

Course Curriculum of Fifth Semester
as per the ICAR-Sixth Deans' Committee Report for
the Academic Programmes in
FOOD TECHNOLOGY

- ❖ **UG-Certificate in Food Technology**
- ❖ **UG-Diploma in Food Technology**
- ❖ **UG-Degree: B.Tech. (Food Technology)**



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UG Degree Syllabus State Coordinator

with

UG Degree Syllabus Discipline Coordinators &

DICC - UG Degree Syllabus Core Committee

Submitted to the

Directors of Instruction Coordination Committee

~ w.e.f. AY, 2026-27

**Course Curriculum of Fifth Semester as per the
ICAR-Sixth Deans' Committee Report for Academic Programmes in
FOOD TECHNOLOGY**

Course Layout
B.Tech. (Food Technology)

Semester: V (New)

w.e.f. Academic Year: 2026-27

Sr. No.	Course No.	Course Title	Credit Hrs.	Remark
1.	AEC-355	Personality Development	2(1+1)	--
2.	FQA-358	Food Biochemistry and Nutrition	3(2+1)	--
3.	FT-352	Processing Technology of Cereals	3(2+1)	--
4.	FT-353	Processing Technology of Fruits and Vegetables	3(2+1)	--
5.	FT-354	Food Packaging Technology and Equipment	2(1+1)	--
6.	FT-355	Processing of Spices and Plantation Crops	3(2+1)	--
7.	FE-3510	Food Storage Engineering	3(2+1)	--
8.	FBM-351	Project Preparation and Management	2(1+1)	--
9.	EDT-351	Study Tour	2(0+2)	NG
10.	OC-1 / OC-2/ ...	Online Course(s) / MOOCs [†]	As opted by student	NG
Total Credits Hrs.			23(13+8)	G
AEC: Ability Enhancement Course, G: Gradual, NG: Non-gradual, OC: Online Course				
[†] Note: It is mandatory for each Student to complete total 6 credits (Non-gradual) of Online Courses from available resources across III to VIII semesters under the guidance of assigned Faculty/Advisor.				

B.Tech. (Food Technology): Fifth Semester

Course-wise Syllabus with Teaching Schedules

Semester	:	V
Course No.	:	AEC-355
Credit Hrs.	:	2(1+1)
Course Title	:	Personality Development
Gradual Common Course for B.Tech. (Agricultural Engineering) and B.Tech. (Food Technology)		

SYLLABUS

Objective: To make students realize their potential strengths and cultivate their inter-personal skills and improve employability.

THEORY

Personality: Definition, Nature of personality, Theories of personality and its types. The humanistic approach- Maslow's self-actualization theory, Shaping of personality, Determinants of personality, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, Personality and Organizational Behaviour. Foundations of individual behavior and Factors influencing individual behavior, Models of individual behavior, Perception and Attributes; Factors affecting perception, Attribution theory and Case studies on Perception and Attribution. Learning: Meaning and Definition, Theories and Principles of Learning, Learning and Organizational behavior, Learning and Training, Learning feedback. Attitude and Values, Intelligence-Types of Intelligence, Theories of intelligence, Measurements of intelligence, Factors influencing intelligence, Intelligence and Organizational behavior, Emotional intelligence. Motivation-Theories and Principles, Teamwork and Group dynamics.

PRACTICAL

MBTI personality analysis, Learning Styles and Strategies, Motivational needs, Firo-B, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict management, Leadership styles, Case studies on Personality and Organizational Behavior.

THEORY [AEC-355]

Lecture No.	Topic	Sub-topics/Key Points	Weightage (%)
1	Personality	Definition, Nature of Personality	5
2	Theories of Personality and its Types	The Humanistic Approach- Maslow's self-actualization theory; Types-Extroversion, Introversion, Conscientiousness, Agreeableness	10
3		Shaping of Personality - improving communication skills, stepping out of comfort zone, learning to say no, tapping into creativity, getting curious, giving yourself a daily affirmation, practicing self-care. Determinants of Personality- Physical, Intellectual, Social and Psychological	10
4		Myers- Briggs Typology indicator Four Indicators- Introvert/Extrovert, Thinking/ Feeling, Sensing/ Intuiting, Judging/ Perception, Locus of Control and Performance	10
5		Type A and Type B Behaviours Theory	5
6	Personality and Organizational Behaviours	Difference between Personality and Organizational behaviours	5
7		Foundations of individual behaviours, Factors influencing individual behaviour- personality, values, motivation, perspectives and social impacts	5
8		Models of Individual behaviour- Rational Economic man, Social man, The Self actuating man, Complex man	5
9	Perception	Attributes and Factors affecting perception; Attribution theory and Case studies on Perception and Attribution	10
10	Learning	Meaning, Definition; Theories and Principles of Learning	10
11		Difference between Learning and Organizational behavior; Difference between Learning and Training; Feedback of Learning	5
12	Attitude and Values	Meaning, Definitions, Concept	5
13	Intelligence	Types of Intelligence, Theories of intelligence	
14		Measurement of intelligence Factors affecting intelligence Difference between intelligence and organizational behaviour, Emotional intelligence	5
15	Motivation	Meaning, Theories and Principles	5
16	Team and Group Dynamics	Meaning, Definitions, Concept	5
Total =			100

TEACHING SCHEDULE

PRACTICAL [AEC-355]

Exercise No.	Exercise Topic
1	Myers- Briggs Type Indicator (MBTI) analysis- Extroversion/ Introversion
2	Myers- Briggs Type Indicator (MBTI) analysis- Sensing/ Intuition
3	Myers- Briggs Type Indicator (MBTI) analysis- Thinking/Feeling
4	Myers- Briggs Type Indicator (MBTI) analysis- Judging/ Perception
5	Learning Styles and Strategies
6	Motivational Needs
7	Fundamental Interpersonal Relations Orientation Behaviour (FIRO-B)
8	Interpersonal Communication
9	Team Work
10	Team Building
11	Group Dynamics
12	Win-Win Game
13	Conflict Management
14	Leadership Styles
15	Case studies on Personality
16	Case studies on Organizational Behaviour

Suggested Readings [AEC-355]:

