

Department of Chemical Engineering  
BIT Mesra, Ranchi

New Programmes From 2014 July Session

Integrated M.Sc. Food Technology (10 Semesters)

With Exit Option of B.Sc. Food Technology after 6 Semesters

Eligibility Criteria:

Pass in Class 12 / equivalent examination with English, Physics, Chemistry, Mathematics  
Marks: 60 % for General, 55% for SC/ST candidates

Total No. of Seats: 30

## Integrated M.Sc. Food Technology, BIT Mesra, Ranchi.

<b>SEMESTER – I</b>					
Course Code	Course Title	L	T	P	C
IMP 1001	Physics I	3	1	0	4
IMC 1001	Chemistry I	3	0	0	3
IMM 1001	Mathematics I	3	1	0	4
CS1302	Fundamentals of Unix & C Programming	1	0	3	3
HU 1103	English	2	1	0	3
IMP 1002	Physics lab I	0	0	3	2
IMC 1002	Chemistry Lab I	0	0	3	2
GA 1006	PT & GAMES/NSS/CA	0	0	3	1
GA 1002	NCC				
GA 1008	CA				
	<b>Total Credits</b>				<b>22</b>

<b>SEMESTER – II</b>					
Course Code	Course Title	L	T	P	C
IMP 2001	Physics II	3	0	0	3
IMC 2001	Chemistry –II	3	1	0	4
IMM 2001	Mathematics –II	3	0	0	3
CS 2301	Fundamental of Data Structure	3	0	0	3
CH 2203	Environmental Science	3	0	0	3
IMP 2002	Physics lab II	0	0	3	2
IMC 2002	Chemistry Lab II	0	0	3	2
CS2302	Data structure lab	0	0	3	2
GA 1006	PT & GAMES/NSS/CA	0	0	3	1
GA 1002	NCC				
GA 1008	CA				
	<b>Total</b>				<b>23</b>

<b>SEMESTER – III</b>					
Course Code	Course Title	L	T	P	C
IMF 3001	Food Composition & Chemistry	3	0	0	3
IMF3003	Food Bio Chemistry & Human Nutrition	3	0	0	3
IMF 3005	Basic Electrical and Electronics Engineering	3	0	0	3
IMF 3007	Food Microbiology and Safety	3	0	0	3
PS 3001	Biological Science	3	0	0	3
IMF 3002	Engineering Drawing	0	0	3	2
IMF 3004	Food Chemistry Laboratory	0	0	3	2
	Basic Electrical and Electronics Engg Lab	0	0	3	2
IMF 3006	Food Microbiology Lab	0	0	3	2
	<b>Total</b>				<b>23</b>

<b>SEMESTER IV</b>					
Course Code	Course Title	L	T	P	C
IMF 4001	Food Engineering-I – Fluid flow and Mechanical Operations	3	0	0	3
IMF 4003	Principles of Food Processing & Preservation	3	0	0	3
IMF 4005	Food Analysis	3	0	0	3
IMF 4007	Fruits & Vegetables Processing	3	0	0	3
	Breadth paper – foreign language	3	0	0	3
IMF 4004	Fruits & Vegetable Processing Lab	0	0	3	2
IMF 4002	Food Analysis Lab – I	0	0	3	2
	Workshop Practice	0	0	3	2
	<b>Total</b>				<b>21</b>

<b>SEMESTER- V</b>					
Course Code	Course Title	L	T	P	C
IMF 5001	Food Packaging Technology	3	0	0	3
IMF 5003	Agricultural Practices	3	0	0	3
IMF 5005	Cereal Technology	3	0	0	3
IMF 5007	Fermented food Products	3	0	0	3
IMF 5009	Food Engineering II – Heat and Mass Transfer	3		0	3
IMF 5002	Food Preservation Lab			3	2
IMF 5004	Food Engineering Lab			3	2
IMF 5006	Cereal Technology Lab			3	2
	<b>Total</b>				<b>21</b>

<b>SEMESTER - VI</b>					
Course Code	Course Title	L	T	P	C
IMF 6001	Dairy Technology	3	0	0	3
IMF 6003	Food Engineering III – Thermodynamics & Refrigeration	3	0	0	3
IMF 6005	Agricultural and rural Economics	3	0	0	3
IMF 6007	Food Additives and Ingredients	3	0	0	3
IMF 6009	Food Industry Waste management	3	0	0	3
IMF 6002	Dairy Technology Lab	0	0	3	2
IMF 6004	Fermented Food Product Lab	0	0	3	2
IMF 6006	Food Analysis Lab – II	0	0	3	2
	<b>Total</b>				<b>21</b>

**Total Credits for B.Sc**

**131**

<b>SEMESTER - VII</b>					
Course Code	Course Title	L	T	P	C
SAF 1001	Advanced Food Microbiology	3	0	0	3
SAF 1003	Advanced Food Chemistry and Nutrition	3	0	0	3
SAF 1005	Advanced Food Engineering	3	0	0	3
SAF 1007	Advanced Food Processing	3	0	0	3
SAF 1002	Food Chemistry & Quality Control Lab I	0	0	6	4
SAF 1004	Advanced Food Engineering Laboratory	0	0	3	2
SAF 1006	Advanced Food Microbiology Lab	0	0	3	2
	<b>Total</b>				<b>20</b>

<b>SEMESTER - VIII</b>					
Course Code	Course Title	L	T	P	C
SAF 2001	Cereal Pulses and Oilseeds Technology	3	0	0	3
SAF 2003	Novel Food Processing and Packaging	3	1	0	4
SAF 2005	Food Laws Standard and Regulation	3	0	0	3
SAF 2007	Food Storage and Transportation	3	0	0	3
	Elective I	3	0	0	3
SAF 2002	Food Chemistry & Quality Control Lab II	0	0	3	2
SAF 2004	Advanced food Processing Lab I	0	0	3	2
	<b>Total</b>				<b>20</b>

