



## FACULTY OF ENGINEERING & TECHNOLOGY

Effective from Academic Batch: 2022-23

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

**Semester:** VII

**Course Code:** 202070708

**Course Title:** Food Storage Engineering

**Course Group:** Professional Elective Course - IV

**Course Objectives:** This course aims to acquaint the learner with fundamentals and types of storage systems for food and agricultural products and design of different food storage structures. This course will enable the student to understand and apply basic concepts of storage in practical situations.

### Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
Lecture	Tutorial	Practical		Theory		J/V/P*		Total
				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	<b>Storage:</b> Need for scientific storage systems for agro-products, Requirements of an ideal food grain storage structure. Post harvest physiology of semi-perishables and perishables: Respiration, Van't Hoff Rule, Calculation of $Q_{10}$ Values, Heat of Respiration, Transpiration and Water Stress, Ripening and Senescence.	06
2	<b>Damages:</b> Types and causes of food spoilage during storage (Mechanical damage, Heat, Moisture, Rodents, Birds, Insects, etc.). Sources of infestation and control. Loss in quantity and quality during storage.	05
3	<b>Storage Structures:</b> Traditional, Improved and Modern food grain storage structures,	05
4	<b>Environment control inside grain storage systems:</b> Moisture and temperature changes in stored grains, Aeration, Process of aeration and its advantages. Aeration theory and aeration system design. Respiration of grains, Hermetic Storage.	06



5	<b>Design of grain storage structures:</b> Functional and structural design of grain storage structures, pressure theories, pressure distribution in the bin, grain storage loads, pressure and capacities, warehouse and silos, Typical godown layout.	07
6	<b>Storage of perishables:</b> Cold storage, Design, Construction and working of cold storage rooms. Types of Cooling Load, Cooling Load Calculation, , Frozen storage	08
7	<b>Controlled and modified atmospheric storage systems:</b> Principles of MAP/CAS, Gases used in MAP/CAS, Methods of creating MA/CAS conditions, Relationship between permeability, respiration and gas composition in MAP/CAS, Metabolic effects of a CAS on fruits and vegetables, CAS Machinery.	08
Total		45

#### List of Practicals / Tutorials:

1	Layout, design and drawing of traditional storage structures
2	Estimation of quantity loss during storage of grains
3	Design of aeration system for food grains
4	Calculation of lateral and vertical pressure in silo
5	Design and layout of commercial bag storage facilities
6	Calculation of cooling load of cold storage room for food product
7	Drawing and layout of cold storage for particular commodity and capacity
8	Calculations for estimations of gases in modified atmosphere packaging
9	To study the effects of controlled atmosphere storage on quality attributes of fruits/vegetables
10	Calculation of shelf life of stored food products
11	Visits to commercial handling and storage facilities

#### Reference Books:

1	Rao, C. G. (2015). Engineering for storage of fruits and vegetables: cold storage, controlled atmosphere storage, modified atmosphere storage. Academic Press.
2	P.H. Pandey. 2014. Principles and Practices of Agricultural Structures and Environmental Control. Kalyani Publishers, Ludhiana.
3	H.K. Sharma and N. Kumar. 2022. Agro-Processing and Food Engineering Springer, Singapore.
4	Myer Kutz. 2007. Handbook of Farm, Dairy, and Food Machinery. William Andrew, Inc., Norwich, NY, USA.
5	A.M. Michael and T.P. Ojha. 2004. Principal of Agricultural Engineering, Vol. I. Jain Brothers, New Delhi.
6	Jayas D.S., White N.D.G., Muir, W.E. 1994. Stored Grain Ecosystems. Marcel Dekker, New York
7	J. Whitaker. 2002. Agricultural Buildings and Structures. Reston Publishing Home, Reston, Virginia, USA.

#### Supplementary learning Material:

1	G. Boumans. 1985. Grain Handling and Storage. Elsevier Science Publishers, Amsterdam, The Netherlands.
2	C.W. Hall. 1980. Drying and Storage of Agricultural Crops. The AVI Publishing Company, Inc., Westport, Connecticut, USA



3	K. M. Sahay and K. K. Singh, "Unit Operations of Agricultural Processing", 2nd edition, Vikas Publishing House, New Delhi, 2004.
4	S. Vijayaraghavan, "Grain Storage Engineering and Technology", 1st edition, Batra Book Service, New Delhi, 1993.
5	J. L. Multon, "Preservation and Storage of Grains, Seeds and their By-products: Cereals, Oil Seeds, Pulses and Animal Feed". 1st edition, CBS Publishing and Distributions, Delhi, 1989.
6	Post Harvest Technology of Fruits and Vegetables- A.K. Thomson

**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	
15%	30%	25%	20%	10%	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 comprehend the need for scientific storage systems for foods, their spoilage during storage and control methods	20
CO-2	To understand various storage techniques for agricultural products	10
CO-3	To acquaint with design aspects of food crop storage structures/systems.	25
CO-4	To select storage structures according to the requirements	10
CO-5	To understand and apply cold storage, controlled and modified atmospheric storage techniques	35

**Curriculum Revision:**

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