1. **Andrews, Sudhir, 1988**, How to Succeed at Interviews. 21st(rep.) New Delhi. Tata - McGraw Hill.
2. **Heller, Robert, 2002**, Effective Leadership. Essential Manager Series. DK Publishing.
3. **Hindle, Tim, 2003**, Reducing Stress. Essential Manager Series. DK Publishing.
4. **Kumar, Pravesh, 2005**, All about Self- Motivation. New Delhi. Goodwill Publishing House.
5. **Lucas, Stephen, 2001**, Art of Public Speaking. New Delhi. Tata - McGraw Hill.
6. **Mile, D.J., 2004**, Power of Positive Thinking. Delhi. Rohan Book Company.
7. **Smith, B., 2004**, Body Language. Delhi: Rohan Book Company.
8. **Shaffer, D. R., 2009**, Social and Personality Development (6th Edn). Belmont, CA: Wadsworth

Semester :	V	
Course No. :	FQA-358	Credit Hrs. : 3(2+1)
Course Title :	Food Biochemistry and Nutrition	

SYLLABUS

- Objectives** :
- (i) To gain an understanding of nutrition and diets.
 - (ii) To understand and learn metabolic pathways for different biomolecules in human body.

THEORY

Concept of Food and Nutrition; Functions of food; Basic food groups; Nutrients supplied by food; Water and Energy balance, Water intake and losses, Basal metabolism; Formulation of diets, Classification of balanced diet, Preparation of balanced diet for various groups; Recommended dietary allowances for various age groups; Malnutrition; Assessment of nutritional status; Food fad and faddism; Potentially toxic substance in human food; Mechanism of Enzyme action; Introduction to enzyme and characteristics, Coenzymes, Kinetics and Mechanism of enzyme action; Derivation of Michaelis- Menten Equation, Enzyme inhibition by pH, Allosteric enzymes; Nucleic acids, Structures of various components of DNA and RNA. Nutrients; Functions, Sources, Digestion, Absorption, Assimilation, Transport of carbohydrates; Functions, sources, Digestion, Absorption, Assimilation, Transport of proteins; Functions, sources, Digestion, Absorption, Assimilation, Transport of fats; Metabolism of carbohydrates. Introduction to carbohydrates metabolism, glycolysis, TCA cycle; Electron transport chain, Oxidative and Substrate level phosphorylation; Metabolism of Lipids; Introduction to lipid metabolism, β -oxidation of long chain fatty acids, Ketosis, Breakdown of phospholipids; Biosynthesis of fatty acids, Triglycerides and Phospholipids; Introduction to protein metabolism, Transamination; Deamination and Decarboxylation; Fixation of Nitrogen, Urea Cycle; Functions, Sources, Absorption, Deficiency of macrominerals, Microminerals and Trace minerals; Functions, Sources, Absorption, Deficiency of Vitamins A and D, Vitamins E and K and Water-soluble vitamins. Information about hormones and relation between vitamins and hormones.

PRACTICAL

Preparation of various solutions and buffers; Qualitative and Quantitative determination of carbohydrates; Qualitative and Quantitative determination of amino acids; Qualitative and Quantitative determination of proteins; Qualitative and Quantitative determination of lipids; Qualitative and Quantitative determination of vitamins; Isolation of enzymes from various sources; Measurement of energy using bomb calorimeter; Determination of pKa of acid; Determination of pI for casein; Estimation of sugars by Anthrone method; Estimation of protein by Lowry method; Estimation of amino acid using Biuret reaction; Separation of amino acids using paper chromatography; Separation of amino acids using thin layer chromatography; Separation of amino acids using electrophoresis; Estimation of phosphorus in food sample. Estimation of iron content in foods; Determination of calcium in food samples; Estimation of β -carotene using column chromatography; Estimation of ascorbic acid using dye method; Effects of acids and alkali on pigments.

TEACHING SCHEDULE**THEORY [FQA-358]**

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 4	Concepts of Food and Nutrition	Functions of food; Basic food groups; Nutrients supplied by food; Water and Energy balance, Water intake and losses, Basal metabolism; Formulation of diets, Classification of balanced diet, Preparation of balanced diet for various groups; Recommended dietary allowances for various age groups.	15
5 - 6	Malnutrition	Assessment of nutritional status; Food fad and faddism; Potentially toxic substance in human food	5
7 - 10	Enzyme	Mechanism of Enzyme action; Introduction to enzyme and characteristics, Coenzymes, Kinetics and Mechanism of enzyme action; Derivation of Michaelis-Menten Equation, Enzyme inhibition by pH, Allosteric enzymes;	10
11 - 13	Nucleic Acid	Nucleic acids, Structures of various components of DNA and RNA.	5
14 - 18	Nutrients	Nutrients; Functions, Sources, Digestion, Absorption, Assimilation, Transport of carbohydrates, Functions, Sources, Digestion, Absorption, Assimilation, Transport of proteins; Functions, Sources, Digestion, Absorption, Assimilation, Transport of fats; Metabolism of carbohydrates.	20
19 - 22	Carbohydrate	Introduction to carbohydrates metabolism, Glycolysis, TCA cycle; Electron transport chain, Oxidative and Substrate level phosphorylation;	8
23 - 26	Metabolism of Lipids	Introduction to lipid metabolism, β -oxidation of long chain fatty acids, Ketosis, Breakdown of phospholipids; Biosynthesis of fatty acids, Triglycerides and Phospholipids;	10
27 - 29	Protein Metabolism	Introduction to protein metabolism, Transamination; Deamination and Decarboxylation; Fixation of Nitrogen, Urea Cycle	7
30 - 32	Membrane Separation Methods	Functions, Sources, Absorption, Deficiency of macrominerals, Microminerals and trace minerals; Functions, Sources, Absorption deficiency of Vitamins A and D, Vitamins E and K and Water-soluble vitamins, Information about hormones and relation between vitamins and hormones.	20
Total =			100

TEACHING SCHEDULE

PRACTICAL [FQA-358]

Exercise No.	Exercise Title
1	Preparation of various solutions and buffers
2	Qualitative and quantitative determination of carbohydrates
3	Qualitative and quantitative determination of amino acids
4	Qualitative and quantitative determination of proteins
5	Qualitative and quantitative determination of lipids
6	Qualitative and quantitative determination of vitamins
7	Isolation of enzymes from various sources
8	Measurement of energy using bomb calorimeter
9	Determination of pka of acid
10	Estimation of protein by Lowry method
11	Estimation of amino acid using Biuret reaction
12	Separation of amino acids using paper chromatography
13	Separation of amino acids using thin layer chromatography
14	Separation of amino acids using electrophoresis
15	Estimation of phosphorus in food sample
16	Estimation of iron content in foods
17	Determination of calcium in food samples
18	Estimation of β -carotene using column chromatography
19	Estimation of ascorbic acid using dye method
20	Effects of acids and alkali on pigments.