<b>ELECTIVE I [3-0-0, Credit 3]</b>			
SAF 2009	Post Harvest technology and Cold Chain Management	SAF 2019	Oils and Fats Technology
SAF 2011	Beverage and snack food technology	SAF 2021	Food Biotechnology
SAF 2013	Renewable Energy for Food Processing	SAF 2023	Agrochemicals and residues in food
SAF 2015	Food Science and technology, [Compulsory for Non food background lateral entry students]	SAF 2025	Food Toxicology
SAF 2017	Nutraceuticals & Health Foods	SAF 2027	Food Microstructure and Texture

<b>SEMESTER –IX</b>					
Course Code	Course Title	L	T	P	C
SAF 3001	Food Business Management	3	0	0	3
SAF 3003	Automation in Food Processing Industry	3	1	0	4
SAF 3005	Food Product Development and sensory evaluation	3	0	0	3
SAF 3007	Animal Product Technology	3	0	0	3
	Elective II	3	0	0	3
SAF 3004	Advanced food Processing Laboratory II	0	0	6	4
	<b>Total</b>				<b>20</b>

<b>ELECTIVE-II [3-0-0, Credit 3]</b>			
SAF 3009	Phytochemicals and Herbal Medicines	SAF 3019	Computer Applications in Food Industry
SAF 3011	Flavour Chemistry and Technology	SAF 3021	Food Supply Chain Management
SAF 3013	Grain Storage Technology	SAF 3023	Food Plant and Equipment Design
SAF 3015	Enzymes in Food Processing	SAF 3025	Plantation Crops, Spices, & condiment Technology
SAF 3017	Statistical Quality Control	SAF 3027	Bakery and Confectionary

<b>SEMESTER – X</b>					
Course Code	Course Title	L	T	P	C
SAF 4002	Entrepreneurship Business Plan	0	0	3	2
SAF 4004	Project				18
	<b>Total</b>				<b>20</b>

**TOTAL Credits - 211**

## **IMP 1001 Physics I - General Properties of Matter and Waves & Oscillations (3-1-0-4)**

### **Module 1**

[6]

Systems of particles: Centre of mass, Linear momentum, Conservation of linear momentum, System with varying mass: A Rocket; Potential energy and conservation of energy, Conservative and non-conservative forces, Force as gradient of potential energy; Particle collisions: Elastic and inelastic collision.

### **Module II**

[6]

Angular momentum of a particle and system of particles, Angular momentum of rigid body rotating about a fixed axis, Conservation of angular momentum, Torque, Rotation about a fixed axis. Moment of inertia and its calculation

### **Module III**

[5]

The world and gravitational force, Newton's law of gravitation, Gravitation near earth's surface, Gravitation inside earth, Gravitational potential energy, Planets and satellites: Kepler's Laws.

### **Module IV**

[5]

Torsion of a cylinder, Bending moment, Cantilever, Beam supported at both ends, Beams clamped at both ends, Reciprocity theorem; Elastic energy in different types of deformation.

### **Module V**

[6]

Molecular forces, Surface tension and surface energy, Angle of contact, Excess pressure over a curved liquid surface, Capillarity, Shape of liquid drops. Ripples, Streamline and turbulent motion, Reynolds's number; Poiseuille's equation. Stokes's law, Rotating cylinder and rotating disc methods for determining the coefficient of viscosity, Euler's equation for liquid flow; Bernoulli's theorem and its applications.

### **Module VI & VII**

[8]

Simple harmonic motion, Motion of simple and compound pendulum, Damping, Forced vibration and resonance, Wave equation in one dimension, Phase velocity, Group velocity, Dispersion. Types of wave, Transverse and longitudinal waves. Speed of a travelling waves, Wave speed on a stretched string, Energy and power of a travelling string wave, The principle of superposition for waves, Interference of waves, Stationary waves, Sound waves, speed of sound Intensity of sound. Measurement of intensity; The Doppler effect, Shock waves

### **Text Books:**

1. Halliday D., Resnick R. and Walker J. Fundamental of Physics, Wiley India
2. Young H.D., Freedman R.A., Ford A.L. Sears and Zemansky's University Physics, Pearson
3. Newman and Searle .General properties of Matter,
4. C. J. Smith .Properties of Matter

### **Reference Books:**

1. D.S.Mathur.Mechanics,
2. Shukla R.K. and Srivastava A.Mechanics,
3. Berkley .Physics Course vol. I,
4. Wood A. B.Textbook of sound
5. French .Waves and Oscillations

## IMC 1001 Chemistry-I Credit: 3 (3-0-0)

### **Module I: Atomic Structure & Periodic Properties [5]**

Atomic Structure, Electronic Configuration, Atomic and ionic radii, ionization energy, electron affinity and electronegativity, trends in periodic table and applications in predicting and explaining the chemical behaviour.

### **Module II: Chemical Bonding [7]**

Covalent Bond – Valence bond theory and its limitations, various types of hybridization and shapes of simple inorganic molecules and ions. Valence shell electron pair repulsion (VSEPR) theory to  $\text{NH}_3$ ,  $\text{H}_3\text{O}^+$ ,  $\text{SF}_4$ ,  $\text{ClF}_3$ ,  $\text{ICl}_2$  and  $\text{H}_2\text{O}$ . MO theory, homonuclear diatomic molecules, multicenter bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference. Weak Interactions – Hydrogen bonding, Van der Waals forces.

