Semester	**:**	**IV**		
Course No.	**:**	**PFE-242**	**Credit Hrs.** **:**	**3(2+1)**
Course Title	**:**	**Post-Harvest Engineering of Cereals, Pulses and Oilseeds**		

SYLLABUS

Objectives **:** To make the students acquainted with the different unit operations in processing of major cereals, pulses and oilseeds and the different equipment for the operations.

THEORY

General unit operations in agricultural process engineering and importance of these unit operations in grain processing; Structure and composition of cereals, pulses and oil seeds. Cleaning and grading. Principles of cleaning, scalping, sorting and grading; Screens, different types of screen separators, fixed and variable aperture screens, capacity and effectiveness of screens, sieve analysis; various types of separators like specific gravity, magnetic, disc, spiral, pneumatic, inclined belt draper, velvet roll separator, colour sorter, cyclone separator. Drying: Moisture content and water activity, free moisture, bound moisture and equilibrium moisture content, isotherm, hysteresis effect, EMC determination. Psychrometric chart and its use in drying. Drying principles and theory, thin layer and deep bed drying analysis, falling rate and constant rate drying periods, maximum and decreasing drying rate periods, drying equations, mass and energy balance, Shedd's equation. Drying methods (conduction, convection, radiation, batch, continuous); Different types of grain dryers (bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray), tempering during drying; dryer performance; Principles of grain storage; different types of grain storage structures; deep bin and shallow bin; design of a silo, structural and functional requirements of a grain storage go-down Size reduction: Principle; Bond's law, Kick's law, Rittinger's law; Sieve analysis; Different classifications of size reduction machines; description of jaw crusher, hammer mill, attrition mill, and ball mill; Material handling: Basic parts of different types of conveyors and elevators, *viz*. belt, roller, chain, screw, and bucket elevator, cranes and hoists, pneumatic conveying, power requirement for conveying and elevating. Milling of rice: parboiling- merits and demerits, changes during parboiling of rice, parboiling methods, *viz.* traditional methods, CFTRI method, Jadavpur method, pressure parboiling; different unit operations and equipment involved in traditional and modern rice milling methods; Preparation of rice products as rice flakes and puffed rice; Milling of wheat: unit operations and equipment; Milling of corn: unit operations and equipment in dry and wet milling methods. Milling of pulses: pre-conditioning, dry milling and wet milling methods, CFTRI and Pantnagar methods, pulse milling machines; Milling of oilseeds: preconditioning of oilseeds, mechanical expression, screw press, hydraulic press, solvent extraction method, refining of oil, stabilization of rice bran.

PRACTICAL

Study of different types of screens and study of screen effectiveness; Study of construction and operation of different types of cleaners and separators; Measurement of moisture content: dry basis and wet basis; Study on drying characteristics of grains and determination of drying constant; Determination of EMC (static and dynamic method); Study of psychrometric chart; Study of various types of dryers; Study of different size reduction machines; Sieve analysis, determination of fineness modulus and uniformity index; Study of different unit operations and machineries in rice mills; Study of different unit operations and machineries in pulse mills; Study of different unit operations and machineries in oil mills; Study of different unit operations and machineries in wheat/ flour mills; Study of different unit operations and machineries in corn processing units; Study of extrusion process; Study of different types of conveying and elevating equipment.

TEACHING SCHEDULE

THEORY [PFE-242]

Lecture No.	Topic	Sub-topics/Key Points	Weightage (%)
1 - 2	**General Unit Operations in Agricultural Process Engineering**	Unit operations and its importance, Grain processing, Structure and composition of cereals, pulses and oilseeds.	5
3 - 6	**Cleaning and Grading**	Principles of cleaning, scalping, sorting and grading; Screens, Different types of screen separators.	12
		Fixed and variable aperture screens, Capacity and effectiveness of screens, sieve analysis.	
		Various types of separators like specific gravity, magnetic, disc, spiral, pneumatic Inclined belt draper, velvet roll separator, colour sorter, cyclone separator.	
7 - 14	**Drying**	Moisture content and water activity, free moisture, bound moisture and equilibrium moisture content, isotherm, hysteresis effect, EMC determination.	22
		Psychrometric chart and its use in drying.	
		Drying principles and theory, Thin layer and Deep bed drying analysis, Falling rate and constant rate drying periods, Maximum and decreasing drying rate periods.	
		Drying equations, Mass and energy balance, Shedd's equation.	
		Drying methods (conduction, convection, radiation, batch, continuous).	
		Different types of Grain dryers (bin, flat bed, LSU, columnar, RPEC, fluidized Rotary and tray), Tempering during drying; dryer performance.	
15 - 16	**Principles of Grain Storage**	Different types of grain storage structures; Deep bin and Shallow bin;	8
		Design of a silo, Structural and functional requirements of a grain storage go-down	