Suggested Readings [FQA-358]:

1. **Berdanier, C.D., Feldman, E.B. and Dwyer, J. 2008.** Handbook of Nutrition and Food, 2nd edn. CRC Press, Boca Raton, FL, USA.
2. **Berg, J.M., Tymoczko, J.L., Stryer, L. and Gatto Jr., G.J. 2002.** Biochemistry, 7th edn. W.H. Freeman and Company, NY, USA.
3. **Buchanan, B.B., Gruissem W. and Jones, R.L. 2002.** Biochemistry and Molecular Biology of Plants. John Wiley and Sons, Inc., NY, USA.
4. **Moe, G., Kelley, D., Berning, J. and Byrd-Bredbenner, C. 2013.** Wardlaw's Perspectives in Nutrition: A Functional Approach. McGraw-Hill, Inc., NY, USA.
5. **Nelson, D.L. and Cox, M.M. 2012.** Lehninger Principles of Biochemistry, 6th edn. Macmillan Learning, NY, USA.
6. **Voet, D. and Voet, J.G. 2011.** Biochemistry, 4th edn. John Wiley and Sons, Inc., NY, USA.

Semester	: V	
Course No.	: FT-352	Credit Hrs. : 3(2+1)
Course Title	: Processing Technology of Cereals	

SYLLABUS

- Objectives :**
- (i) To learn milling technology of rice, wheat, corn and barley,
 - (ii) To get knowledge about breakfast cereals and their processing.

THEORY

Present status and Future prospects of cereals and millets; Morphology, Physico-chemical properties of cereals, Major and Minor millets, Chemical composition and Nutritive value; Paddy processing and Rice milling: Conventional milling, Modern milling; Milling operations, Milling machines, Milling efficiency; Quality characteristics influencing final milled product; Parboiling; Rice bran stabilization and its methods; Ageing of rice; Enrichment of rice – Methods of enrichment; Rice fortification; Wheat milling: Break system, Purification system and Reduction system; Extraction rate and its effect on flour composition; Quality characteristics of flour and their suitability for baking; Corn milling: Dry and Wet milling of corn, Starch and Gluten separation, Milling fractions and Modified starches; Barley: Malting and Milling; Oat/Rye: Processing, Milling; Sorghum: Milling, Malting, Pearling; Millets (Pearl millets, Finger millets): Processing of millets for food uses; Secondary and Tertiary products processing of cereals and millets; By-products processing of cereals and millets; Processing of infant foods from cereals and millets; Breakfast cereal foods: Flaked, Puffed, Expanded, Extruded and Shredded.

PRACTICAL

Morphological characteristics of cereals; Physical properties of cereals; Chemical properties of cereals; Parboiling of paddy; Cooking quality of rice; Milling of rice; Conditioning and Milling of wheat; Production of sorghum Flakes; Production of popcorns, Flaked rice, Puffed rice, Noodles; Preparation of sorghum malt; Determination of gelatinization temperature by amylograph; Processing of value-added products from millets; Visit to Cereal processing unit.

TEACHING SCHEDULE**THEORY [FT-352]**

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 3	Present Status and Prospects	Present status and future prospects of cereals and millets	10
4 - 6	Morphology	Morphology, Physico-chemical properties of cereals, Major and Minor millets, Chemical composition and Nutritive value	5
7 - 9	Paddy Processing and Rice milling	Conventional milling, Modern milling; Milling operations, Milling machines, Milling efficiency	10
10 - 11		Parboiling; Rice bran stabilization and its methods; Ageing of rice	5
12 - 14	Enrichment and Fortification	Enrichment of rice - Methods of enrichment; Rice fortification	10
15 - 17	Wheat Milling	Break system, Purification system and Reduction system; Extraction rate and its effect on flour composition; Quality characteristics of flour and their suitability for baking	10
18 - 20	Corn Milling	Dry and wet milling of corn; Starch and Gluten separation; Milling fractions and Modified starches	10
21 - 23	Minor Cereals and Millets Milling	Barley; Malting and milling; Oat/Rye: Processing, Milling; Sorghum: Milling, malting, pearling; Millets (Pearl millets, Finger millets)	10
24 - 26	Millet Processing	Processing of millets for food uses; Secondary and Tertiary products processing of cereals and millets	10
27 - 29	By-products and Infant Foods	By-products processing of cereals and millets; Processing of infant foods from cereals and millets.	10
30 - 32	Cereal Products	Breakfast cereal foods: Flaked, Puffed, Expanded, Extruded and Shredded.	10
Total =			100

TEACHING SCHEDULE**PRACTICAL [FT-352]**

Exercise No.	Exercise Title
1	Morphological characteristics of cereals
2	Physical properties of cereals
3	Chemical properties of cereals
4	Milling of rice
5	Parboiling of paddy
6	Cooking quality of rice
7	Milling of rice
8	Conditioning and milling of wheat
9	Production of sorghum flakes
10	Production of popcorns
11	Production of flaked rice, puffed rice
12	Preparation noodles
13	Preparation of sorghum malt
14	Determination of gelatinization temperature by amylograph
15	Processing of value-added products from millets
16	Visit to Cereal processing unit.

