

<b>5<sup>th</sup> Semester</b>	<b>RAG5C003</b>	<b>Post-Harvest Engineering of Cereals, Pulses and Oilseeds</b>	<b>L-T-P 3-0-0</b>	<b>3 CREDITS</b>
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**Module I****(6 Hours)****Cleaning and Grading**

Importance of different unit operations in processing of cereals, pulses and oilseeds; Cleaning and grading: Screening, type of screens, grizzly, revolving screen, shaking screen, rotary screen, vibratory screen, horizontal screen, perforated metal screen, wire mesh screen, scalping, size separators; Ideal and actual screen, effectiveness of screens, aspiration; Various types of separators (specific gravity, magnetic, disc, spiral, pneumatic, inclined belt draper, velvet roll separator, colour sorters, cyclone separator) and their capacity, shape graders

**Module II****(10 Hours)****Drying**

Objective of drying, physicothermal properties of food grains important in drying: Moisture content on dry basis and wet basis, water activity, specific heat, thermal conductivity, enthalpy, thermal diffusion, surface heat transfer coefficient; Moisture content determination, direct methods, hot air oven method, vacuum oven method, indirect methods, electrical resistance method, dielectric method, chemical method; Unbound and bound moisture, free moisture, equilibrium moisture content, isotherm, hysteresis effect, EMC determination: static method, dynamic methods, desorption method, isothermographic method; EMC models: Kelvin equation, Harkins-Jura equation, Chung-Pfost equation, Handerson equation, importance of EMC; Psychrometric chart and its use in drying, dry-bulb temperature, wet-bulb temperature, dew point temperature, absolute humidity, percentage humidity, relative humidity, saturated pressure, humid heat, humid volume, enthalpy; Drying theory, thin layer and deep bed drying, drying rate periods, constant rate period, falling rate period, maximum and decreasing drying rate period; Drying equations, mass and energy balance, Shedd's equation, different methods of drying (batch, continuous, mixing, non-mixing), dryer performance; Sun drying, mechanical drying methods, contact drying, convective drying, freeze drying, radiation drying, superheated steam drying, osmotic drying, fluidized bed drying, desiccated air drying, tempering during drying, types of air flow in mechanical drying system.

**Module III****(6 Hours)****Size Reduction and Mixing**

Size Reduction- grain shape, average size of particle in a ground product, sieve analysis, fineness modulus; Principle of size reduction, crushing efficiency, Bond's law, Kick's law, Rittinger's law, procedure (crushing, impact, cutting and shearing), hulling/milling efficiency; Size reduction machinery (jaw crusher, hammer mill,

attrition mill, ball mill), Mixing- Theory of mixing of solids and pastes, mixing index; Types of mixers for solids, liquid foods and pastes (tumbling mixer, ribbon mixer, impeller type mixer, sigma blade mixer)

#### **Module IV**

**(8 Hours)**

Milling of rice- Conditioning and parboiling, advantages and disadvantages, traditional methods, CFTRI and Jadavpur methods of parboiling, pressure parboiling method; Principles of operation of huller, under runner disk sheller, centrifugal sheller; Modern rice milling, different unit operations and equipment (cleaning, shelling, husk separation, paddy separation); Modern rice milling, different unit operations and equipment (polishing, bran removal, grading, colour sorting, glazing); Milling of wheat- Unit operations and equipment; Milling of pulses- Traditional milling methods, commercial methods, pre-conditioning, dry milling and wet milling methods, CFTRI and Pantnagar methods and milling machines; Milling of corn and its products: Dry and wet milling; Milling of oilseeds- Mechanical expression, screw press, hydraulic press, solvent extraction methods; Preconditioning of oilseeds, refining of oil, stabilization of rice bran

#### **Module V (7 Hours)**

Extrusion Cooking, By-product Utilization and Material Handling

Extrusion cooking- Principle, factors affecting extrusion cooking, single and twin screw extruders; By-products utilization of grain processing industries; Material handling equipment- Types of conveyors (belt, roller); Material handling equipment- Types of conveyors (belt, roller); Chain and screw conveyor, Elevators (bucket, cranes & hoists); Trucks (refrigerated/ unrefrigerated), pneumatic conveying.

#### **Books**

1. Chakraverty, A. 1999. *Post Harvest Technology of cereals, pulses and oilseeds*. Oxford & IBH publishing Co. Ltd., New Delhi.
2. Dash, S.K., Bebartta, J.P. and Kar, 2012. *A. Rice Processing and Allied Operations*. Kalyani Publishers, New Delhi.
3. Sahay, K.M. and Singh, K.K. 1994. *Unit operations of Agricultural Processing*. Vikas Publishing house Pvt. Ltd. New Delhi.
4. Geankoplis C. J. 2002. *Transport processes and unit operations*, Prentice Hall of India Pvt. Ltd, New Delhi
5. McCabe, W.L., Smith J.C. and Harriott, P. *Unit operations of Chemical Engineering*. McGraw Hill.
6. Mangaraj, S, Dash, S K, Swain S. and Ali, N. 2017. *Agricultural Process Engineering Vol II (Post Harvest Unit Operations)*. Kalyani Publishers, New Delhi. 428 p.
7. Mangaraj, S, Ali, N. Swain S. and **Dash, S K** 2017. *Agricultural Process Engineering Vol III (Storage Engineering and Technology)*. Kalyani Publishers, New Delhi. 348 p.