### **Module III & IV Gaseous & Liquid States of Matter [8]**

Postulates of kinetic theory of gases, deviation from ideal behavior, van der waals equation of state. Law of corresponding states. Molecular velocities: Root mean square, average and most probable velocities. Qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter. Liquification of gases (based on Joule Thomson- effect) Intermolecular forces, structure of liquid. Structural differences between solids, liquids and gases. Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic and cholestric phases. Thermography and seven segment cell.

### **Module V Introductory Organic Chemistry [7]**

IUPAC nomenclature: Alkanes, cyclo-alkanes, alkenes, alkynes, halogen compounds, alcohols, ethers, aldehydes, ketones, carboxylic acids, nitro compounds. Hybridization and Geometry of Molecules: methane, ethane, ethylene, acetylene. Electronic Effects: Inductive, resonance, hyper conjugation and steric effect. Cleavage of bonds: homolytic and heterolytic C-C bond fission. Reaction Intermediates and their stability: carbonations, carbon ions and free radicals.

### **Module VI & VII: Basic Organic Synthesis and Principles [9]**

Alkanes: preparation by reduction of alkyl halides, Wurtz reaction and Kolbe's electrolytic methods with mechanism; Alkenes: preparation by dehydration of alcohols, dehydrohalogenation of alkylhalides, dehalogenation of vicdihalides and by Kolbe's electrolytic method. Alkynes: Preparation by dehydrohalogenation of vic-dihalides and gem-dihalides, dehalogenation of tetrahalides and Kolbe's electrolytic method. Reactions: addition reactions with hydrogen, halogens, hydrogen halide (markownikoffs rule, peroxide effect), hydroboration, ozonolysis, hydroxylation with  $\text{KMnO}_4$ , allylic substitution by NBS. Conjugated Dienes; Electrophilic addition of dienes: 1,2, & 1,4 addition, Diels . Alder reaction

### **Books Recommended:**

1. Organic Chemistry, Morrison and Boyd, Prentice Hall.
2. Advanced Organic Chemistry, Bahl, B S, Bahl A.
3. Physical Chemistry by P. W. Atkins, Elbs
4. Basic Inorganic Chemistry by F. A. Cotton & Wilkinson, John Wiley
5. Inorganic Chemistry by J. E. Huhey, Harpes & Row

## **IMM 1001 Mathematics I Analytical Geometry and Calculus (3-1-0- 4)**

### **Module I**

**Analytical Geometry (2D & 3D):** Polar equation of conics. Cones, cylinders and conicoids, Central conicoids, normals and conjugate diameters. [5L]

### **Differential Calculus:**

#### **Module II**

Successive differentiation of one variable and Leibnitz theorem. Curvature and asymptotes, concavity, convexity and point of inflection, Curve tracing. Taylor's and Maclaurin's expansion of functions of single variable. [5L]

#### **Module III**

Functions of several variables, partial derivatives, Euler's theorem, derivatives of composite and implicit functions, total derivatives, Jacobian's. Taylor's and Maclaurin's expansion of functions of several variables, Maxima and minima of functions of several variables, Lagrange's method of undetermined multipliers. [5L]

#### **Module IV**

**Integral Calculus:** Improper integrals, convergence of improper integrals, test of convergence, Beta and Gamma functions and its properties, Differentiation under integral sign, differentiation of integrals with constant and variable limits, Leibnitz rule. [5L]

#### **Module V**

Evaluation of double integrals, Change of order of integrations, change of coordinates, evaluation of area using double integrals, Evaluation of triple integrals, change of coordinates, evaluation of volumes of solids and curved surfaces using double and triple integrals. Mass, center of gravity, moment of inertia and product of inertia of two and three-dimensional bodies and principal axes. [5L]

#### **Module VI**

**Vector Calculus:** Scalar and vector fields, Level surfaces, differentiation of vectors, Directional derivatives, gradient, divergence and curl and their physical meaning, vector operators and expansion formulae. [5L]

#### **Module VII**

Line, surface and volume integrations, Theorems of Green, Stokes and Gauss, Application of vector calculus in engineering problems, orthogonal curvilinear coordinates, expressions of gradient, divergence and curl in curvilinear coordinates. [5L]

### **Books:**

1. T. M. Apostol : Calculus Vols I and II, 2<sup>nd</sup> Edition, John Wiley and sons, 1967 and 1969.
2. M. D. Weir, J. Hass and F. R. Giordano: Thomas' Calculus, 11<sup>th</sup> edition, Pearson Educations, 2008
3. Dennis G. Zill, Warren S. Wright: Advanced Engineering Mathematics, 4<sup>th</sup> edition, Jones and Bartlett Publishers, 2010
4. E. Kreyszig : Advanced Engineering Mathematics, 8<sup>th</sup> Edition John Wiley and sons 1999.
5. Murray R Spiegel, Theory and problems of Vector Analysis and an Introduction to Tensor Analysis, McGraw Hill, Schaum's Outline Series



## **CS 1302 Fundamentals of UNIX and C Programming (2-0-3-4)**

### **Module – I**

The Free Software Movement, Open source definition, Open source business strategy, Problem Solving and its tools, Flow chart, Pseudo code, Modular programming. Fundamentals of Unix Operating System, Login & Password, Different Commands, Unix directory, Structure and working with directories, Vi-editor, Basic Structure and execution of C programmes, Constants, Variables, and Data Types and various type of declarations, Different type operators and Expressions, Evaluation of Expressions, Operator Precedence and Associability, Mathematical Functions. [6]

### **Module –II**

Managing Input and Output operations, Decision Making and Branching Decision Making and Looping. [4]

### **Module – III**

One – dimensional Arrays and their declaration and Initialisations, Two-dimensional Arrays and their initialisations, Multidimensional Arrays, Dynamic Arrays, String Variables, Reading and Writing Strings, Arithmetic Operations on characters, Putting Strings together, Comparison of Two Strings, String – handling functions. [6]