Suggested Readings [FT-352]:

1. Araullo, E.V., De Padua, D.B. and Graham, M. 1976. Rice Post Harvest Technology. IDRC, Canada.
2. Chakraverty, A. and Singh, R.P. 2014. Post Harvest Technology and Food Process Engineering. CRC Press, Boca Raton, FL, USA.
3. Chakraverty, A., Mujumdar, A.S., Vijaya Raghavan G.S. and Ramaswamy, H.S. 2003. Handbook of Post Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA.
4. Champagne, E.T. 2004. Rice: Chemistry and Technology, 3rd edn. AACC International, Inc., St. Paul, MN, USA.
5. David, A.V. Dendy and Dobraszczyk, B.J. 2001. Cereal and Cereal Products: Technology and Chemistry. Springer-Verlag, US.
6. Kent, N.L. and Evers, A.D. 1994. Kent's Technology of Cereals: An Introduction for Students of Food Science and Agriculture, 4th edn. Elsevier Science Ltd., Oxford, UK.
7. Khan, K. and Shewry, P.R. 2009. Wheat: Chemistry and Technology, 4th edn. AACC International, Inc., St. Paul, MN, USA.
8. Matz, S.A. 1991. The Chemistry and Technology of Cereals as Food and Feed, 2nd edn. Springer Science + Business Media, NY, USA.
9. Wrigley, C. 2004. Encyclopedia of Grain Science. Academic Press, London, UK.
10. White, P.J. and Johnson, L. Lawrence A. 2003. Corn: Chemistry and Technology, 2nd edn. AACC International, Inc., St. Paul, MN, USA.

Semester	: V	
Course No.	: FT-353	Credit Hrs. : 3(2+1)
Course Title	: Processing Technology of Fruits and Vegetables	

SYLLABUS

- Objectives :**
- (i) To understand methods of preservation of fruits and vegetables.
 - (ii) To get knowledge of FSSAI specifications of fruits and vegetables products.

THEORY

Production and Processing scenario of fruits and vegetables in India and World; Scope of fruit and vegetable processing industry in India; Overview of principles and preservation methods of fruits and vegetables; Supply chain of fresh fruits and vegetables; Primary processing and pack house handling of fruits and vegetables; Peeling, Slicing, Cubing, Cutting and Other size reduction operations for fruits and vegetables; Minimal processing of fruits and vegetables; Blanching-operations and equipment; Canning: - Definition, Processing steps, Equipment Cans and Containers, Quality assurance and Defects in canned products; FSSAI specifications and Preparation and Preservation of juices, Squashes, Syrups, Sherbets, Nectars, Cordials, etc.; Processing and Equipment for above products; FSSAI specifications of crystallized fruits and Preserves, Jam, Jelly and Marmalades, Candies; Preparation, Preservation and Machines for manufacture of above products; Preparation, Preservation and Machines for manufacture of Chutney, Pickles, Sauce, Puree, Paste, Ketchup; Toffee, Cheese, Leather, Dehydrated, Wafers and Papads, Soup powders; Production of pectin and vinegar; Commercial processing technology of selected fruits and vegetables for production of various value added processed products; By-products of fruit and vegetable processing industry.

PRACTICAL

Primary processing of selected fruits and vegetables; Canning of Mango/ Guava/ Papaya; Preparation of jam from selected fruits; Preparation of jelly from selected fruits; Preparation of Fruit marmalade; Preparation of RTS; Preparation of Squash; Preparation of syrup; Preparation of raisins, dried fig and dried banana; Preparation of Anardana; Preparation of papain; Preparation of pickles; Preparation of dried ginger; Preparation of dried onion and garlic; Preparation of banana and potato wafers; Preparation of dehydrated leafy vegetables; Visit to fruits and vegetables pack house, Canning plant, Vegetable dehydration plant.

TEACHING SCHEDULE**THEORY [FT-353]**

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 2	Introduction and Scope	Production and processing scenario of fruits and vegetables in India and world	5
3		Scope of fruit and vegetable processing industry in India	5
4 - 6		Overview of principles and preservation methods of fruits and vegetables; Supply chain of fresh fruits and vegetables;	10
7 - 10	Primary Processing	Primary processing and pack house handling of fruits and vegetables; Peeling, Slicing, Cubing, Cutting and Other size reduction operations for fruits and vegetables	10
11 - 13	Minimal Processing and Blanching	Minimal processing of fruits and vegetables; Blanching- operations and Equipment	10
14 - 17	Canning	Definition, Processing steps and equipment, Cans and containers, Quality assurance and Defects in canned products	10
18 - 20	FSSAI Specifications and Preparation and Preservation of Products	FSSAI specifications and preparation and preservation of juices, squashes, syrups, sherbats, nectars, cordials, etc. Processing and equipment for above products	10
21 - 23		FSSAI specifications of crystallized fruits and preserves, jam, jelly and marmalades, candies; Preparation, Preservation and Machines for manufacture of above products	10
24 - 26	Preparation, Preservation and Machines for Manufacture of Products	Chutney, Pickles, Sauce, Puree, Paste, Ketchup; Toffee, Cheese, Leather, Dehydrated, Wafers and Papads, Soup powders	10
27 - 28	Pectin and Vinegar	Production of pectin and vinegar	5
29 - 30	Commercial Processing Technology	Commercial processing technology of selected fruits and vegetables for production of various value-added processed products	10
31 - 32		By-products of fruit and vegetable processing industry	5
Total =			100

TEACHING SCHEDULE

PRACTICAL [FT-353]

Exercise No.	Exercise Title
1	Primary processing of selected fruits and vegetables
2	Canning of Mango/ Guava/ Papaya
3	Preparation of Jam from selected fruits
4	Preparation of jelly from selected fruits
5	Preparation of RTS
6	Preparation of Squash
7	Preparation of Syrup
8	Preparation of Raisins and Dried fig
9	Preparation of Dried banana
10	Preparation of Anardana
11	Preparation of Pickles
12	Preparation of Dried ginger
13	Preparation of Dried onion and garlic
14	Preparation of Banana and potato wafers
15	Preparation of Dehydrated leafy vegetables
16	Visit to Fruits and Vegetables processing plant

Suggested Readings [FT-353]:

