



# GUJARAT TECHNOLOGICAL UNIVERSITY

## BACHELOR OF ENGINEERING

Subject Code: 3165107

Subject Name: Transport Phenomena in Food Processing

WEF Academic Year:	2022-23
Semester:	6
Category of the Course:	Open Elective - II

**Prerequisite:** Nil

**Rationale:** To acquaint and equip the students with the principles of heat and mass transfer and its applications in food processing

**Course Scheme:**

Teaching Scheme			Total Credits	Assessment Pattern and Marks				Total Marks
L	T	PR	C	Theory		Practical		
				ESE (E)	PA(M)	ESE (V)	PA (I)	
2	0	2	3	70	30	30	20	150

**Course Content:**

Sr. No.	Course Content	No. of Hours	% of Weightage
1	<b>UNIT I</b> Introduction to Transport Phenomenon: Classification of Transport Processes, Conservation Laws, Vector and Tensor Calculus	3	10
2	<b>UNIT II</b> Principles of Momentum Transport: Concept of Viscosity, Newton's Law of Viscosity, Shell Momentum Balance, Application of Shell Momentum Balance, Flow of Falling Film, Flow Through Circular Pipe, Flow Through annulus, Flow Over Moving Plate	15	25
3	<b>UNIT III</b> Convective heat transfer in food processing systems involving laminar and turbulent flow heat transfer in boiling liquids, heat transfer between fluids and solid foods.	10	20
4	<b>UNIT IV</b> Functional of heat exchangers: Shell and tube, plate and scraped surface heat exchangers, Jacketed vessels. Radiation heat transfer and its governing laws, its applications in food processing	8	20
5	<b>UNIT V</b>	12	25



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Molecular diffusion in gases, liquids and solids; molecular diffusion in biological solutions and suspensions molecular diffusion in solids, unsteady state mass transfer and mass transfer coefficients, molecular diffusion with convection and chemical reaction, diffusion of gases in porous solids and capillaries, mass transfer applications in food processing.		
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### Reference Book:

- 1) Benjamin G. 1971. Heat Transfer. 2<sup>nd</sup> Ed. Tata McGraw Hill.
- 2) Coulson JM & Richardson JF. 1999. Chemical Engineering. Vol. II, IV. The Pergamon Press.
- 3) Earle RL. 1985. Unit Operations in Food Processing. Pergamon Press.
- 4) R. Byron Bird, "Transport Phenomena", 2<sup>nd</sup> Edition, John Wiley & Sons (Asia) pvt. Ltd.
- 5) Geankoplis J Christie 1999. Transport Process and Unit Operations. Allyn & Bacon.
- 6) Holman JP. 1992. Heat Transfer. McGraw Hill.
- 7) Kreith Frank 1976. Principles of Heat Transfer. 3<sup>rd</sup> Ed. Harper & Row.
- 8) McCabe WL & Smith JC. 1999. Unit Operations of Chemical Engineering. McGraw Hill.
- 9) Treybal RE. 1981. Mass Transfer Operations. McGraw Hill.
- 10) Warren Gredt H. 1987. Principles of Engineering Heat Transfer. Affiliated East-West Press.

### Course Outcome :

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level*
CO-1	Introduction to heat and mass transfer and their analogous behaviour, steady and unsteady state heat conduction, analytical and numerical solution of unsteady state heat conduction equations, use of Gurnie-Lurie and Heisler Charts in solving heat conduction problems.	RM
CO-2	Applications in food processing including freezing and thawing of foods. Convective heat transfer in food processing systems involving laminar and turbulent flow heat transfer in boiling liquids, heat transfer between fluids and solid foods.	UN
CO-3	Functional design of heat exchangers: Shell and tube, plate and scraped surface heat exchangers, Jacketed vessels. Radiation heat transfer and its governing laws, its applications in food processing.	UN
CO-4	Molecular diffusion in gases, liquids and solids; molecular diffusion in biological solutions and suspensions molecular diffusion in solids, unsteady state mass transfer and mass transfer coefficients, molecular diffusion with convection and chemical reaction, diffusion of gases in porous solids and capillaries, mass transfer applications in food processing.	AP



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\*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

### Suggested Practical List:

- 1) Determine the viscosity of fluids using viscometers under varying conditions.
- 2) Measure flow rates and pressure drops to analyze fluid behavior in a pipe.
- 3) Study fluid flow through annular spaces to understand flow dynamics.
- 4) Measure heat transfer coefficients during boiling to assess heat exchange efficiency.
- 5) Analyze heat transfer efficiency in plate heat exchangers under different operating conditions.
- 6) Study heat transfer via radiation to understand its principles and applications.
- 7) Measure diffusion coefficients in liquids to analyze molecular movement.
- 8) Study gas diffusion through porous materials to understand transport mechanisms.
- 9) Investigate mass transfer processes in food products over time.
- 10) Measure heat transfer characteristics in vessels with jacketed walls to assess thermal efficiency.

### List of Laboratory/Learning Resources Required:

#### Open-Source websites:

- 1) NPTEL
- 2) <http://foodscience.uark.edu/>
- 3) <http://www.sciencedirect.com/science/book/>
- 4) <http://www.ucc.ie/en/ace-dfsct/>

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