FACULTY OF ENGINEERING & TECHNOLOGY

Effective from Academic Batch: 2022-23

Programme: **Bachelor of Technology (Food Processing Technology)**

Semester: **III**

Course Code: **202070303**

Course Title: **Food Engineering Transport Phenomena**

Course Group: **Professional Core Course**

Course Objectives: To introduce and explain the fundamentals of fluid flow, which is used in the applications of food processing technology. To inculcate the importance of the principles of continuity, momentum, energy, fluid flow measurement and its applications in industries.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Theory		J/V/P*		Total
Lecture	Tutorial	Practical		Internal	External	Internal	External	
3	0	2	4	50/18	50/17	25/9	25/9	150/53

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**Fluid Properties and Types of Flow:** Definition of a fluid, properties of fluid, density, specific eight, specific volume, specific gravity bulk modulus of elasticity, vapour pressure, surface tension, capillarity, viscosity, dynamic & Kinematic viscosity. Viscous versus inviscid flows, incompressible versus compressible flows, internal versus external flows, steady versus unsteady flows, laminar versus turbulent flows, 1-D, 2-D and 3-D flows, Newtonian versus non-Newtonian fluid flow.	04
2	**Kinematics of Fluid Motion:** Eulerian and Lagrangian descriptions of fluid motion. Concept of local, convective and material derivatives. Streamline, streakline, pathline and timeline.	03
3	**Fluid Statics:** Pressure at a point, basic equation of fluid statics, Units and scales of pressure measurement, Pressure measurements, Manometry, Forces on immersed plane and curved surface, Buoyant force, Stability of floating and submerged bodies, relative equilibrium.	10

4	**Viscous Effects &Integral Analysis for a Control Volume:** Steady incompressible flow through simple pipe systems. Steady uniform flow inopen channels, Boundary layer concepts, Boundary layer thicknesses, displacement thickness and momentum thickness. Reynolds Transport Theorem (RTT) for conservation of mass, linear and angular momentum.	**07**
5	**Turbulent Flow:** Empirical relations for laminar and turbulent flows, Reynolds's experiment, Major and minor losses, Darcy-Weisbach relation and Moody's chart.	**07**
6	**Fluid-Flow Concepts And Basic Equations:** Velocity potential and stream function, Euler's equation of motion along a streamline, Integration of Euler's equation of motion. Navier-Stokes equations, Bernoulli equation; Reversibility Irreversibility and losses. Application of Energy equation to steady Fluid-Flow situations. Orifice meter,Venturi meter, pitot tube, Notches and Weirs.	**09**
7	**Dimensional Analysis:** Dimensions and units, Concept of geometric, kinematic and dynamic similarity. The Buckingham Pi Theorem, Discussion of Dimensionless Numbers.	**05**
	Total	**45**

List of Practicals / Tutorials:

1	To verify Bernoulli's Theorem
2	To find out average value of discharge coefficient for notch- rectangular and triangular
3	To find out friction factor of pipes having various sizes and materials
4	To find out metacentric height of ship model
5	To get average value of discharge coefficient, C_d through venturimeter and orificemeter
6	To find out loss coefficient for given elbow, bend, and sudden contraction
7	Determination of discharge coefficients for mouthpiece and orifice.
8	To find out theoretical and actual force acting on stationary flat vane and curved vane
9	To find out type of flow and critical Reynolds number
10	To carry out dimensional analysis using Buckingham Pi Theorem

Reference Books:

1	Transport Phenomena by R.Byron Bird, Warron E. Stewart & Edwin N. Lightfoot, Wiley International Edition, John Wiley &Sons.
2	Transport Process & Unit Operations by Christie J. Geankoplis, Prentice Hall of India PrivateLimited. Modi P. N. and Seth S. M Hydraulics and Fluid Mechanics, Standard Book House
3	Fluid Mechanics by Streeter V. L. and Wylie E. B., McGraw Hill, SIEdition
4	Fluid Mechanics and Hydroulics by Bansal R K., Laxmi publications, NewDelhi
5	Fluid Mechanics by White, F.M., 5th ed., McGraw-Hill, 2003.
6	Introduction to Fluid Mechanics by Fox, R.W. and Mc Donald, A.T., , 6 th ed., John Wiley, 2003
7	Introduction to Fluid Machines, S.K. Som and G. Biswas, 2nd Edition, Tata McGraw-Hill Publishers Pvt.

Supplementary learning Material:	
1	https://nptel.ac.in/courses/103/104/103104043/
2	https://nptel.ac.in/courses/112/104/112104118/
3	https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-01-unified-engineering-i-ii-iii-iv-fall-2005-spring-2006/fluid-mechanics/
4	Engineering Fluid Mechanics by K.L. Kumar, Multicolor revised edition, S. Chand and Co, Eurasia Publishing House, New Delhi, 2014
5	Fluid Mechanics, Yunus A. Cenegal, and John M. Cimbala, second edition, Mc Graw Hill Education (India) Pvt. Ltd, 2013

Pedagogy:

- Direct classroom teaching
- Audio Visual presentations/demonstrations
- Assignments/Quiz
- Continuous assessment
- Interactive methods
- Industrial/ Field visits
- Course Projects

Internal Evaluation:

The internal evaluation comprised of written exam (40% weightage) along with combination of various components such as Certification courses, Assignments, Mini Project, Simulation, Model making, Case study, Group activity, Seminar, Poster Presentation, Unit test, Quiz, Class Participation, Attendance, Achievements etc. where individual component weightage should not exceed 20%.

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks in %						**R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating
R	**U**	**A**	**N**	**E**	**C**	
10%	30%	20%	10%	30%	0	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	To understand fundamental knowledge of fluid, its properties, relationship between the properties and different types of flow.	**10**
CO-2	To develop understanding about hydrostatic law, pressure measurement, principle of buoyancy and stability of a floating body	**20**
CO-3	To imbibe basic laws and equations used for analysis of static and dynamic fluids.	**25**
CO-4	Understand the principles of continuity, momentum, and energy as applied to fluid motions. Recognize these principles written in form of mathematical equations.	**20**
CO-5	To determine the losses in a flow system, flow through pipes, boundary layer concepts.	**15**

CP-6	Apply dimensional analysis to predict physical parameters that influence the flow in fluid mechanics.	**10**

Curriculum Revision:	
Version:	2
Drafted on (Month-Year):	June-2022
Last Reviewed on (Month-Year):	
Next Review on (Month-Year):	June-2025