1. **Chavan, U.D. and Patil, J.V. 2013.** Industrial Processing of Fruits and Vegetables. Astral International Pvt. Ltd., New Delhi.
2. **Chakravarty, A. Mujumdar, A.S. Vijaya Raghavan, G.S. and Ramaswamy, Hosahalli S. 2003.** Handbook of Post Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA.
3. **Cruess, W.V. 2004.** Commercial Fruit and Vegetable Products. Agrobios India, Jodhpur.
4. **Dauthy, M. E. 1995.** Fruit and Vegetable Processing. FAO Agricultural Services Bulletin No.119. FAO of UN, Rome.
5. **EIRI Board of Consultants and Engineers.** Manufacture of Snacks, Namkeen, Papads and Potato Products. EIRI, New Delhi.
6. **Hui, Y.H. 2006.** Handbook of Fruits and Fruit Processing. Blackwell Publishing Ltd., Oxford, UK.
7. **Hui, Y.H., Chazala, S., Graham, D.M., K.D. Murrell and Wai-Kit Nip. 2004.** Handbook of Vegetable Preservation and Processing. Marcel Dekker, Inc., NY, USA.
8. **Lal, G., Siddappa, G.S. and Tandon, G.L. 1959.** Preservation of Fruits and Vegetables. ICAR, New Delhi.

Semester	: V		
Course No.	: FT-354	Credit Hrs.	: 2(1+1)
Course Title	: Food Packaging Technology and Equipment		

SYLLABUS

- Objectives** :
- (i) To understand concept of packaging, its type and properties of packaging materials,
 - (ii) To gain knowledge about intelligent, smart and active packaging,
 - (iii) To learn labelling requirement and regulations.

THEORY

Packaging situations in World and India; Need of packaging; Package requirements, Package functions; Properties of different packaging materials; Package materials: Classification of packages, Paper as package material, Its manufacture, Types, Advantages of corrugated and paper board boxes, etc.; Glass as package material, Manufacture, Advantages, Disadvantages; Metal (Aluminium/Tin/SS) as package material-manufacture, Advantages, Disadvantages, Plastic as package material, Classification of polymers, Properties of each plastics, Uses of each plastics; Lamination: Moulding-Injection, blow, extrusion; Coating on paper and films; Aseptic packaging: Need, Advantages, Process, Comparison of conventional and Aseptic packaging, System of aseptic packaging and materials used in aseptic packaging; Permeability: Theoretical considerations, Permeability of gases and vapours; Permeability of multilayer materials; Permeability in relation to packaging requirement of foods; Intelligent/Smart/Active packaging systems and their food applications, CAP/MAP; Retort structure and packaging; Edible packaging-Types and Sources; Microwavable packaging-Types and Applications. Transport properties of barriers; Simulations of product: Package environment interaction; Packaging of specific foods, Mechanical and Functional tests on package. Packaging practices followed for fruits and vegetables and their products, Packaging machines, Filling machines, vacuum packaging machines. Bottle fillers, Fillers for dry mixers, Ice-cream fillers, Form fill and Seal (FFS) machines, Vacuum packaging machine, Shrink wrap packaging machine, Aseptic tetra pack system; Labelling requirements, Methods of coding, Regulation and Standards of labelling of food packages.

PRACTICAL

Classification of various packages based on material and rigidity; Measurement of thickness of paper, paper boards; Measurement of basic weight and grammage of paper and paperboards; Measurement of water absorption of paper, Paper boards; Measurement of bursting strength of paper, Paper boards; Measurement of tear resistance of papers; Measurement of puncture resistance of paper and paperboard; Measurement of tensile strength of paper, Paper boards; Measurement of grease resistance of papers; Determination of gas and water transmission rate of package films; Determination of Lacquer integrity test; Drop test, Box compression test; Identification of plastic films; Determination of seal integrity, Ink adhesion; Packaging practices followed for packing fruits and vegetables; Shelf life calculations for food products; Head space analysis of packaged food; Study of vacuum packaging machines, Bottle filling machines and form-fill-seal machines, shrink wrap packaging machine, Aseptic tetra pack system.

TEACHING SCHEDULE**THEORY [FT-354]**

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1	Introduction	Packaging situations in World and India; Need of packaging; Package requirements, Package functions	5
2	Properties and Classification	Properties of different packaging materials; Package materials: Classification of packages	5
3	Paper	Paper as package material, Its manufacture, Types, Advantages of Corrugated and Paper board boxes	5
4	Glass	Glass as package material, Manufacture, Advantages, Disadvantages;	5
5	Metal and Plastic	Metal (Aluminium/ tin/ SS) as package material- Manufacture, Advantages, Disadvantages, Plastic as package material, Classification of polymers, Properties of each plastics, Uses of each plastics	10
6	Lamination	Moulding- Injection, Blow, Extrusion; Coating on Paper and Films	5
7	Aseptic Packaging	Need, Advantages, Process, Comparison of Conventional and Aseptic packaging, System of aseptic packaging and materials used in aseptic packaging;	10
8 - 9	Permeability	Theoretical considerations, Permeability of gases and vapours; Permeability of multilayer materials; Permeability in relation to packaging requirement of foods;	9
10	Intelligent/Smart/ Active packaging, CAP/MAP	Intelligent/Smart/Active packaging systems and their food applications, CAP/MAP; Retort structure and packaging;	9
11	Edible and Microwavable Packaging	Edible packaging- Types and Sources; Microwavable packaging – Types and Applications.	9
12	Transport properties and Simulation of product	Transport properties of barriers; Simulations of product: Package environment interaction;	5
13 - 14	Packaging of specific food, Packaging tests and Machines	Packaging of specific foods, Mechanical and Functional tests on package. Packaging practices followed for fruits and vegetables and their products, Packaging machines, Filling machines, Vacuum packaging machines.	9

Continued...

