



Department of Chemical Engineering		LP: CH22302
		Rev. No: 00
B.E/B.Tech/M.E/M.Tech : Chemical Engineering	Regulation: 2022	Date:
PG Specialisation : NA		25.07.2023
Sub. Code / Sub. Name : CH22302 - MOMENTUM TRANSFER		
Unit : I		

FUNDAMENTALS OF FLUID AND FLUID FLOW: Fluid – properties of fluid – Continuum concept of fluid – Newton’s law of viscosity, pressure and temperature dependence – classification of fluids – Newtonian fluid – Non-Newtonian fluid and their classification. Classification of fluid flow – Incompressible and Compressible flow – Steady, Unsteady, Uniform and Non – Uniform flow. Flow visualization – streamline, pathline, streak line, velocity and stress field.

Objective: To impart knowledge on fluid properties, types of fluid, types of fluid motion and the concept of fluid as continuum

Session No *	Topics to be covered	Ref	Teaching Aids
1	Fluid, Fluid mechanics, Importance of Fluid Mechanics, Difference between solids, liquids and gases, significance of units and basic concepts	T2,Ch1; Pg 1-9 R1,Ch 1, Pg. 1-5 T1, Ch. 1, Pg. 29-30	PPT & BB
2	Fluid as continuum; Fluid properties-density, viscosity, surface tension and capillarity	T2,Ch 1; Pg. 1-22 R1, Ch.2, 20-23	PPT & BB
3	Problems in fluid properties – classification of fluids	T2,Ch 1; Pg. 1-22 R1, Ch 1; Pg. 23	PPT & BB
4	Types of fluid, Newtonian & non-Newtonian fluids – Time independent and Time dependent fluids- Compressible and incompressible	T1, Ch 3; Pg. 45-52; R1, Ch. 2, Pg. 34-39	PPT & BB
5	Classification of fluid motion – uniform & non-uniform, steady & unsteady,	T2,Ch 1; Pg. 1-22 R1, Ch.2, Pg. 25-29; & Pg.38-40.	PPT & BB
6	Flow patterns – Stream line, streak line, path line, time line	T2,Ch 1; Pg. 1-22 R1, Ch.2, Pg. 25-29; & Pg.38-40.	PPT & BB
7	Velocity and stress field	R1,Ch 2; Pg.29-30	PPT & BB
8	Problems on shear stress and velocity gradient	R1,Ch 2; Pg.29-30	PPT & BB
9	Problems on shear stress and velocity gradient	R1,Ch 2; Pg.29-30	PPT & BB

Content beyond syllabus covered (if any): Flow patterns

* Session duration: 50 minutes



Sub. Code / Sub. Name: CH22302 – MOMENTUM TRANSFER

Unit : II

FLUID STATICS AND FLUID KINEMATICS: Fluid statics – Pressure concept, Hydrostatic equilibrium, Manometer and their types. Fluid flow - Differential analysis of fluid motion – Conservation of mass – Equation of continuity and Equation of motion - Euler's equation, Bernoulli equation and with correction for fluid friction – correction for pump work. Navier – Stokes Equations and Applications

Objective: To understand the forces acting on a fluid - fluid pressure, pressure measurement, buoyancy and the applications of Continuity equation, Bernoulli equation and Navier – Stokes equation.

Session No *	Topics to be covered	Ref	Teaching Aids
10	Fluid statics - Newton's law of motion, forces on fluid elements, Pascal's law of hydrostatics,	T1, Ch 2, Pg:31-44 R1, Ch. 3, Pg: 56-61	PPT & BB
11	Hydrostatic equilibrium, Basic equation for pressure field	T1, Ch. 2, Pg. 31-34 R1, Ch. 3, Pg. 56-59	PPT & BB
12	Pressure measurement – manometer, barometer, types of manometers	T1, Ch 2, Pg: 35-39 R1, Ch. 3, Pg. 61-68	PPT & BB
13	Hydrostatic force on plane submerged surface, Hydrostatic forces on a curved submerged surface	T2, Ch 2, Pg: 63-87 R1, Ch. 3, Pg. 69-72 & 76-78	PPT & BB
14	Problems - manometers and calculating the pressure drop	T2, Ch 2, Pg: 103-107 R1, Ch.3, Pg. 65-66	PPT & BB
15	Problems - manometers and calculating the pressure drop	T1, Ch 2, Pg: 73-101 R1, Ch.3, Pg. 65-67	PPT & BB
16	Scalar & Vector field, Differential analysis of fluid motion, Continuity equation	T1 Ch.3 Pg. 45-47, T1, Ch 4, 68-74	PPT & BB
17	Bernoulli equation, Bernoulli equation with pump work	T1, Ch. 4, 86-94 T2, Ch. 8, Pg. 202-204; R1, Ch. 6, Pg. 241-242	PPT & BB
18	Bernoulli equation—problems based on continuity equation and Bernoulli's equation	T1, Ch. 4, 86-93 T2, Ch. 8, Pg. 202-204	PPT & BB