Continued…

17 - 18	**Size Reduction**	Principle; Bond's law, Kick's law, Rittinger's law; Sieve analysis.	8
		Different classifications of size reduction machines; Description of jaw crusher, hammer mill, attrition mill and ball mill.	
19 - 21	**Material Handling**	Basic parts of different types of conveyors and elevators, *viz.* belt, roller, chain and screw.	10
		Basic parts of different types of conveyors and elevators, *viz.* bucket elevator, cranes and hoists.	
		Pneumatic conveying, Power requirement for conveying and elevating	
22 - 26	**Milling of Rice**	Parboiling- Merits and demerits, Changes during parboiling of Rice.	15
		Parboiling methods *viz.* Traditional methods, CFTRI method, Jadavpur method.	
		Pressure parboiling; Different unit operations and equipment involved in Traditional milling methods	
		Pressure parboiling; Different unit operations and equipment involved in Modern Rice milling methods	
		Preparation of Rice products as- Rice flakes and Puffed rice.	
27	**Milling of Wheat**	Unit operations and equipment for Wheat	6
28	**Milling of Corn**	Unit operations and equipment in dry and wet milling methods	
29 - 30	**Milling of Pulses**	Pre-conditioning, Dry milling and Wet milling methods, CFTRI and Pantnagar methods, Pulse milling machines.	8
31 - 32	**Milling of Oilseeds**	Preconditioning of oilseeds, Mechanical expression, screw press, hydraulic press. Solvent extraction method, Refining of oil, Stabilization of Rice bran	6
		Total =	**100**

TEACHING SCHEDULE

PRACTICAL [PFE-242]

Exercise No.	Exercise Title
1.	Study of different types of screens and its effectiveness.
2.	Study of construction and operation of different types of cleaners.
3.	Study of construction and operation of different types of Separators.
4.	Measurement of moisture content: dry basis and wet basis.
5.	Study of drying characteristics of grains and determination of drying constant. Determination of EMC (static and dynamic method).
6.	Study of psychrometric chart.
7.	Study of various types of dryers.
8.	Study of different size reduction machines. Sieve analysis-
9.	Determination of fineness modulus and uniformity index.
10.	Study of different unit operations and machineries in Rice mills.
11.	Study of different unit operations and machineries in pulse mills.
12.	Study of different unit operations and machineries in oil mills.
13.	Study of different unit operations and machineries in Wheat/ flour mills.
14.	Study of different unit operations and machineries in corn processing units.
15.	Study of extrusion process.
16.	Study of different types of conveying and elevating equipment.

Suggested Readings [PFE-242]:

1. Sahay K.M. and Singh K.K. 1994. Unit Operations of Agricultural Processing. Vikas Publishing House Pvt. Ltd. New Delhi.
2. Chakraverty A. 1999. Post-Harvest Technology of Cereals, Pulses and Oilseeds. Oxford & IBH publishing Co. Ltd., New Delhi.
3. B.L. Bala, 1997, Drying and Storage of Cereals Grains, Oxford and IBH Publishing Co. Ltd., Calcutta.
4. Dash S.K. Bebartta J.P. and Kar A. 2012. Rice Processing and Allied Operations. Kalyani Publishers, New Delhi.
5. Swain S, Dash S.K. Mangaraj S, and Ali N. 2016. Agricultural Process Engineering. Vol I. Kalyani Publishers, New Delhi.
6. Geankoplis C.J. 2002. Transport Processes and Unit Operations. Prentice Hall of India Pvt. Ltd, New Delhi.
7. McCabe W.L, Smith J.C. and Harriott P. 1993. Unit Operations of Chemical Engineering. McGraw Hill.