15	Filling machines and different packaging machines	Bottle fillers, Fillers for dry mixers, Ice-cream fillers, Form Fill and Seal (FFS) machines, Vacuum packaging machine, Shrink wrap packaging machine, Aseptic tetra pack system;	9
16	Labelling: Regulations and Standards	Labelling requirements, Methods of coding and Regulation and Standards of labelling of food packages.	5
Total =			100

TEACHING SCHEDULE**PRACTICAL [FT-354]**

Exercise No.	Exercise Title
1	Classification of various packages based on material and rigidity;
2	Measurement of thickness of paper and paper boards
3	Measurement of basic weight and grammage of paper and paperboards
4	Measurement of water absorption of paper and paper boards
5	Measurement of bursting strength of paper and paper boards
6	Measurement of tear resistance of papers
7	Measurement of puncture resistance of paper and paperboard
8	Measurement of grease resistance of papers
9	Determination of gas and water transmission rate of package films
10	Determination of lacquer integrity test
11	Drop test, Box compression test
12	Identification of plastic films
13	Determination of seal integrity, ink adhesion
14	Packaging practices followed for packing fruits and vegetables
15	Shelf-life calculations for food products
16	Head space analysis of packaged food; Study of vacuum packaging machines, Bottle filling machines and form-fill-seal machines, shrink wrap packaging machine, Aseptic tetra pack system.

Suggested Readings [FT-354]:

1. Ahvenainen, R. 2003. Novel Food Packaging Techniques. CRC-Woodhead Publishing Ltd., Cambridge, England.
2. Coles, R., McDowell, B. and Kirwan, M.J. 2003. Food Packaging Technology. Blackwell Publishing Ltd., Oxford, UK
3. Han, J.H. 2007. Packaging for Nonthermal Processing of Food. Blackwell Publishing Ltd., Oxford, UK.
4. Han, J.H. 2005. Innovations in Food Packaging. Elsevier Sci. & Technology Books, UK.
5. Lee, D.S. 2008. Food Packaging Science and Technology. CRC Press, Boca Raton FL, USA.
6. Robertson, G.L. 2014. Food Packaging: Principles and Practice, 3rd edn. CRC Press, Boca Raton, FL, USA.
7. Robertson, G.L. 2010. Food Packaging and Shelf Life – A Practical Guide. CRC Press, Boca Raton, FL, USA.

Semester	:	V
Course No.	:	FT-355
	Credit Hrs.	: 3(2+1)
Course Title	:	Processing of Spices and Plantation Crops

SYLLABUS

- Objectives** :
- (i) To learn processing technology of different spices,
 - (ii) To understand post-harvest technology of tea, coffee, cocoa etc.

THEORY

Production and Processing scenario of Spice, Flavour and Plantation crops and its scope; Major spices: Post Harvest Technology, Composition; Processed products of Spices: Ginger, Chilli, Turmeric, Onion and Garlic, Pepper, Cardamom. Equipment for cryogenic grinding; Minor spices: Herbs, Leaves and Spartan seasonings and their processing and utilization; All spice, Annie seed, Sweet basil; Caraway seed, Cassia, Cinnamon clove, Coriander, Cumin, Dill seed; Fennel seed, Nutmeg, Mace, Mint marjoram; Rosemary, Saffron, Sage; Savory, Thyme, Ajowan; Asafoetida, Curry leaves; Postharvest technology for Tea, Coffee, Cocoa, Vanilla and Annatto processing; Post-Harvest Technology and Processing of Areca nut, Cashew nut, Oil palm, Coconut. Flavours of minor spices; Flavour of major spices. Spice oil and Oleoresins: Extraction techniques; Super critical fluid extraction of spices. Standard specification of spices; Standards like ESA, ASTA, FSSAI and maintenance of quality by fumigation, CAS and ETO sterilization. Functional packaging of spices and spice products; By-products of plantation crops and spices.

PRACTICAL

Identification and characterization of flavouring compounds of spices; Valuable oil determination; Extraction of oil from clove, pepper, cardamom, chilli; Extraction of oleoresins: Turmeric, Ginger, Pepper, Clove; Piperine estimation in pepper oleoresin; Steam distillation of spices; Determination of curcumin content in turmeric; Chemical analysis of spices: Moisture, Valuable oil specific gravity, Refractive index, Acid value; Study of standard specification of spices; Packaging study of spices; Preparation of curry powder; Visit to Spice Industry.

TEACHING SCHEDULE**THEORY [FT-355]**

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 2	Present Status and Prospects	Production and processing scenario of spice, flavour and plantation crops and its scope	5
3 - 5	Major Spices	Post Harvest Technology; Composition	10
6 - 8	Processed Products of Spices	Ginger, Chilli, Turmeric, Onion and Garlic, Pepper, Cardamom; Equipment for Cryogenic grinding.	10
9 - 11	Minor Spices	Herbs, leaves and spartan seasonings and their processing and utilization	10
12 - 14	Spices Production	All spice, Annie seed, Sweet basil; Caraway seed, Cassia, Cinnamon Clove, Coriander, Cumin, Dill seed, Fennel seed, Nutmeg, Mace.	10
15 - 16	Spices Processing	Mint marjoram; Rosemary, Saffron, Sage, Savory, Thyme, Ajowan; Asafoetida, Curry leaves.	10
17 - 18	Post Harvest Technology	Postharvest technology for Tea, Coffee, Cocoa, Vanilla and Annatto processing.	5
19 - 20	Post Harvest Technology and Processing	Post-harvest technology and Processing of Areca nut, Cashew nut, Oil palm, Coconut.	5
21 - 22	Flavors of Spices	Flavours of Minor spices; Flavour of Major spices.	5
23 - 25	Spice Oil and Oleoresins	Spice oil and oleoresins: Extraction techniques; Super critical fluid extraction of spices.	10
26 - 28	Standards and Specification	Standard specification of spices; Standards like- ESA, ASTA, FSSAI and Maintenance of quality by fumigation, CAS and ETO sterilization.	10
29 - 30	Functional Packaging	Functional packaging of spices and spice products.	5
31 - 32	Byproducts	Byproducts of plantation crops and spices.	5
Total =			100

TEACHING SCHEDULE

PRACTICAL [FT-355]

Exercise No.	Exercise Title
1 - 2	Identification and Characterization of flavouring compounds of spices
3	Valuable Oil determination
4 - 5	Extraction of Oil from clove, pepper, cardamom, chilli
6 - 7	Extraction of Oleoresins: Turmeric, ginger, pepper and clove
8	Piperine estimation in pepper oleoresin
9	Steam distillation of spices
10	Determination of curcumin content in turmeric
11 - 12	Chemical analysis of spices: Moisture, Valuable oil, Specific gravity, Refractive index and Acid value
13	Study of standard specification of spices
14	Packaging study of spices
15	Preparation of curry powder
16	Visit to Spice Industry.