Content beyond syllabus covered (if any): Hydrostatic forces acting on a plane and curved surface

* Session duration: 50 mins



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Unit : III

FLOW THROUGH CONDUITS, FIXED & FLUIDIZED BEDS: Reynolds number, experiment and significance, Hagen Poiseuille equation and Darcy-Weisbach equation; internal flow - flow through conduit – friction factor – friction factor chart – head loss due to friction, sudden expansion and contraction. External flows - Flow over a sphere – friction and pressure drag - flow through fixed and fluidized beds - Kozeny Carman equation – Blake Plummer equation and Ergun equation.

Objective: To impart knowledge on flow through pipes, conduits fittings, fixed and fluidized beds.

Session No *	Topics to be covered	Ref	Teaching Aids
19	Reynolds number, experiment and significance	T1, Ch.3, Pg. 53-55 T2, Ch. 6, Pg. 341-346	PPT & BB
20	Hagen Poiseuille equation and Darcy-Weisbach equation;	T1, Ch. 5, Pg. 103-107 T2, Ch. 4, Pg. 268-270	PPT & BB
21	Internal flow; flow through conduit; friction factor	T2, Ch.6, Pg. 346-349 R1, Ch.2, Pg. 43- 44	PPT & BB
22	Friction factor-chart-Head loss due to friction, sudden expansion and contraction	T1,Ch. 5, Pg.114-141 R1, Ch. 8, Pg. 357-361	PPT & BB
23	External flows-flow over sphere	T1, Ch. 7, Pg. 155-162 R1,Ch.9, Pg. 421- 444	PPT & BB
24	Problems based on friction factor; Reynolds number Problems based on flow measurements	T2, Ch. 6, Pg. 351-352; 366-367 R1, Ch.9, Pg. 449-450 T2, Ch.6, Pg.377-382	PPT & BB
25	Friction and Pressure drag	T1, Ch. 7, Pg. 155-162 R1, Ch. 9, Pg. 445-458	PPT & BB
26	Pressure drop under laminar and turbulent flow conditions Packed bed and fluidized bed; Kozeny Carman equation	T1, Ch.7, Pg. 163-167 T2, Ch.6, Pg.377-382	PPT & BB
27	Blake Plummer equation and Ergun equation	T1, Ch.7, Pg. 163-167	PPT & BB

Content beyond syllabus covered (if any): Flow over non cylindrical surfaces.

* Session duration: 50 mins



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Unit : IV

TRANSPORTATION OF FLUIDS: Flow measurement –classification flow measuring devices – Principle and working of Orifice meter, Venturi meter, Pitot tube and Rotameter. Brief introduction to non-conventional methods: Laser Doppler velocimetry, Particle image velocimetry, ultrasonic flow meters, electromagnetic flow meters. Valves, Types and characteristics of Valves; Pumps – Classification and working of Centrifugal pumps and Reciprocating pumps, Centrifugal pump: Cavitation and priming – performance characteristics – Net positive suction head – factors influencing selection of pump. Introduction to compressors, fans and blowers.

Objective: To impart knowledge on transportation of fluids using centrifugal and positive displacement pumps and measurement of flow.

