



S.No.	Topic	No. of Practicals
12.	Determination of solid gain and moisture loss during osmotic dehydration in fruits	1
13.	Study of components and design of controlled atmosphere storage	1
14.	Study of quality evaluation of fruits and vegetables	2
	<b>Total</b>	<b>15</b>

## X. Suggested Reading

- Bhatti S and Varma U. 1995. *Fruit and Vegetable Processing*. CBS.
- Cruess WV. 2000. *Commercial Fruit and Vegetable Products*. Agrobios Publisher.
- Danthy ME. 1997. *Fruit and Vegetable Processing*. International Book Publisher.
- Simson. 2016. *Post-Harvest Technology of Horticultural crops*. AAP.
- Singh. 2018. *Advances in Post-Harvest Technologies of Vegetable Crops*. AAP.
- Srivastava RP and Kumar S. 1994. *Fruit and Vegetable Preservation*. Principles and Practices. International Book Distr.
- Thompson AK. 1996. *Post Harvest Technology of Fruits and Vegetables*. Blackwell.
- Verma LR and Joshi VK. 2000. *Post Harvest Technology of Fruits and Vegetables*. Vols. I-II. Indus Publisher.

**I. Course Title : Storage Engineering and Handling of Agricultural Produce**

**II. Course Code : PFE 505**

**III. Credit Hours : 2+1**

### IV. Aim of the course

To acquaint and equip the students with the safe storage of food materials, design of storage structures and the design of different material handling equipment used in the industries.

### V. Theory

#### Unit I

Storage of grains, biochemical changes during storage, production, distribution and storage capacity estimate models, storage capacity models, ecology, storage factors affecting losses, storage requirements.

#### Unit II

Bag and bulk storage, godowns, bins and silos, rat proof godowns and rodent control, method of stacking, preventive method, bio-engineering properties of stored products, function, structural and thermal design of structures, aeration system.

#### Unit III

Grain markets, cold storage, controlled and modified atmosphere storage, effects of nitrogen, oxygen, and carbon dioxide on storage of durable and perishable commodities, irradiation, storage of dehydrated products, food spoilage and preservation, BIS standards.

#### Unit IV

Physical factors influencing flow characteristics, mechanics of bulk solids, flow through hoppers, openings and ducts; design of belt, chain, screw, roller, pneumatic conveyors and bucket elevators, principles of fluidization, recent advances in handling of food materials.



### VII. Learning outcome

Student's capability to mill and process (value added products) all kinds of horticultural crops as per requirement of food industries.

### VIII. Lecture Schedule

S.No.	Topic	No. of Lectures
1.	Importance of postharvest technology of fruits and vegetables, structure, cellular components, composition and nutritive value of fruits and vegetables.	1
2.	Techniques for harvesting and washing of fruits and vegetables. Fruit ripening and spoilage.	2
3.	Pre-cooling of fruits and vegetables.	1
4.	Blanching: importance and objectives, blanching methods, effects on food (nutrition, colour, pigment, and texture).	1
5.	Different preservation techniques for fruits and vegetables.	1
6.	Commercial canning of fruits and vegetables.	1
7.	Minimal processing of fruits and vegetables.	1
8.	Modified and CA storage of fruits and vegetables, Cold storage, heat load calculations and design.	5
9.	Quality deterioration in fruits and vegetables.	1
10.	Different storage techniques for fruits and vegetables.	1
11.	Dehydration techniques of fruits and vegetables: osmotic dehydration, foam mat drying, freeze drying, microwave heating, applications, radiation preservation of fruits and vegetables, irradiation sources.	4
12.	Intermediate moisture foods.	1
13.	Ohmic heating and high pressure processing principle for fruits and vegetables.	2
14.	Applications of different processing techniques for fruits and vegetables.	1
15.	Sensory evaluation of fruit and vegetable products.	1
16.	Packaging technology for fruits and vegetables.	2
17.	General principles of quality standards and control.	2
18.	FPO, quality attributes for fruits and vegetables.	2
	<b>Total</b>	<b>30</b>

