



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: Food Engineering & Technology

Subject Code: BE05051011

Subject Name: Food Drying, Dehydration and Preservation

WEF Academic Year :	2024-25
Semester :	5
Category of the Course :	Professional Core Course

Prerequisite :	A basic understanding of thermodynamics, heat and mass transfer, food science and unit operations
Rationale :	This course provides fundamental and applied knowledge of moisture removal and preservation techniques used in the food industry. It covers the principles of heat and mass transfer, drying mechanisms and moisture behavior to help students understand drying kinetics and process efficiency. The inclusion of various types of dryers and basic design aspects develops practical and engineering skills required for industrial applications. Additionally, the course emphasizes product quality, energy efficiency, and emerging drying technologies, enabling students to address modern challenges in food processing and preservation.

Course Outcome :

After Completion of the Course, Student will able to :

No.	Course Outcomes
01	Understand moisture content, moisture removal and its requirement.
02	Understand moisture content measurement and thermal properties related to drying.
03	Understand drying mechanism for foods.
04	Select suitable dryer meeting requirement.
05	Develop functional design of dryers and understand novel drying technologies
06	Understand change in properties of dehydrated and rehydrated products

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	45	120	04	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.	Introduction: Drying definition, Moisture removal and its need, Dehydration of food, Utilities of drying, Theoretical aspects of drying, Fundamentals of heat and mass transfer in drying, Thermal properties related to drying of foods.	7	14
2.	Food Moisture: Moisture content measurement, representation and determination, Equilibrium moisture content (EMC), its determination, methods, models and importance, Moisture sorption curves, Hysteresis phenomenon.	7	15
3.	Drying theory and mechanisms: Drying process and methods, influencing factors of drying, Drying rate periods– constant and falling rate periods and their calculation, Mechanism of moisture movement: capillary and diffusion theory, Thin layer and deep bed drying, Dryer performance indices–overall thermal efficiency, specific energy consumption, coefficient of performance.	8	15
4.	Classification and selection of dryers: Classification of dryers and Quality criteria for dryer selection.	2	8
5.	Types of dryers and their applications: Basic construction, working and application of the following dryers –Tray dryers, Vacuum dryers, Spray dryers, Fluidized bed dryers, Freeze dryers, Flash Dryers, Super-heated steam drying, Solar energy based dryers, Osmotic Dehydration, Drum dryer.	6	15
6.	Dryer design: Basic design steps of dryer, heat requirement calculation and Basic design considerations –Tray dryer	3	7
7.	Properties of dried products: Physical, Chemical and Microbiological characteristics of de-hydrated foods, Re-hydration ratio, size and density, shelf-life, water-activity.	4	9
8.	Emerging Trends in Drying Technologies: Novel drying techniques, Hybrid dryers, Energy efficient drying technologies and environmental aspects- energy conservation.	4	9
9.	Food Preservation and Processing: Basic concepts of food preservation, factors affecting the food deterioration and different preservation techniques.	4	8



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Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
25	20	20	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 Food Drying, Dehydration and Preservation 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 :

1. Unit operations of chemical engineering by McCabe and Smith. McGraw-Hill
2. Drying of Foods, Vegetables and Fruits (Volume 1), Sachin V. Jangam, Chung Lim Law and Arun S. Mujumdar.
3. Drying Technologies for Foods: Fundamentals and Applications, Prabhat K. Nema, Barjinder Pal Kaur, ArunS. Mujumdar, CRC Press, 2018
4. Handbook of Industrial Drying, Edited By ArunS. Mujumda, CRC Press, 2006
5. Hand Book of Food Dehydration & Drying, by Eiri Board, Published by Engineers India Research Institute (2008)
6. Drying and Dehydration of Foods Paper back by Harry W. Von Loesecke, Delany Pres, 2012

Suggested Course Practical List :

1. To measure thermal properties of food product
2. Equilibrium Moisture Content (EMC) determination of grains
3. Determination of drying rate characteristics
4. Evaluate performance of tray dryer
5. Evaluate dehydration and rehydration of food product
6. Study of spray dryer
7. Study of solar drying
8. Study of freeze-drying process
9. Study of quality changes during drying of food materials
10. Study of LSU type grain dryer
11. Experiment on vacuum drying



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List of Laboratory/Learning Resources Required :

Equipment :

- Tray dryer
- Vacuum dryer
- Hot air oven
- Weighing balance
- Microwave oven
- Solar dryer
- Moisture meters
- Freeze dryer
- Infrared dryer

List of Open Source Software/learning website :

- http://www.aces.uiuc.edu/vista/html_pubs/DRYING/dryfood.html
- <http://nchfp.uga.edu/how/dry.html>
- <http://www.britannica.com/EBchecked/topic/172410/drying-process>
- http://science.utcc.ac.th/lecturer/muanmai/AITdownload/Ch5_moisture&drying.ppt

* 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 drying units (spray drying, freeze drying, tray drying), R&D centers working on dehydration, food processing units (milk powder, dried fruits/vegetables).	10 h (Visit + Report)	Report with observations, flow diagram, critical control points
2	Technical Video-Based Learning	Unit operations in drying, drying equipment (tray, spray, freeze dryer), moisture analysis, drying kinetics.	10 h	Report/Presentation based on learning outcomes
3	Assignment Writing (Numericals)	Moisture content calculations, drying rate, EMC models, heat and mass balance in drying systems.	10 h	Based on assignment depth and accuracy
4	Problem Solving / Coding	Drying rate modeling, thin layer drying models, moisture sorption isotherms, curve fitting for drying kinetics.	10 h	Based on correctness and code output
5	Online Course (MOOCs)	Courses on food dehydration, drying technologies, food preservation, thermal processing of foods.	10 h	Based on completion certificate and assessment



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6	Complex Problem Solving	Case study: spoilage in dried foods (milk powder, dried fruits), identifying drying faults, moisture reabsorption issues.	10 h	Based on root cause analysis and justification
7	Industrial Safety Videos	Safety in drying operations, handling high temperature air, explosion risks in spray drying, hygiene in dehydration units.	10 h	Based on quiz or summary report
8	Discussion on Research Papers	Recent advances in drying (microwave, infrared, hybrid drying), energy-efficient drying, quality changes during drying	20 h (5 papers × 4 h)	Evaluation of scientific depth, summary of findings
9	Poster/Chart/Power Point Presentation	Drying curves, types of dryers, moisture sorption isotherms, drying mechanisms, comparison of drying methods.	6 h	Presentation clarity and content relevance
10	Model Development (Working/Non-working)	Drying curves, types of dryers, moisture sorption isotherms, drying mechanisms, comparison of drying methods.	8–12 h	Internal/external demonstration and explanation
11	Industrial Exposure (2–3 Days)	Observation of industrial drying processes (milk powder plants, fruit dehydration units), identification of inefficiencies in drying systems.	20 h	Critical evaluation report with suggested solutions
12	Group Discussion (Technical Trends)	Mechanism of moisture removal, Drying rate periods, Construction and working of different dryers, Novel drying technologies.	1 h per GD	Technical input and communication skill
13	Case Study-Based Learning	Real case: Effect of drying on nutritional quality, Moisture reabsorption in dried products, Quality deterioration in dried Fruits.	10 h	Report with fact analysis and regulatory links
14	Application / Software Development	Moisture loss calculator, Drying characteristics calculator, nutritional loss calculator.	10 h	Based on functionality and usability

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