topics to be covered	Chapter in the Text Book
1-2 (Module1 = M1)	General introduction to the Fluid Mechanics	Definition of a fluid; Basic Equations; Methods of Analysis; Units and Dimensions; Dimensional Analysis.	T1: 1.1 – 1.4 T2: Page 15
3-6 (M2)	Fundamental Concepts [Introduction to new concepts and definitions of Fluid Mechanics]	Fluid as a Continuum; Pressure, Velocity and Stress fields; Viscosity and Surface Tension; Description and Classification of Fluid Motions.	T1: 2.1 – 2.6
7-11 (M3)	Fluid statics [Study of the principles of Fluid Statics and their applications for various purposes]	Basic Equations of Fluid Statics; Pressure variation in Static Fluids; Hydrostatic force on submerged surfaces; Hydrostatic Equilibrium in a Centrifugal Field.	T1: 3.1, 3.3, 3.4 T2: Pages 33–34
12-16 (M4)	Basic Equations in Integral form for a Control Volume [General Mathematical Formulations for a Control Volume using laws of Mechanics, Physics and Thermodynamics]	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 Laws of Thermodynamics.	T1: 4.1– 4.4, 4.7.1, 4.8
17 – 21 (M5)	Introduction to Differential Analysis of Fluid Motion	Conservation of Mass and Momentum Equations [Navier-Stokes equations: Rectangular coordinates only]; Motion of fluid Elements.	T1: 5.1 – 5.4 T2: Pages 68-82
22 – 26 (M6)	Fundamentals of Incompressible Inviscid flows	Euler's Equations; Bernoulli's Equation; Bernoulli's Equation as an Energy Equation.	T1: 6.1 – 6.3, T2: Pages 86-94
27 – 29 (M7)	Dimensional Analysis and Similitude [Significance of Non-Dimensionalization Technique and Non Dimensional numbers]	Buckingham PI theorem/ Rayleigh's Method; Significant Dimensionless Groups in Fluid Mechanics.	T1: 7.1 – 7.4 T2: Page 16-20
30-34 (M8)	Internal Incompressible flow [Study of the Mechanics of flows inside Solid bodies, Aspects of Transportation and Metering of fluids]	Flow between parallel plates; Flow in pipes and ducts; Energy considerations in Pipe flow; Pumps; Flow Measurement Techniques (Venturi and Orifice meters, Pitot tubes etc.).	T1: 8.1 – 8.9 T2: Pages 98-108, 202-214

Lecture No.	Learning objectives	Topics to be covered	Chapter in the Text Book
35-39	External Incompressible	Boundary layer concept; Boundary	T1: 9.1, 9.2, 9.6

(M9)	Viscous flow (Flow over Flat Plates and Flow past Immersed bodies) and Associated effects. Introduction to Compressible flow	Layer thickness; Boundary layer formation and Separation; Drag & Streamlining; Flow through beds of solids; Compressible flow and the equations relevant.	T2: Pages 60-65, 133-138; 155-167
40-42 (M10)	Agitation and Mixing of Liquids [Agitation and Mixing of Homogeneous Liquids, Liquid-Liquid, Gas-Liquid and Solid-Liquid Dispersions]	Agitated Vessels and Accessories; Flow patterns in Vessels, Velocity patterns and Gradients, Power Consumption; Blending & Mixing, Static Mixers; Scale up	T2: Chap. 9 Pages 244-271

Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time	Nature of Component
Test 1	30 min	15	September 10 –September 20 (During scheduled class hour)	OB
Test 2	30 min	15	October 09 –October 20 (During scheduled class hour)	OB
Test 3	30 min	15	November 10 – November 20 (During scheduled class hour)	OB
Assignment/quiz		20		OB
Comprehensive	120 min	35		OB

Chamber Consultation Hour: To be announced in the first class.

Notices: To be posted on CMS.

Make-up Policy: Granted for genuine cases only. Prior permission of IC is compulsory.

INSTRUCTOR-IN-CHARGE
CHE F212