### IX. List of Practicals

S.No.	Topic	No. of Practicals
1.	Determination of size of fruits and vegetables	1
2.	Determination of shape of fruits and vegetables	1
3.	Determination of bulk density and true density of fruits and vegetables	1
4.	Determination of area-volume-mass relationship of fruits and vegetables	1
5.	Determination of sugar-acid ratio of fruits	1
6.	Evaluation of different types of washers for fruits and vegetables	1
7.	Evaluation of different types of graders for fruits and vegetables	1
8.	Different types of packaging methods for fruits and vegetables	1
9.	Determination of the water vapor permeability of packaging materials	1
10.	Different types of drying methods for fruits and vegetables	1
11.	Comparative evaluation of different dryers for fruits and vegetables	1



S.No.	Topic	No. of Practicals
12.	Determination of solid gain and moisture loss during osmotic dehydration in fruits	1
13.	Study of components and design of controlled atmosphere storage	1
14.	Study of quality evaluation of fruits and vegetables	2
	<b>Total</b>	<b>15</b>

## X. Suggested Reading

- Bhatti S and Varma U. 1995. *Fruit and Vegetable Processing*. CBS.
- Cruess WV. 2000. *Commercial Fruit and Vegetable Products*. Agrobios Publisher.
- Danthy ME. 1997. *Fruit and Vegetable Processing*. International Book Publisher.
- Simson. 2016. *Post-Harvest Technology of Horticultural crops*. AAP.
- Singh. 2018. *Advances in Post-Harvest Technologies of Vegetable Crops*. AAP.
- Srivastava RP and Kumar S. 1994. *Fruit and Vegetable Preservation*. Principles and Practices. International Book Distr.
- Thompson AK. 1996. *Post Harvest Technology of Fruits and Vegetables*. Blackwell.
- Verma LR and Joshi VK. 2000. *Post Harvest Technology of Fruits and Vegetables*. Vols. I-II. Indus Publisher.

**I. Course Title : Storage Engineering and Handling of Agricultural Produce**

**II. Course Code : PFE 505**

**III. Credit Hours : 2+1**

### IV. Aim of the course

To acquaint and equip the students with the safe storage of food materials, design of storage structures and the design of different material handling equipment used in the industries.

### V. Theory

#### Unit I

Storage of grains, biochemical changes during storage, production, distribution and storage capacity estimate models, storage capacity models, ecology, storage factors affecting losses, storage requirements.

#### Unit II

Bag and bulk storage, godowns, bins and silos, rat proof godowns and rodent control, method of stacking, preventive method, bio-engineering properties of stored products, function, structural and thermal design of structures, aeration system.

#### Unit III

Grain markets, cold storage, controlled and modified atmosphere storage, effects of nitrogen, oxygen, and carbon dioxide on storage of durable and perishable commodities, irradiation, storage of dehydrated products, food spoilage and preservation, BIS standards.

#### Unit IV

Physical factors influencing flow characteristics, mechanics of bulk solids, flow through hoppers, openings and ducts; design of belt, chain, screw, roller, pneumatic conveyors and bucket elevators, principles of fluidization, recent advances in handling of food materials.



## VI. Practical

Physical factors influencing flow characteristics, mechanics of bulk solids, flow through hoppers, openings and ducts, design of belt, chain, screw, roller, pneumatic conveyors and bucket elevators; principles of fluidization; recent advances in handling of food materials.

## VII. Learning outcome

Student's capability to understand and undertake mechanical handling of food as per requirement of food industries as well as storage devices and systems for safe storage of food for longer period of time.