### **Module –IV**

Need and Elements for user –defined Functions, Definition of Functions, Return values and their types, Function calls and Declaration, Arguments and corresponding return values, Functions that return multiple values, Nesting of functions, Recursion, Passing arrays and strings to functions, The Scope, Visibility and Life time of variables. [5]

### **Module –V**

Defining Structure, Declaring Structure Variable and Accessing Structure Members, Initialisation of Structure, Comparing Structure Variables, Operation on Individual Members, Arrays of Structures, Structures within structures, Structures and Functions, Unions, Size of Structures, Bit Fields. [5]

### **Module- VI**

Understanding Pointers, Accessing the Address of a Variable, Declaration and Initialisation of Pointer Variables, Accessing a Variable through its Pointer, Chain of Pointers, Pointer Expressions, Pointer Increments and Scale Factor, Pointers and Arrays, Pointers and Character Strings, Arrays of Pointers, Pointers and Function Arguments, Functions Returning Pointers, Pointers to Functions, Pointers and Structures, [6]

### **Module – VII**

File Management in C. use of fopen(), fclose(), Formatted file I/O, Searching through files using fseek(), ftell(), rewind(). [4]

### **Text Book :**

- 1 Kernighan K. R., Ritchie D. M. - The C Programming Language, Ansi C Edition, Prentice Hall, India
- 2 E. Balagurusamy – Programming in ANSI C, 3<sup>rd</sup> Edn. , TMH, New Delhi ; 2004
- 3 A. N. Kanthane – Programming with ANSI and TURBO C, Pearson Education, New Delhi; 2004
- 4 Y. Kanetkar – Let us C, 4<sup>th</sup> Edition, BPB Publication , New Delhi; 2002
- 5 Chris DiBona, Sam Ockman , Open Sources : Voices from the Open Source Revolution (Web book), Oreilly Press, 2<sup>nd</sup> edition,1999

**HU 1103 ENGLISH (2-1-0-3)**

**Module 1:**

1. Short stories
    - A) The castaway – Rabindra nath Tagore
    - B) Mr. know all - somerset Maugham
- (4)

**Module-II**

2. Essays
    - a) Life’s Philosophy – Jawaharlal Nehru
    - b) Ideas that have helped mankind – Bertrand Russell
- (4)

**Module III & IV:**

3. Vocabulary
    - a) One word substitution
    - b) Idioms & Phrases
    - c) Pairs of word
    - d) Synonyms & Antonyms
  4. Comprehension
- (12)

**Module V:**

1. Communication
    - a) Definition & Meaning
    - b) Effective communication
    - c) Barriers to communication
    - d) Verbal & Non- Verbal communication
- (8)

**Module VI**

2. Official correspondence
    - a) Memorandum
    - b) Notice, Agenda, Minutes
    - c) Invitation letter for Seminar etc.
    - d) Refusal & Acceptance letter
- (8)

**Module VII:**

3. Drafting C.V. & writing Application
  4. Paragraph writing
- (4)

**Reference books:**

1. Selected short stories , Prof. Damodar Thakur(ed)- Mcmillan India Ltd.
2. Modern Masters – An Anthology of English prose; Bord of editors- Orient longman
3. Student’s Companion- W D Best - Rupa & Co.
4. Effective Business Communication- Asha Kaul- Prentice Hall of India
5. Business Communication- Satya Swaroop Debasish, Bhagban Das- Prentice hall of India

## **IMP 2001 Physics II - Basic Electromagnetic Theory (3-0-0-3)**

### **Module I**

#### **Fields: [6]**

Vector and scalar fields, physical and mathematical concepts of gradient, divergence and curl, Gauss's theorem and Stokes' theorem.

### **Module II & III**

#### **Electrostatics: [9]**

Coulomb's law, Gauss's law in integral and differential form, electric potential and relation with E, electrostatic energy density, dielectrics, Relation between E, D and P vectors, dielectric susceptibility, boundary conditions on E and D.

### **Module IV & V**

#### **Magnetism: [9]**

Motion of charged particles in electric and magnetic fields, Biot-Savart law, Ampere's law in integral and differential form, applications, Hall effect.

Types of magnetism – diamagnetism, **paramagnetism** and ferromagnetism, Weiss field, domains, magnetic permeability and susceptibility, Relation between B, H and M vectors, boundary conditions on B and H, hysteresis.

### **Module VI & VII**

#### **Electromagnetic theory: [12]**

Faraday's law of electromagnetic induction in integral and differential form, Inductance, magnetic energy density, continuity equation for charge, displacement current, Maxwell's equations in free space, electromagnetic wave equation for plane waves in dielectric medium and free space, relation between  $E$ ,  $B$ , and  $k$ , Poynting vector, radiation pressure.

#### **Text books:**

1. Fundamental of Physics: Halliday, Resnick & Walker (6<sup>th</sup> Edition)
2. Engineering Electromagnetics: [William Hayt](#), [John Buck](#), McGraw-Hill Companies (7<sup>th</sup> Edition)

#### **Reference books:**

1. Introduction to Electrodynamics: David J Griffiths, 3rd Ed.
2. Electricity and Magnetism: Jackson

## IMC2001 Chemistry II (3-1-0-4)

### **Module- I Colloidal State [5]**

Definition of colloid, classification of colloids. Solids in liquids (sols): properties – kinetic, optical and electrical: stability of colloids, protective action Hardy-Schulze law, gold number. Liquids in solids (gels): classification, preparation and properties, inhibition, general application of colloids.

### **Module-II Chemical kinetics and Catalysis [6]**

Introduction to chemical kinetics Theories of chemical kinetics: effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy, Simple collision theory based on hard sphere model transition state theory (equilibrium hypothesis) Expression for the rate constant based on equilibrium constant and thermodynamic aspects. Catalysis, characteristics of catalysed reactions, classification of catalysis, miscellaneous examples.