Session No *	Topics to be covered	Ref	Teaching Aids
28	Measurement of fluid flow-various devices and principles to measure fluid flow, non-conventional methods	T1, Ch. 8, Pg. 224-240 T1, Ch.6, Pg. 402-411 R3, Ch.2, Pg. 92 - 96	PPT & BB
29	Venturimeter and Orificemeter	T1, Ch. 8, Pg. 224-227 R1, Ch. 8, Pg. 393-394	PPT & BB
30	Orificemeter and Pitot tube	T1, Ch. 8, Pg. 227-232 R1, Ch.8, Pg. 395-396	PPT & BB
31	Rotameter, Insertion meters, problems based on venturimeter, orificemeter	T1, Ch. 8, Pg. 232-240 R1, Ch.8, Pg. 387-391 R2, Ch. 8, Pg. 412	PPT & BB
32	Characteristics of valves- Pumps-classification of pumps	T1, Ch. 8, Pg. 194-202 R1 Ch. 10, Pg. 516-521 T2, Ch.10, Pg. 693-724	PPT & BB
33	Centrifugal pump-Cavitaion and Priming-NPSH- Reciprocating pump	T1, Ch. 8, Pg. 202-207 R1, Ch. 10, Pg. 526-529	PPT & BB
34	Problems based on Pumps-calculation of efficiency of pump	T1, Ch. 8, Pg. 221-224 R1, Ch.10, Pg. 550-551	PPT & BB
35	Factors influencing the efficiency of pump-characteristic curves-selection of pump	T1, Ch. 8, Pg. 208-214 R1, Ch.10, Pg. 516-524 & 529-530	PPT & BB
36	Fans and Blowers	T1, Ch. 8, Pg. 214-220 R1, Ch. 10, Pg. 541-548	PPT & BB

Content beyond syllabus covered (if any): System curve versus pump operating curve

* Session duration: 50 mins



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Unit : V

TURBULENCE AND SIMILARITY: Introduction to turbulence: Structure of turbulence, visualization of turbulence, Reynolds decomposition. Fundamental dimension of quantities, dimensional homogeneity – dimensional analysis: Physical significance of dimensionless numbers, Geometric – Kinematic and Dynamic Similarity.

Objective: To impart knowledge about the inter relation of fluid, heat and mass transport through analogies.

Session No *	Topics to be covered	Ref	Teaching Aids
37	Introduction to Turbulence: Structure and Visualization	R1 Ch-16, Pg 469 - 480	PPT & BB
38	Reynolds Decomposition	R1 Ch-16, Pg 481 - 487	PPT & BB
39	Significance of dimensions and unit-Dimensional homogeneity	T1, Ch. 1, Pg. 16-19 R1, Ch. 1, Pg. 294-296	PPT & BB
40	Dimensional analysis-Application- Rayleighs method-problem using Rayleigh method	T1, Ch. 1, Pg. 16-19 R1, Ch. 7, Pg. 296-298	PPT & BB
41	Buckingham π -theorem-problems using Bukingham π theorem	T1, Ch. 1, Pg. 16-19 R1, Ch. 7, Pg. 297-298	PPT & BB
42	Non-dimensionalization of basic equations	R1, Ch. 7, Pg. 290-296	PPT & BB
43	Dimensionless numbers-Reynolds, Froude, Weber, Schmidt, Grashof number-Physical significance	R1, Ch. 7, Pg. 303-317	PPT & BB
44	Geometric similarity and kinematic similarity	R1, Ch. 7, 304-309	PPT & BB
45	Dynamic similarity; Problems based on similitude	R1, Ch. 7, 304-309	PPT & BB

Content beyond syllabus covered (if any): Analogies between momentum, heat and mass transport

* Session duration: 50 mins



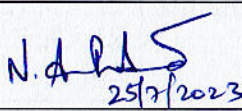

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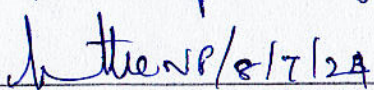
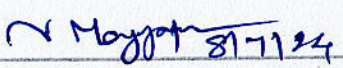
1. McCabe W.L, Smith, J C and Harriot. P “Unit Operations in Chemical Engineering”, McGraw Hill, Seventh Edition, 2005.
2. White, F.M., “Fluid Mechanics”, McGraw-Hill Inc., Seventh Edition, 2011.

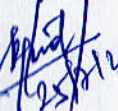
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1. Robert W. Fox and Alan T. McDonald, “Introduction to Fluid Mechanics” John Wiley & Sons, Inc, Fifth Edition, 2009.
2. Noel de Nevers, “Fluid Mechanics for Chemical Engineers”, McGraw-Hill, Third Edition, 2005.
3. J. O. Wilkes, Fluid Mechanics for Chemical Engineers, Prentice Hall, 1999.
4. R. B. Bird, W. L. Stewart and E. L. Lightfoot, Transport Phenomena (Second edition), Wiley Singapore, 2002.
5. M. M. Denn, Process Fluid Mechanics, Prentice Hall, 1980.

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Date	25/7/2023	31/07/2023
Remarks *:		

* If the same lesson plan is followed in the subsequent semester/year it should be mentioned and signed by the Faculty and the HOD

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Signature	 8/7/24	 8/7/24
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