



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: Food Engineering & Technology

Subject Code: BE05051051

Subject Name: Numerical Concept in Food Engineering

Academic Year :	2024-25
Semester :	5
Category of the Course :	Professional Elective Course - 2

Prerequisite :	NA
Rationale :	This course aims to strengthen students ability to apply numerical methods for solving complex problems related to heat and mass transfer, reaction engineering, and fluid flow in food systems. It enables students to interpret experimental data, perform modeling, and optimize food processing operations.

Course Outcome :

After Completion of the Course, Student will able to :

No.	Course Outcomes
01	Apply principles of heat transfer to analyze conduction, convection, and radiation problems in food systems.
02	Evaluate mass transfer operations under steady and unsteady state conditions including diffusion and convection.
03	Analyze reaction engineering problems and compute reaction rates, conversion, and energy changes in food processes.
04	Use interpolation and curve fitting techniques to analyze experimental data and develop predictive models.
05	Evaluate rheological behavior of food materials and apply fluid flow principles in pipe and non-Newtonian systems.

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
L	T	P	PBL*	TH		Theory		Tutorial / Practical			
						ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	0	30	15	90	03	70	30	20	30	50	200

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End- Semester Examination, PA = Progressive Assessment

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**



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Course Content

Sr. No.	Course Content	No. of Hours	% of Weightage
1.	Heat and Mass Transfer: Steady state conduction and convection heat transfer, Convective heat transfer coefficients, Radiation heat transfer molecular diffusion, Convective mass transfer, Heat and mass transfer analogies.	10	22
2	Mass and Energy balance: Steady state operation with no reaction, and with chemical reaction, Unsteady state operation with no reaction. General mass balance equation, Energy balance with phase change, Saturated steam, Super-heated steam, Enthalpy balances and psychrometric properties.	12	27
3	Interpolation and Curve Fittings: Single interpolation, Double interpolation, Numerical integration (Trapezoidal & Simpsons's rule), Coordinate system, Logarithmic transformations, Semi-log graph and Log-log graphs, regression analysis and error analysis.	11	24
4	Rheology of Foods: Measurement of rheological properties, Continuity equations, determination of flow regime, flow of Newtonian fluids in pipe and non-Newtonian fluids flow, time dependent flow behaviour, continuity equation, Reynold's number.	12	27

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	25	25	20	15	00

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

The syllabus of Numerical Concept in Food Engineering directly contributes to:

SDG 2	Zero Hunger
SDG 4	Quality Education
SDG 7	Affordable and Clean Energy
SDG 9	Industry, Innovation and Infrastructure
SDG 12	Responsible Consumption and Production
SDG 13	Climate Action

Reference Book :

- Math Concepts for Food Engineering by Richard W. Hartel
- Introduction to Food Engineering by Singh R. P.
- Chemical Engineering Hand Book by Perry R.H.
- Transport Processes and Unit Operation by Christie J. Geankoplis



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• Suggested list of tutorials:

1. Graphs and curve fittings
2. Interpolation of data in food engineering problems
3. Manipulations of equations and the rules of equations applied to food engineering
4. Numerical problems on Mass balance and Energy balance
5. Determination of flow regime in foods
6. Numerical problems on unsteady state heat transfer and Radiation heat transfer
7. Numerical problems on freezing of food products
8. Molecular diffusion on food products
9. Numerical problems on convective mass transfer
10. Numerical problems on unsteady state heat transfer

List of Open-Source Software/learning website :

1. https://elmoukrie.com/wp-content/uploads/2022/04/transport-processes-and-unit-operations-third-edition-christie-j.-geankoplis-z-lib.org_.pdf
2. https://www.youtube.com/watch?v=ZwBoZVrZxbk&list=PL2E9_TlQKsGRQy05HBihSowy1WP9HBtdy
3. <https://nptel.ac.in/courses/126105015/>

*** List of suggested activities for Problem Based Learning:**

Sr. No.	Activity Name	Suggested Topics/Focus Area	Hours	Evaluation Criteria
1	Industry/Research Laboratory Visit	Visit to food processing units focusing on heat transfer (pasteurization, drying), mass transfer operations, energy balance in processing units, steam generation systems, and fluid flow equipment (pumps, pipelines).	10 h (Visit + Report)	Report with observations, flow diagram, critical control points
2	Technical Video- Based Learning	Videos on heat and mass transfer applications, steam tables, psychrometric charts, fluid flow behavior, rheological measurements, and numerical solution methods (interpolation, regression).	10 h	Report/Presentation based on learning outcomes
3	Assignment Writing (Numericals)	Numerical problems based on heat transfer, mass and energy balance, steam calculations, interpolation, numerical integration (Trapezoidal/Simpson's), regression and error analysis.	10 h	Based on assignment depth and accuracy



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4	Problem Solving / Coding	Development of solutions using Excel/MATLAB for interpolation, curve fitting, solving balance equations, numerical methods (Newton-Raphson, integration), and data analysis.	10 h	Based on correctness and code output
5	Online Course (MOOCs)	Courses on numerical methods, transport phenomena, food process engineering, data analysis in engineering, and computational tools (Excel/MATLAB).	10 h	Based on completion certificate and assessment
6	Complex Problem Solving	Case studies on mass and energy balance in food processing, drying calculations, heat exchanger analysis, rheology-based flow problems, and process optimization.	10 h	Based on root cause analysis and justification
7	Industrial Safety Videos	Safety related to thermal operations (boilers, steam systems), pressure systems, fluid flow hazards, and safe handling of processing equipment.	10 h	Based on quiz or summary report
8	Discussion on Research Papers	Research papers on heat and mass transfer modeling, rheology of food materials, numerical simulation of food processes, drying kinetics, and computational food engineering.	20 h (5 papers × 4 h)	Evaluation of scientific depth, summary of findings
9	Poster/Chart/Power Point Presentation	Topics like heat transfer mechanisms, mass transfer operations, energy balance systems, psychrometric charts, steam properties, rheological behavior of foods, and numerical methods (interpolation, regression, error analysis).	6 h	Presentation clarity and content relevance
10	Model Development (Working/Non-working)	Models on heat exchangers, drying systems, fluid flow in pipes, rheological flow behavior (Newtonian vs non-Newtonian), mass balance systems, and numerical simulation models using Excel/MATLAB.	8–12 h	Internal/external demonstration and explanation
11	Industrial Exposure (2–3 Days)	Plant operations focusing on mass and energy balance in food processing, steam generation and utilization, drying operations, fluid transport systems, and process optimization techniques.	20 h	Critical evaluation report with suggested solutions
12	Group Discussion (Technical Trends)	Discussions on advancements in heat and mass transfer, computational modeling in food engineering, numerical methods in process optimization, rheology applications in industry, and data-driven food processing.	1 h per GD	Technical input and communication skill



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13	Case Study-Based Learning	Case studies on heat transfer in pasteurization, drying kinetics, mass balance in food plants, rheological challenges in processing, and numerical analysis of process efficiency.	10 h	Report with fact analysis and regulatory links
14	Application / Software Development	Development of tools for mass and energy balance calculations, interpolation and regression analysis, numerical integration, rheological data analysis, and process simulation using Excel/MATLAB.	10 h	Based on functionality and usability

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