### **Module III: s- and p- Block Elements [5]**

Comparative study, diagonal relationships, salient features of hydrides, solvation and complexation tendencies, an introduction to alkyls and aryls.

Chemical properties of the noble gases, chemistry of xenon, structure and bonding xenon compounds Role of Mg, Na, K, Ca ions in biology.

### **Module IV: Acids and Bases [4]**

Arrhenius, Bronsted-Lowry, solvent system, Lewis and HSAB concept of acids and bases.

### **Module V: Aromatic Compounds & Aromaticity [5]**

Aromatic hydro carbons and aromaticity, resonance in benzene, Huckel's (4n+2) rule and its simple applications. Acidic character of phenols - explanation on the basis of resonance stabilization. Electrophilic substitution reactions in aromatic compounds. General mechanisms of nitration, halogenation, sulphonation, Friedel-Craft's acylation and alkylation, ortho/para/meta directive influence with examples.

### **Module VI: Elimination & Substitutions Reactions [5]**

SN1 and, SN2 reaction mechanism: effects of structure, substrate, solvent, nucleophile and leaving groups. Mechanisms of E1 and E2 reactions, Hoffmann and Sayetzeffs rules cis and trans eliminations, Elimination Vs substitution.

### **Module VII: Stereochemistry [6]**

Introduction, Concept of Isomerism, Classification of Stereoisomers, Optical isomerism, Chirality & Elements of symmetry, Wedge formula, Fischer projection, Newmann projection. Relative and absolute configurations, sequence rules, D & L, R & S systems of nomenclature. Understanding with examples for Enantiomers, mesoform, erythro/threo forms, diastereoisomers, inversion, retention, and racemization. Conformational understanding with an example of ethane, n-butane, Cyclohexane and Decalin.

### **Books Recommended:**

1. Fundamentals of Organic Chemistry Solomons, John Wiley
2. Introduction to Organic Chemistry, Streitwiesser, Hathcock and Kosover, Macmillan.
3. Physical Chemistry Vol. 1-5, by K.L Kapoor
4. Physical Chemistry: A Molecular Approach by McQuarrie & Simon Viva
5. Concise Inorganic Chemistry by **J D Lee**, Amazon
6. Comprehensive Co-ordination Chemistry by G. Wilkinson, R. D. Gillars & J. A. McCleverty, Pergamon
7. Chemistry of the Elements by N. N. Greenwood & Earnshaw, Pergamon

## **IMM 2001 Mathematics II - Matrix Algebra & Complex Variables (3-0-0-3)**

### **Module I**

**Inequalities-** A.M., G.M. Cauchy Schwartz inequality, Weierstrass inequality, Holder's inequality. Simple Continued Fractions [3]

### **Module II**

**Infinite series** -- Convergency and divergency of Infinite series. Comparison test, D' Alembert's Ratio test, Raabe's test, logarithmic test, Cauchy's root test, Higher Logarithmic ratio Test, Gauss's Test, Alternating series, Leibnitz test, absolute and conditional convergence, power series, uniform convergence. [6]

### **Module III**

**Matrix Algebra:** Orthogonal, Hermitian, skew- Hermitian and unitary matrices, Elementary row and column transformations, rank and consistency conditions and solution of simultaneous equations, linear dependence and consistency conditions and solution of simultaneous equations, linear dependence and independence of vectors, Linear and orthogonal transformations [6]

### **Module IV**

Eigen values and Eigen vectors, properties of Eigen values, Cayley-Hamilton theorem, reduction to normal forms, quadratic forms, reduction of quadratic forms to canonical forms, index, signature, Matrix calculus & its applications in solving differential equations. [4]

### **Module V**

**Theory of equations-** Descartes's rule of Signs. Relation between roots and coefficients of a polynomial equation, transformation of equation, reciprocal equation, symmetric function of roots, solution of cubic polynomial by Cardon's method, solution of bi-quadratic equations by Ferrari's and Descarte's method. [5]

### **Module VI**

**Complex variables:** Introduction to complex variables. Functions of a complex variable. Limit, continuity, differentiability and analyticity of complex functions. Cauchy-Remann equations.[6]

### **Module VII**

Complex Integration, Cauchy's theorem and Cauchy's Integral formula, Morera's Theorem, Power series, Taylor's, Laurent's Theorems, Cauchy's inequality, Liouville's theorem, fundamental theorem of algebra. Calculus of residues, Contour integrals, Conformal mappings, and Bilinear Transformations. [6]

### **Text Books:**

1. M. D. Weir, J. Hass and F. R. Giordano: Thomas' Calculus, 11<sup>th</sup> edition, Pearson Educations, 2008.
2. Complex Variables and applications- R.V. Churchill and J.W. Brown, 7th edition, 2004, McGraw-Hill.
3. A.D. Wunsch, Complex Variables with Applications, 3rd edition, Pearson Education, Inc.
4. M J Ablowitz and A S Fokas, Complex Variables Introduction and Applications Cambridge Texts, 2nd Ed.
5. Higher Algebra- **S Branard & J M Child**, Maxford Books (2003)
6. Introduction to Matrices and Linear Transformations: Third Edition- [Daniel T. Finkbeiner](#), Dover Publications, 2011
7. Higher Algebra-Hall & Knight - Arihant Prakashan.
8. T. M. Apostol : Calculus Vols I and II, 2<sup>nd</sup> Edition, John Wiley and sons, 1967 and 1969.