Suggested Readings [FT-355]:

1. **Gupta, S.** Handbook of Spices and Packaging with Formulae. Engineers India Research Institute, New Delhi.
2. **Hirasa, K. and Takemasa, M. 1998.** Spice Science and Technology. Marcel Dekker, NY, USA.
3. **Panda, H.** Handbook on Spices and Condiments (Cultivation, Processing and Extraction). Asia Pacific Business Press Inc., New Delhi.
4. **Pruthi, J.S. 2001.** Spices and Condiments – Major Spices of India. National Book Trust, New Delhi.
5. **Pruthi, J.S. 2001.** Spices and Condiments – Minor Spices of India. National Book Trust, New Delhi.
6. **Purseglove, J.W., Brown, E.G., Green, C.L. and Robins.** Spices, Vol. I and II. SRJ Academic Press, New Delhi.
7. **Shanmugavelu, K.G.** Spices and Plantation Crops. Oxford and IBH Publishing Co., New Delhi.

Semester :	V	
Course No. :	FE-3510	Credit Hrs. : 3(2+1)
Course Title :	Food Storage Engineering	

SYLLABUS

- Objectives** :
- (i) To understand storage structure for grains and other perishables.
 - (ii) To learn the design of storage structure.

THEORY

Introduction: Importance of scientific storage systems, Post-harvest Physiology of semi-perishables and perishables, Climacteric and Non-climacteric fruits, Respiration, Ripening, changes during ripening, Ethylene bio-synthesis.

Damages: Direct damages, Indirect damages, Causes of spoilage in storage (Moisture, Temperature, Humidity, Respiration loss, Heat of respiration, Sprouting), Destructive agents (Rodents, Birds, Insects, etc.), Sources of infestation and control.

Storage structures: Traditional storage structures, Improved storage structures, Modern storage structures, Godown layout, Staking pattern and rodent proof godown design; Farm silos: Horizontal silos, Tower silos, Pit silos, Trench silos, Size and Capacity of silos. Storage of grains: Respiration of grains, Moisture and Temperature changes in stored grains; Conditioning of environment inside storage through ventilation. Aeration and Stored grain management: Purposes of aeration, Aeration theory, Aeration system design, Aeration system operation.

Storage pests and control: Damage due to storage insects and pests, its control, Seed coating, Fumigations, etc.; Damage caused by rodents and its control. Storage of perishables: Cold storage, Controlled and Modified atmospheric storage, Hypobaric storage, Evaporative cooling storage, Conditions for storage of perishable products, Control of temperature and Relative humidity inside storage. Design of storage structures: Functional and Structural design of grain storage structures, Pressure theories, Pressure distribution in the bin, Grain storage loads, Pressure and Capacities, Warehouse and Silos, BIS specifications, Functional, Structural and Thermal design of cold stores.

PRACTICAL

Visits to traditional storage structures; Layout design, Sizing, Capacity and Drawing of traditional storage structures; Measurement of respiration of fruits/grains in the laboratory; Study on fumigation; Visits to FCI godowns; Design of grain godowns for particular capacity and commodity; Drawing and layout of grain godown for particular commodity and capacity; Visits to cold storage. Design of cold storage for particular capacity and commodity; Drawing and layout of cold storage for particular commodity and capacity; Visits to CA storage; Design of CA storage for particular capacity and commodity; Drawing and Layout of CA storage for particular commodity and capacity; Visits to evaporative cooling system for storage; Storage study in the MAP.

TEACHING SCHEDULE**THEORY [FE-3510]**

Lecture No.	Topic	Sub-topics/Key Points	Weightage (%)
1 - 4	Introduction	Importance of scientific storage systems, Post-harvest Physiology of Semi-perishables and Perishables, Climacteric and Non-climacteric fruits, Respiration, Ripening, Changes during ripening, Ethylene biosynthesis.	15
5 - 8	Damages	Direct damages, Indirect damages, Causes of spoilage in storage (Moisture, Temperature, Humidity, Respiration loss, Heat of respiration, Sprouting), Destructive agents (Rodents, Birds, Insects, etc.), Sources of infestation and control.	15
9 - 12	Storage Structures	Traditional storage structures, Improved storage structures, Modern storage structures, Godown layout, Staking pattern and Rodent proof godown design; Farm Silos: Horizontal silos, Tower silos, Pit silos, Trench silos, Size and Capacity of silos.	15
13 - 16	Storage of Grains	Respiration of grains, Moisture and Temperature changes in stored grains; Conditioning of environment inside storage through ventilation.	10
17 - 19	Aeration and Stored Grain Management	Purposes of aeration, Aeration theory, Aeration system design, Aeration system operation.	5
20 - 23	Storage Pests and Control	Damage due to storage insects and pests, its control, Seed coating, Fumigations, etc.; Damage caused by rodents and its control.	10
24 - 28	Storage of Perishables	Cold storage, Controlled and Modified atmospheric storage, Hypobaric storage, Evaporative cooling storage, Conditions for storage of perishable products, Control of temperature and relative humidity inside storage.	15
29 - 32	Design of Storage Structures	Functional and Structural design of grain storage structures, Pressure theories, Pressure distribution in the bin, Grain storage loads, Pressure and Capacities, Warehouse and Silos, BIS specifications, Functional, Structural and Thermal design of cold stores.	15
Total =			100

TEACHING SCHEDULE**PRACTICAL [FE-3510]**

Exercise No.	Exercise Title
1 - 2	Visits to Traditional storage structures; Layout design, Sizing, Capacity and Drawing of Traditional storage structures.
3	Measurement of respiration of fruits in the Laboratory
4	Measurement of respiration of grains in the Laboratory
5	Study on fumigation
6	Visits to FCI godowns
7	Design of grain godowns for particular capacity and commodity
8	Drawing and layout of grain godown for particular commodity and capacity
9	Visits to Cold storage
10	Design of cold storage for particular capacity and commodity
11	Drawing and layout of cold storage for particular commodity and capacity
12	Visit to CA storage
13	Design of CA storage for particular capacity and commodity
14	Drawing and layout of CA storage for particular commodity and capacity
15	Visit to evaporative cooling systems for storage
16	Storage study in the MAP.

