Course No.	Course Name	L-T-P-Credits	Year of Introduction
CH205	FLUID AND PARTICLE MECHANICS-I	3-1-0-4	2016

Prerequisite: Nil

Course Objectives

To expose the students to the concepts of fluid mechanics that is relevant and used for applications in chemical engineering.

Syllabus

Fundamental Concepts: Continuum Hypothesis, Fluid Statics, Fluid Kinematics, Classification of Flow, Basic Equations of Fluid Flow, Laminar and Turbulent Flow of incompressible fluid in conduits, Pipe and tubing, Joints and fittings, Valves, Metering of Fluids.

Expected Outcome

At the end of the course the students will be able to

1. Summarize various properties of fluids and distinguish the different types of flow systems.
2. Summarize the fluid statics principles and examine the mathematical models for flow behaviour in different systems utilizing the principles of kinematics.
3. Analyze the basic fluid dynamic equations of change for isothermal systems
4. Explain the concepts of flow in boundary layers.
5. Select suitable flow measuring/metering devices and distinguish the different types of valves used in process industries

References Books:

- McCabe W.L. & Smith J.C., Unit Operations of Chemical Engg, McGraw Hill
- Streeter V.L., Fluid Mechanics, McGraw Hill
- An Introduction to Fluid Mechanics, Joseph Katz, Cambridge University Press
- Coulson J.M. & Richardson J.F., Chemical Engg. Vol. 1, Pergamon
- Foust, Wenzel, Clump, Maus& Anderson, Principles of Unit Operation
- Noel de Nerves, Fluid Mechanics for Chemical Engineers, McGraw Hill.
- Fluid Dynamics and Heat Transfer, Knudsen and Katz.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Continuum hypothesis, Definition of fluid, Newton's law of viscosity. Physical properties of fluid: Density, specific weight, specific volume, specific gravity, viscosity, compressibility & elasticity, surface tension & capillarity. Variation of viscosity and density with temperature and pressure. Measurement of viscosity using Newton's law of viscosity (Coaxial cylinder viscometer). Rheology of fluids, Classification of fluids.	8	15%

II	Pascal's law, Hydrostatic equilibrium in gravity and centrifugal field. Barometric equation. Principles of continuous gravity decanter and centrifugal decanter. Lapse rate. Principles of Manometer-Simple manometer, Differential manometer, Inclined tube manometer. Buoyancy and Floatation: Buoyancy, Buoyant Force and Centre of Buoyancy. Metacentre and Metacentric Height. Stability of submerged and floating bodies.	8	15%
FIRST INTERNAL EXAMINATION			
III	Introduction to fluid flow: Flow field, Eulerain and Lagrangian approach, velocity potential, stream function, circulation and vorticity. Stream line, Path line, Streak line, Stream tube. Classification of flow: Steady & unsteady flow, Uniform & non uniform flow, Rotational & irrotational flow. Reynolds experiment, Reynolds number, Turbulance, Reynolds stress, Flow in boundary-layers, Boundary-layer formation in straight tubes, Boundary-layer separation and wake formation.	10	15%
IV	Basic equations of fluid flow: Continuity Equation, Macroscopic Momentum Balance (Navier-Stoke's equation), Bernoulli Equation, Kinetic energy correction factor, Correction for fluid friction, Pump work in Bernoullis equation.	8	15%
SECOND INTERNAL EXAMINATION			
V	Laminar flow of incompressible fluids in conduits and thin layers: Shear stress and Velocity distribution, Maximum and average velocity-Hagen Poiseuille equation-Definition of Friction factor on Reynolds number in laminar flow. Turbulent flow of incompressible fluids in pipes and conduits: Universal velocity distribution equation, Friction factor and Reynolds number relationship-Nikuradse and Karman equation-Blasius equation (derivation not required), Prandtl one seventh power law-Friction factor chart-Frction from changes in velocity or direction-Sudden expansion and contraction-Effect of fittings and valves. Flow of liquids in thin layers.	14	25%
VI	Pipe and tubing, Joints and fittings, Valves – Gate valves and globe valves, Plug cokes and ball valves, Check valves. General Description and Flow rate equation for Venturi; Orifice; Flow Nozzle; Pitot tube; Rectangular, Triangular & Trapezoidal weir; Rotameter.	8	15%
END SEMESTER EXAMINATION			

Evaluation Scheme

- **Internal Evaluation: Total Marks: 50**
  (i) *Total Marks for Assignment/Seminar/Project/Case study or any other appropriate tool used for the evaluation of the course outcomes:* **10**
  A minimum of above two tools shall be used. If more than 2 tools are used, proportionate change shall be made in the marks so that the total contribution of marks for item (i) above remains at 10.
  (ii) Marks for Tests: Two tests each carrying 40% weightage shall be conducted with total contribution of **40 marks***.*

- **External Evaluation :** University Examination
  Maximum Marks : 100
  Exam Duration : 3 Hours

Question Paper Pattern:

There shall be **Three questions** uniformly covering Modules 1 and 2, each carrying 15 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in one main question with a total of 15 marks for all the subdivisions put together.
(2 x15= 30 Marks)

There shall be **Three questions** uniformly covering Modules 3 and 4, each carrying 15 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in one main question with a total of 15 marks for all the subdivisions put together.
(2 x15= 30 Marks)

There shall be **Three questions** uniformly covering Modules 5 and 6, each carrying 20 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in one main question with a total of 20 marks for all the subdivisions put together.
(2 x20= 40 Marks)