FIRST SEMESTER 2015-16
Course Handout (Part II)

Date: 30th July, 2015

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.	**:**	**CHE F212**
Course title	**:**	**Fluid Mechanics**
Instructor-in-charge	**:**	**Banasri Roy**
Instructors (Tutorial)	**:**	**Neha Chomal and Shweta Sharma**
Lectures	**:**	**T Th S, 12 noon, room 6105 (NAB)**
Tutorials	**:**	**W 8 am, room 6105 (Neha Chomal)**
		W 8 am, room 6106 (Shweta Sharma)

1. Course Description

Dimensions and Units, Velocity and Stress Fields, Viscosity and surface tension, Non-Newtonian flow, Types of flows, Fluid Statics, Bernoulli equation, Differential and Integral analysis methods of analysis, Navier Stokes equation, Potential flows, Stream functions and velocity potential, Boundary Layer Theory, Dimensional Analysis (Buckingham PI theorem), Flow measurement, Pipe flow analysis, Flow past immersed objects, Packed beds, Fluidized beds, Sedimentation, Pumps and compressors Agitation and Mixing, (Power consumption, mixing times, scale up), Introduction to Turbulent Flows (Reynolds equations), Compressible flows.

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 (8th Ed.)*, John Wiley & Sons Inc., 2012. ISBN: 978-81-265-4128-7. (Please bring your text to each class –we will often use figures and charts in class.)

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

4. Reference Books

R1 Bird, R.B., W.E. Stewart and E.N. Lightfoot, *Transport Phenomena (2nd 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 (4th 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 (5th Ed.)*, Pergamon Press.

R4 Nevers, N. de, *Fluid Mechanics for Chemical Engineers (3rd 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., 5th Reprint 2012.

5. COURSE PLAN

Lecture Number	Learning Objectives	Topics to be Covered	Reference (Text Book)
1-2 (Module 1 = M1)	Introduction to the Fluid Mechanics	Definition of a fluid, Basic equations, Dimensions and unit, Dimensionless equations and Consistent units, Dimensional equations, Method of analysis.	T1: 1.2 – 1.6 T2: Page 15
3-4 (M2)	Fundamental concepts [Introduction to new concepts and definitions of fluid mechanics]	Concept of fluid continuum, Velocity and stress field, Viscosity, Viscosity of gases and liquids, Surface tension, Description and classification of fluid motions.	T1: 2.1 – 2.6 T2: Pages 45-52
5 (M3)	Fluid statics [Study of the principles of fluid statics and their application for various purposes]	Basic equations of fluid statics, Pressure variation in static fluids, Hydrostatic Equilibrium in a centrifugal field, Buoyancy and stability.	T1: 3.1, 3.3, 3.6 T2: Pages 32-41
6-7 (M4)	Basic equations in integral form for a control volume [General mathematical formulations for a control volume using basic 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 law of thermodynamics.	T1: 4.1, 4.3, 4.4, 4.7.1, 4.8-4.9
8 – 9 (M5)	Introduction to differential analysis of fluid motion	Conservation of mass and momentum equation [Navier-Stokes equations: Rectangular coordinates only], Motion of fluid elements.	T1: 5-1.1, 5-1.2, 5-3 – 5.4 T2: Pages 68-82
10 – 11 (M6)	Fundamentals of incompressible inviscid flow	Euler's equations, Bernoulli's equation, Relation between first law of thermodynamics and Bernoulli's equation	T1: 6.1 – 6.4, 6.6: 6-6.1, 6-6.2 T2: Pages 86-94
12 (M7)	Dimensional analysis and Similitude [Significance of non-dimensionalization technique and non dimensional numbers]	Buckingham PI theorem/ Reyleigh method, Significant dimensionless group in fluid mechanics	T1: 7.1 – 7.4 T2: Page 16-20
13-14 (M8)	Internal incompressible flow [Study of the mechanics of flows in side solid bodies, aspects transportation and metering of fluid]	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.)	T1: 8.1 – 8.11 T2: Pages 98-132, 202-214
15-18 (M9)	External incompressible viscous flow (flow over immersed bodies) and associated effects.	Boundary layer concept, Boundary layer thickness, Pressure gradient in boundary layer, Drag & flow through beds of solids	T1: 9.1 – 9-2, 9-4-9.5, 9-7.1-9-7.3 T2: Pages 53-65, 155-167
19-25 (M10)	Fluid Machinery Mostly centrifugal pump	Turbomachinery analysis, Euler turbomachine equation, velocity diagram, pump performance, dimensional analysis, Pumps: Applications of Euler	T1: 10.1-10.3 T2:Pages 194-214

		turbomachine equations to centrifugal pumps, performance characteristics, similarity rule, cavitation & NPSH, Pump selection.	
26-35 (M11)	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	T2: Chap. 9 Pages 244-271

6. EVALUATION SCHEME

Component	Duration	Date	Weightage (300 marks/100%)	Remarks
Assignments	-		60 (20%)	
Class Assessments	-		30 (10%)	Attendances /Class problems
Mid Semester Test	90 min	9/10 2:00 - 3:30 PM	75 (25%)	CB and/or OB
Tutorial Evaluations	-		30 (10%)	CB and/or OB
Comprehensive Examination	3 hours	11/12 FN	105 (35%)	CB and/or OB

CB - Close book OB - Open book

- 15 marks (3%) extra for class participation, and attendance
- **Chamber consultation hour** will be announced in the class.
- The **notices** will be displayed on the Nalanda only.
- **Make-up** will be granted for genuine cases only. Certificate from authenticated doctor from the Medical Center must accompany make-up application (*only prescription or vouchers for medicines will not be sufficient*). Prior permission of IC is compulsory.
- No make up for tutorial tests.

Instructor-in-charge
CHE F212