## VIII. Lecture Schedule

S.No.	Topic	No. of Lectures
1.	Importance of storage, Types of losses, Principle of storage, Aeration of grains, Factors causing deterioration of grains, Sources of infestation	3
2.	Biochemical changes during storage, Grain storage capacity estimation models	2
3.	Factors affecting losses, Storage requirements	2
4.	Bag and bulk storage, godowns, bins and silos, Selection of storage type, Deep and shallow bins	3
5.	Rat proof godowns and rodent control, method of stacking, preventive method, bio-engineering properties of stored products	2
6.	Functional, structural and thermal design of structures, aeration system.	2
7.	Grain markets- Recent reforms, Continued constraints to grain market integration, Rice and wheat marketing channels in India, Import, export and food policy, Food grains management system	2
8.	Cold storage, Controlled and modified atmosphere storage, Effects of nitrogen, oxygen, and carbon dioxide on storage of durable and perishable commodities.	3
9.	Food irradiation, Storage of dehydrated products, Food spoilage and preservation, BIS standards.	2
10.	Physical factors influencing flow characteristics, Rolling resistance, Mechanics of bulk solids - Shear apparatus for determination of flow properties, Yield locus, Time yield locus and effective yield locus.	3
11.	Flow through hoppers, openings and ducts – Types of flow along bins or hopper wall, Flow function and Critical flow factor, Critical dimensions of hopper openings;	2
12.	Material handling equipment, Design of belt, chain, screw, roller, pneumatic conveyors and bucket elevators.	4
13.	Principles of fluidization, recent advances in handling of food materials.	2
	<b>Total</b>	<b>32</b>

## IX. List of Practicals

S.No.	Topic	No. of Practicals
1.	Determination of angle of repose	1
2.	Determination of coefficient of internal friction	1
3.	Determination of coefficient of external friction	1
4.	Physical factors influencing flow characteristics	1



S. No	Topic	No. of Practicals
5.	Determination of flow properties using Shear apparatus	1
6.	Determination of Yield locus, Time yield locus and effective yield locus from Mohr's circle	1
7.	Flow through hoppers, openings and ducts	1
8.	Design of belt conveyors	1
9.	Design of chain conveyors	1
10.	Design of screw conveyors	1
11.	Design of bucket elevators	1
12.	Design of roller conveyors	1
13.	Design of pneumatic conveyors	1
14.	Principles of fluidization	1
15.	Recent advances in handling of food materials	2
	Total	16

### X. Suggested Reading

- Boumans. 1985. *Grain Handling and Storage*. Elsevier.
- FAO. 1984. *Design and Operation of Cold Stores in Developing Countries*. FAO.
- Golob. 2002. *Crop Post-Harvest: Science and Technology*. Vol 1 Wiley-blackwell.
- Hall CW. 1970. *Handling and Storage of Food Grains in Tropical and Sub-Tropical Areas*. FAO Publisher Oxford & IBH.
- Henderson S and Perry SM. 1976. *Agricultural Process Engineering*. 5<sup>th</sup> Ed. AVI Publisher.
- Hodges 2004. *Crop Post-Harvest: Science and Technology*. Vol 2, Wiley-blackwell.
- Ripp BE. 1984. *Controlled Atmosphere and Fumigation in Grain Storage*. Elsevier.
- Shefelt RL and Prussi SE. 1992. *Post Harvest Handling – A System Approach*. Academic Press.
- Vijayaraghavan S 1993. *Grain Storage Engineering and Technology*. Batra Book Service.

**I. Course Title : Food Package Engineering**

**II. Course Code : PFE 506**

**III. Credit Hours : 1+1**

#### IV. Aim of the course

To acquaint and equip the students with packaging methods, packaging materials, packaging machineries, modern packaging techniques etc.

#### V. Theory

##### Unit I

Introduction of packaging: Package, functions and design. Principle in the development of protective packaging. Deteriorative changes in foodstuff and packaging methods of prevention.

##### Unit II

Food containers: Rigid containers, glass, wooden boxes, crates, plywood and wire bound boxes, corrugated and fibre board boxes, textile and paper sacks, corrosion of containers (tin plate). Flexible packaging materials and their properties. Aluminum as packaging material. Evaluation of packaging material and package performance.

##### Unit III

Packaging equipment: Food packages, bags, types of pouches, wrappers, carton and other traditional package. Retortable pouches: Shelf life of packaged foodstuff.