## **CS 2301 Fundamentals of Data Structures (3-0-0-3)**

### **Module – I**

**Algorithms and Analysis of Algorithms:** Definition, Structure and Properties of Algorithms, Development of an Algorithm, Data Structures and Algorithms, Data Structure – Definition and Classification, Efficiency of Algorithms, Apriory Analysis, Asymptotic Notations, Time Complexity of an Algorithm using  $O$  Notation, Polynomial Vs Exponential Algorithms, Average, Best and Worst case Complexities, Analyzing Recursive Programs, Open source software development process. [5]

### **Module – II**

**Arrays, Stacks and Queues:** Array Operations, Number of Elements in an Array, Representation of Arrays in Memory, Applications of Array, Stack-Introduction, Stack Operations, Applications of Stack, Queues-Introduction, Operations on Queues, Circular Queues, Other Types of Queues, Applications of Queues. [5]

### **Module – III**

**Linked List, Linked Stacks and Linked Queues:** Singly Linked Lists, Circularly Linked Lists, Doubly Linked Lists, Multiply Linked Lists, Applications of Linked Lists, Introduction to Linked Stack and Linked Queues, Operations on Linked Stacks and Linked Queues, Dynamic Memory Management and Linked Stack, Implementations of Linked Representations, Applications of Linked Stacks and Linked Queues. [5]

### **Module – IV**

**Trees, Binary Trees, BST, AVL Trees and B Trees:** Trees: Definition and Basic Terminologies, Representation of Trees, Binary Trees: Basic Terminologies and Types, Representation of Binary Trees, Binary Tree Traversals, Threaded Binary Trees, Applications, BST & AVL Trees: Introduction, BST: Definition and Operations, AVL Trees: Definition and Operations, B Trees: Introduction, m-way search trees: Definition and Operations, B Trees: Definition and Operations. [6]

### **Module – V**

**Graphs:** Introduction, Definitions and Basic Terminologies, Representations of Graphs, Graph Traversals, Single-Source Shortest-Path Problem, Minimum Cost Spanning Trees. [5]

**Module – VI : Sorting:** Introduction, Shell Sort, Quick Sort, Heap Sort. [5]

**Module – VII : Searching:** Introduction, Binary Search, Transpose Sequential Search, Interpolation Search. [5]

#### **Text Book:**

1. G A V Pai – Data Structures and Algorithms: Concepts, Techniques and Applications, 2<sup>nd</sup> Edn, Tata McGraw-Hill, 2008
2. Horowitz E.Sahni, S., Susan A., Fundamentals of Data Structures in C, 2<sup>nd</sup> Edition, University Press, 2010

#### **Reference Books:**

1. J. P. Tremblay , P. G. Sorenson – An Introduction to Data Structures With Applications, 2<sup>nd</sup> Edn, McGraw-Hill, Inc. New York, NY, USA.
2. Seymour Lipschutz – Data Structures, 6<sup>th</sup> Edn, 9<sup>th</sup> Reprint 2008, Tata McGraw-Hill.
3. Adam Drozdek – Data Structures and Algorithms in C++, Thomson Learning, ND– 2007.
4. J. Feller, B. Fitzgerald -Understanding Open Source Software Development, Pearson Edu. Ltd. ND.

## **CH 2203 Environmental Science (3-0-0-3)**

### **Module 1** [6]

**Introduction to Environment Pollution:** Environmental Awareness, concept of an ecosystem, structure and function of an ecosystem, energy and nutrient flow biogeochemical cycle, sources, pathways and fate of environmental pollutants.

### **Module II** [8]

**Air Pollution:** Composition, major sources of air pollution, their detrimental effects, stationary emission sources, some control methods, eg.cyclon separators, wet scrubbers electrostatic precipitators etc.

Automobile emission control, smog, green house effect, ozone depletion, global warming and acid rains etc.

### **Module III** [6]

**Water Pollution:** Water resources, sources of water pollution, various pollutants their detrimental effects.

Portability limits as per WHO & PHED specification, treatment of municipal supply water, slow sand filters, rapid sand filter, disinfections, their advantage & disadvantages, break point chlorination.

### **Module IV** [5]

**Industrial Water:** Specification for boiler feed water, internal and external treatment, ion exchange electro dialysis and revers osmosis.

### **Module V** [5]

**Sewage Treatment:** Composition aerobic & anaerobic treatment, chemical & biological oxygen demand.

### **Module VI**

A brief Introduction to Noise Pollution & Radioactive Pollution [3]

### **Module VII**

Soil pollution and solid waste management [3]

### **Book Recommended:**

De.A.K.Environmental Chemistry, Wiley Eastern ltd,

Miller T.G.Jr., Environmental Science, Wadsworth publishing House, Meerut

Odum.E.P.1971. Fundamental of Ecology. W.B. Saunders Co.U.S.A.

## **IMF 3001-FOOD COMPOSITION AND CHEMISTRY**

**Module I :** Introduction to food chemistry; Definition, Proximate composition of foods; Functions of various food constituents in brief.

Water: Definition of water in foods, physical properties of water and ice; structure of water and ice; interaction of water with solutes; sorption phenomenon; types of water; water activity.

**Module II :** Carbohydrates : Definition, classification, structure of monosaccharides, disaccharides, oligosaccharides polysaccharides(starch, glycogen, cellulose, hemi-cellulose, lignins, pectins, gums and mucilages); chemical reactions of carbohydrates; effect of processing and storage on carbohydrates. Role of carbohydrates in the food industry. Modified starches.

**Module III :** Lipids : Definition, classification, structures, physical and chemical properties of lipids and fatty acids, effect of processing and storage on fats and oils (oxidative and hydrolytic rancidity). Refining of crude oils, hydrogenation and winterization, vegetable and animal fat, Margarine, lard, butters, trying and shortening.

