I. **Course Title**   : **Textural and Rheological Characteristics of Food Materials**

II. **Course Code**   : **PFE 603**

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

IV. **Aim of the course**

To acquaint and equip the students with advances in measurement of textural and rheological characteristics affecting the food quality.

V. **Theory**

Unit I

Rheological properties of foods; Food rheology, physical states of materials, classical ideal material, rheological models, elements in the models, electrical equivalence, maxwell model, Kelvin model and four element burger's model, stress-strain behavior. Elastic–plastic behavior, visco-elastic behavior, creep behavior, dynamic visco-elastic behavior, flow behavior of fluids, creep, stress relaxation.

Unit II

Viscometry; Capillary viscometry, casson model, flow rate equation, friction losses in pumping, turbulent flow, newtonian fluid, power law fluid, cone and plate viscometry, parallel plate viscometry, mixer viscometry. Flow through a converging die, cogswell's equations, gibson's equations, empirical method. Applications of stress and strain, shear modulus and shear loss modulus, storage compliance and loss compliance, comparison of moduli and compliances.

Unit III

Objective and subjective measurements of texture; Texture classification, relation of food texture with structure and rheology, principles and practices of objective or instrumental texture measurements, fundamental rheological tests, physiological aspects, mechanical aspects and viscosity measurements and relationship between fundamental tests and sensory evaluation. Imitative and empirical measurements of texture; Tenderometer, brabenderfarinograph, firmness meter, texture profile method, dynamic methods for evaluation of food texture, dimensional analysis of food texture, firmness and hardness measurement.

Unit IV

Mathematical models and their application along with pipe line design and pump selection for non-newtonian fluids. Recent advances in textural, rheological and viscoelastic characteristics of foods and their associated mathematical models.

VI. **Practical**

Determination of viscosity of liquid foods, gumminess, chewiness, springiness and hardness of various fruits, vegetables and processed foods using texture profile analysis.Determination of force-distance relationship.Sensory evaluation/ subjective measurement and correlation between subjective and objective measurements of foods.

VII. **Learning outcome**

Student's capability to determine textural and rheological properties of food materials and their application in control of food processing operations.

VIII. Lecture Schedule

S.No.	Topic	No. of Lectures
1.	Objective and subjective measurements of texture: Texture classification, relation of food texture with structure and rheology.	3
2.	Principles of Objective Texture Measurement.	2
3.	Practices of objective or instrumental texture measurements.	2
4.	Fundamental rheological tests, physiological aspects, mechanical aspects and viscosity measurements and relationship between fundamental tests and sensory evaluation.	2
5.	Imitative and empirical measurements of texture: Tenderometer, brabender farinograph, firmness meter, texture profile method, dynamic methods for evaluation of food texture, dimensional analysis of food texture, firmness and hardness measurement.	2
6.	Rheological properties of foods: Food rheology, physical states of materials, classical ideal material.	2
7.	Elastic–plastic behavior, visco-elastic behavior, creep behavior, dynamic visco-elastic behavior, flow behavior of fluids, creep, stress relaxation.	2
8.	Rheological models, elements in the models, electrical equivalence, maxwell model, Kelvin model and four element burger's model, stress-strain behavior.	2
9.	Viscometry; Capillary viscometry, casson model, flow rate equation, friction losses in pumping, turbulent flow, newtonian fluid, power law fluid, cone and plate viscometry, parallel plate viscometry, mixer viscometry.	2
10.	Flow through a converging die, cogswell's equations, gibson's equations, and empirical method.	2
11.	Applications of stress and strain, shear modulus and shear loss modulus, storage compliance and loss compliance, comparison of moduli and compliances.	2
12.	Correlation between physical measurements and sensory assessments of texture and viscosity.	2
13.	Mathematical models and their application along with pipe line design and pump selection for non-newtonian fluids.	2
14.	Recent advances in textural, rheological and viscoelastic characteristics of foods and their associated mathematical models.	2
	Total	**30**

IX. List of Practicals

S.No.	Topic	No. of Practicals
1.	Introduction to Texture analyzer	1
2.	Study of different attachments of texture analyzer used in texture analysis of various agricultural commodities.	1
3.	To study the texture profile curve for food material	1
4.	To study the textural profile kinetics of various fruits	2
5.	To study the textural profile kinetics of various vegetables	2
6.	To study the textural profile kinetics of various processed foods	2
7.	To study the textural properties of liquid food	1
8.	To study the Compression, puncture, elongation and bending tests for food materials	3
9.	Introduction to Rapid Visco analyser	2
10.	Subjective measurement and correlation between subjective and objective measurements of foods.	1
	Total	**16**

X. Suggested Reading

- Bourne MC. 2002. *Food Texture and Viscosity: Concept and Measurement*. Academic Press.
- Deman JM. 1976. *Rheology and Texture in Food Quality*. AVI Publications.
- Mohsanin NN. 1989. *Physical Properties of Plant and Animal Material*. Vol. I, II. Gordon and Breach Science Publications.
- Steffe JF. 1992. *Rheology and Texture in Food Quality*. AVI Publications.

I. **Course Title** : **Agricultural Waste and By-Products Utilization**

II. **Course Code** : **PFE 604**

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

IV. Aim of the course

To acquaint and equip the students with the techniques of utilization of agricultural waste and by-products and also about development of value added products from wastes.

V. Theory

Unit I

Conversion processes: Thermo-chemical conversions, densification, combustion and gasification, extraction, biological conversions, anaerobic digestion, biochemical digestion process, digestion systems, energy from anaerobic digestion, cellulose degradation, fermentation process. Agricultural wastes as paper, boards and fuel.

Unit II

Briquetting: Briquetted fuel from husk, hull and other wastes selection, design of briquetting machines. Utilization of shell, stem and stalk:Production of activated carbon. By-products of agro-industries:Rice mill, oil mill, cattle feed mill, valuable constituents and composition. Utilization of rice husk: Production of silica and cement from rice husk.Stabilization and storage of rice bran, extraction of rice bran oil.

Unit III

By-products of oil refining: Fatty acids/soap stock, wax and gum, characteristics and utilization. Rice germ and broken rice. Production of starch and infant food, industrial uses of starch. By-products of oil milling:Oil cake and defatted oil cake, cattle feed and industrial uses. Utilization of starch and other industrial wastes: Microcrystalline cellulose, production of ethanol, wastes of tapioca starch industries,thippi-utilization as fuel, extraction of starch by hydrolysis, utilization of starch for food, adhesives and feed purposes.

Unit IV

By-products of sugar industry: Sugarcane tops, bagasse, molasses and pressmud, utilization as animal feed. By-products of fruits and vegetables based agro-industries: Mango seed kernel and pineapple waste.

VI. Practical

Exercises on stepped grate and fixed grate rice husk furnaces, waste fired furnace, briquette machine, production of alcohol from waste materials, production and testing of paperboards and particleboards from agricultural wastes.

VII. Learning outcome

Student's capability to develop processes for effective utilization of wastes generated through milling and processing of food materials.