Suggested Readings [FE-3510]:

1. **Boumans, G. 1985.** Grain Handling and Storage. Elsevier Science Publishers, Amsterdam, The Netherlands.
2. **Brooker, D.B., Bakker-Arkema, F.W. and Hall, C.W. 1976.** Drying Cereal Grains. The AVI Publishing Company, Inc., Connecticut, MA, USA.
3. **Hall, C.W. 1980.** Drying and Storage of Agricultural Crops. The AVI Publishing Company, Inc., Westport, Connecticut, USA.
4. **Jayas, D.S., White N.D.G. and Muir, W.E. 1994.** Stored Grain Ecosystems. Marcel Dekker, New York.
5. **Kutz, M. 2007.** Handbook of Farm, Dairy, and Food Machinery. William Andrew, Inc., Norwich, NY, USA.
6. **Michael, A.M. and Ojha, T.P. 2004.** Principal of Food Technology, Vol. I. Jain Brothers, New Delhi.
7. **Newbaver, L.W. and Walker, H.B. 2003.** Farm Buildings Design. Prentice-Hall Inc., New Jersey, USA.
8. **Pandey, H., Sharma, H.K., Chauhan, R.C., Sarkar, B.C. and Bera, M.B. 2010.** Experiments in food process engineering. New Delhi: CBS Publisher and Distributors Pvt. Ltd.
9. **Pandey, P.H. 1997.** Post Harvest Technology of Fruits and Vegetables. Saroj Prakashan, Allahabad.

Semester	: V	
Course No.	: FBM-351	Credit Hrs. : 2(1+1)
Course Title	: Project Preparation and Management	

SYLLABUS

- Objectives :**
- (i) To understand concepts of project management,
 - (ii) To develop knowledge to develop a project plan and its analysis.

THEORY

Project and Project Management, Evolution of Project Management, Forms and Environment of Project Management; Project Life Cycle; Project Identification, Screening, Project Appraisal, Project Selection, Project Proposal and Project Scope; Project Planning; Work break down structure and Network Scheduling; Critical Path Method; Program Evaluation and Review Technique; Time-Cost relationship in project; Resource Considerations in Projects, Resource Profiles and levelling, Limited Resource Allocation; Project Implementation, Monitoring and Control: Project Management Process and Role of project manager, Team building, Leadership in Projects, Organizational and Behavioural issues in Project Management; Project Monitoring and Control; Project Completion and Review; Project Management - Recent trends and Future directions. Computers in Project Management.

PRACTICAL

Brainstorming exercise to identify a set of projects and their evaluation; Work break down structure for different projects; Network Scheduling and Drawing network charts for different projects; Formulation of CPM scheduling for a specific project; Formulation of PERT scheduling for a specific project; Reduction of Project duration: Time/Cost trade off; Resource Profiles and Levelling; PERT/Cost Method, Earned value analysis.

TEACHING SCHEDULE

THEORY [FBM-351]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 3	Introduction	Project and Project Management, Evolution of Project Management, Forms and Environment of Project Management	15
4 - 5		Project Life Cycle; Project Identification, Screening, Project Appraisal, Project Selection, Project Proposal and Project Scope	15
6	Project Planning	Project Planning; Work breakdown structure and Network Scheduling	10
7	Critical Path Method	Critical Path Method; Program Evaluation and Review Technique	10
8	Time - Cost Relationship	Time - Cost relationship in project	8
9 - 10	Resources	Resource Considerations in Projects, Resource Profiles and Levelling, Limited resource allocation	10
11 - 13	Project Implementation	Project Management Process and Role of Project Manager; Team building, Leadership in Projects, Organizational and Behavioural issues in Project Management	15
14 - 15	Project Monitoring and Control	Project Monitoring and Control; Project Completion and Review	10
16	Recent Trends	Recent trends and Future directions; Computers in Project Management.	7
Total =			100

TEACHING SCHEDULE

PRACTICAL [FBM-351]

Exercise No.	Exercise Title
1 - 2	Brainstorming exercise to identify a set of projects and their evaluation
3 - 4	Work break down structure for different projects
5 - 6	Network Scheduling and Drawing network charts for different projects
7 - 8	Formulation of CPM scheduling for a specific project
9 - 10	Formulation of PERT scheduling for a specific project
11	Reduction of Project duration
12 - 13	Time / Cost trade off
14	Resource Profiles and Levelling
15 - 16	PERT / Cost Method, Earned value analysis

Suggested Readings [FBM-351]:

1. **Chandra, P. 1980.** Projects - Preparation, Appraisal, Budgeting and Implementation. Tata McGraw-Hill Publication Ltd., New Delhi, India.
2. **Chandra, P. 2014.** Projects - Planning, Analysis, Selection, Financing, Implementation and Review. McGraw-Hill Education Pvt. Ltd., New Delhi, India.
3. **Gopalakrishnan, P. and Rama Moorthy, V.E. 2014.** Textbook of Project Management. Laxmi Publications Pvt. Limited.
4. **Kerzner, H. 2006.** Project Management – A System Approach to Planning, Scheduling and Controlling. CBS Publishers and Distributors.
5. **Nicholas, J.M. 2005.** Project Management for Business and Technology – Principles and Practices. Pearson Prentice Hall.
6. **Panneerselvam, R. 2004.** Operations Research, 2nd edn. International Book House, Mumbai.

Semester : V	
Course No. : EDT-351	Credit Hrs. : 2(0+2) NG
Course Title : Study Tour	

The study / educational tour shall be of 10 to 14 days' duration during the V Semester, and this course shall ordinarily be assigned to the Department of Food Plant Operations.

The students shall visit Industries/ Institutions, preferably outside the State, so that, in addition to visiting the Organizations/ Industries (related to the profession).

They will also be exposed to the geographical, social, socio-economic and cultural diversity of different places/ states.

After the visit, the students shall submit a 'Report'/ make a 'Presentation'.