**Module IV :** Proteins : Amino-acids - definitions, classification, essential and non-essential amino-acids, structures and properties; peptides -peptide bonds and some important peptides; purification and denaturation of proteins, Protein interaction and degradation, protein-lipid complexes and protein-carbohydrate complex. Major protein systems and factors affecting them. Metabolic antagonist and allergens associated with food proteins. Modified protein. Classification and structures of proteins physical and chemical properties of proteins; important food proteins; changes of proteins on processing and storage with special emphasis on enzymatic and non-enzymatic browning such as Maillard reactions and Strecker degradation.

**Module V:** Vitamins : structures and functions in brief. Minerals: Occurrence and functions in brief. Enzymes - general characteristics, enzymes in food processing, immobilization of enzymes, removal of toxicants through enzymes.

**Module VI:** Flavor and Aroma of foods - Taste, odor, feeling, blends, control of aroma in processed food.

Pigments and their colorants- Chlorophyll, Myoglobin Hemoglobin and Carotenoids.

**Module VII:** Survey and composition of various food products such as Fruits, Vegetables, milk, meat and cereals.

Books:

1. Fennema, OR. Food Chemistry, McGraw Hill.
2. Belitz, HD and Grosch, W (1987), Food Chemistry, SpringerVerlag.
3. Meyer LH (1960), Food Chemistry, AVI, New York.
4. AOAC (2008). Official Methods of Analysis of AOACInternational, 18th ed. Washington DC.
5. Kirk RS and Sawyer R (1991). Composition and Analysis ofFoods, Longman Scientific and Technical, UK.



## **IMF 3003- FOOD BIOCHEMISTRY AND HUMAN NUTRITION**

**Module-I** : Structure and functions of biomolecules - Carbohydrate - Definition, classification specially chemical and Ring structures. Proteins and Amino acids - Definition of peptide bonds, chemical structures of proteins (primary, secondary, tertiary and quaternary) .Definition, classification and nutritional importance of lipids.

**Module –II** : Structure and chemistry of Nucleic Acids-DNA and RNA and its importance, DNA-fingerprinting, Vitamins- Sources, structure, functions, Deficiency diseases and dietary allowances.

**Module-III** : Enzymes and coenzymes- Definition, classification and factors affecting the catalytic activity of enzymes.

Biochemical separation methods (chromatography, GLC TLC and HPLC and photometry.

Biological membranes and transport across them. Bioenergetics.

**Module-IV:** Major anabolic and catabolic pathways and their regulation, glycogenesis, glycolysis, Krebs cycle, H.M.P. shunt pathways.

Synthesis of protein and catabolic processes i.e. - Determination, transamination decarboxylation and urea cycle.

Biosynthesis of fatty acids and Beta-oxidation of fatty acids.

Metabolic pathways of typical microbes.

**Module-V** : Definitions of food, nutrition and health and interrelationship between them.

Food behavior and food habits - factors affecting food acceptability. Food production and consumption pattern in different parts of India-food requirements and availability. Diet and nutrition in India.

**Module VI:** Functions of food. Nutritional aspects of carbohydrates (including glycemic index and load), proteins and fats. Functions of energy and minerals and vitamins and water. Food sources of nutrients. Concept of a balanced diet. Dietary fibre, its sources and importance

**Module-VII** : Recommended dietary allowances for various age groups. Weaning foods. Malnutrition-under and over nutrition. Common nutritional deficiencies.

Books:

BioChemistry

1. Lehninger A.L., Nelson D.L. and Cox MM (2008), Principles of Biochemistry, MacMillan.

2. Stryer L., Berg J.M. and Tymoczko J.L. (2002), Biochemistry, Freeman & Co.

3. Voet D.J. and Voet J.G. (1999), Fundamentals of Biochemistry, John Wiley & Sons.

4. Murray et al. (2009), Harper's Illustrated Biochemistry,

5. Devlin T. (2010), Textbook of Biochemistry with Clinical

Nutrition

1. Many N.S. Shadakshasawamy M, Food Facts and Principles, New Age International, 2004.

2. Gopalan C et al, Nutritive Value of Indian Foods, Indian Council of Medical Research, 1997.

3. Williams S.R., Essentials of Nutrition and Diet Therapy, Times Mirror, 1997.

4. Khanna et al, Textbook of Nutrition and Dietetics, Phoenix Publisher House Pvt. Ltd., New Delhi, 1997.

5. Sachdev and Choudhary, Nutrition in Children, Developing countries concerns, 1994.

## **IMF 3005 -BASIC ELECTRICAL & ELECTRONICS ENGINEERING**

### **Electrical : Section A**

**Module I:**Electrical elements their classification and characteristics: Resistance, Inductance, Capacitance, Voltage source, Current source.

**Module II:**DC circuits: KCL & KVL equations, Loop current and node voltage method series & parallel resistance.

**Module III:** Theorems: Superposition, Thevenin's, & Norton's, Maximum power transfer.

**Module IV:**AC single phase circuit : Common signals & their wave form, RMS & Average value, form factor. Phasor quantities, impedance, power, power factor, apparent power.

Transformer Introduction

### **Electronics : Section B**

**Module V:**Introduction to semiconductor: Intrinsic & Extrinsic, PN junction, Diode Characteristic

**Module VI:** Rectifier –Half wave, Full wave, Bridge rectifier, Rectifier filter, SMPS. Fundamentals of Transistor, characteristic, C.B. & C.E. Common Emitter Transistor, Amplifier Introduction to load line & Q-point , Frequency response of amplifier.

**Module VII:** Introduction to feedback in amplifier, introduction to oscillator, Barkhausen Criterion. Introduction to FET, & op-amp, CMMR.

### **Books Recommended:-**

Test Books:

1. Basic Electrical Science & Technology by K.Murugesk Kumar (Vikas Publishing)
2. Electronics Fundamentals & Applications, D. Chattodhay and P.C. Rakshit (New ate International)

Reference Books:

1. Basic Electrical Engineering By V.N.Mittle, Tata McGraw Hill Publishing Company
2. Electronic Devices and circuits Theory by R.L.Boylestade and L. Nashelsky (PHI)
3. An introduction to Electronic Devices and Circuits by Allen Mottershed. PHI learning

## **IMF 3007 - FOOD MICROBIOLOGY AND SAFETY**

**Module I:** Introduction to Food Microbiology, History of microbiology of food, Food microbiology and its scope, Types of microorganism normally associated with food: bacteria, fungi, yeast & mold. Growth kinetics and factors affecting growth of microorganisms, Microbiology of different foods, Sources of microbial contamination in food. Abiotic, Biotic and probiotics.

**Module II :**Food Contamination and Spoilage Food microbiology and public health - Food poisoning, food poisonings due to pathogens, important features - A brief account of various organisms related with food poisoning.

Food Borne diseases. Microbial spoilage problems associated with typical raw and processed foods such as dairy products, fruits and vegetables, grains and oilseeds, meat fish and poultry, spices and herbs, and their control.

**Module III:** Beneficial roles of microorganisms. Introduction to biotics and probiotics. Fermented Milk and milk products, Fermented fruits and vegetables, Fermented fish, Fermented meats, cereal based fermented foods, Fermented beverages- Beer, Vinegar and Wine, Role of enzymes in food processing.

**Module IV:** Screening, detection and enumeration techniques including rapid detection techniques for Food Microorganisms including pathogens

**Module V:** Requirements of microbiology laboratory for food analysis: Preparation and maintenance of cultures, media, reference standard; sterilization techniques; disposal of used cultures and media Detection and detection techniques of microorganism in foods: culture, microscopic examinations, physical, chemical and immunological methods of microbial detection. Bio-burden.

**Module VI:** Quality Control/Quality Assurance, Legislation for food safety – national and international criteria, sampling schemes, records, risk analysis, risk management. **Module**

**Module VII:** QC-microbial source, code Indicators of food safety and quality: Microbiological criteria of foods and their significance. The HACCP system and Food Safety Management Systems used in controlling microbiological hazards.

### **Books:**

1. James M.J. (2000) Modern Food Microbiology, 5<sup>th</sup> Edition, CBS Publishers.
2. Barnart, G.J. (1997) Basic Food Microbiology, CBS Publishers.
3. Adam M.R. & Moss, M.O. (1995) Food Microbiology, New Age International Pvt. Ltd. Publishers.
4. Bibek Ray (1996) Fundamental Food Microbiology, CRC Press.
5. Stanier, R.Y. (1996) General Microbiology, Vth Edition, MacMillan

**PS: 3001 BIOLOGICAL SCIENCE (3-0-0-3)**

**Module – I**

Nature and scope of Biology, Life and its origin, Evolution and Maintenance. [5]

**Module - II**

The cell as a unity of Life, Structural Organization of Cell, cell division. [4]

**Module - III**

Elements of Heredity and variation, Genes and chromosomes, Gene mutation and polyploidy. [6]

**Module - IV**

Animal Tissues, Respiratory Gas exchange, Nervous System, Endocrine System, Cardiovascular System. [8]

**Module - V**

Biosynthesis of Fats and terpenoids, Protein Synthesis, Enzymes. [5]

**Module - VI**

Recent developments in Biotechnology. [3]

**Module - VII**

Health education: Communicable and Non Communicable diseases, Drug abuse, Drug addition. [5]

**Books recommended:**

1. Elementary Biology - Trueman's
2. Plant Physiology - Dieter Hess
3. Text book of Botany - A.C. Dutta
4. Text book of Zoology - R.D. Vidyarthi
5. Human Anatomy & Physiology - Marib
6. Text book of Medical Physiology - Guyton & Hall

## **IMF 4001–Food Engineering I – Mechanical Operations and Fluid Flow**

**Module I :** Introduction: to food process engineering, Material and energy balances : Basic principles, Total mass balance and component mass balance. Material balance calculations involved in dilution, concentration and dehydration.

**Module II:** Material handling - Theory, classification of various material handling equipment - conveyors (gravity and powered conveyors), elevators (bucket and screw type elevators), trucks (high lift and pallet trucks), cranes and hoists.

Cleaning - Types of contaminants found on raw foods, aims of cleaning, methods of cleaning- dry, wet and combination methods. Dry cleaning methods: screening, aspiration, magnetic cleaning and abrasive cleaning. Wet cleaning methods: soaking, spray washing, flotation washing and ultrasonic washing.

**Module III:** Particle size analysis, Industrial screen. Sorting and Grading - Advantages of sorting and grading, grading factors, methods of sorting and grading. Size Reduction: Reasons/benefits of size reduction, nature of forces used in size reduction, criteria of size reduction, equipment selection (hardness of feed, mechanical structure of feed, moisture content and temperature sensitivity of feed), mode of operation of size reduction equipment - open circuit and closed circuit grinding, free crushing, choke feeding and wet milling. Size reduction of solid foods, fibrous foods and liquid foods. Effects of size reduction on solid and liquid foods. Design procedure

**Module IV :** Mixing and Conveying of paste - Mixing terminology (agitating, kneading, blending, and homogenizing). Mixing equipment - mixers for liquids of low or moderate viscosity (Paddle agitators, turbine agitators and propeller agitators), mixers for high viscosity pastes (Pan mixer, horizontal mixer and dough mixer), mixers for dry solids (tumbler mixer & vertical screw mixer), Extruders (single & Twin screw), effects of mixing on foods. Power consumption and efficiencies, Design of conveyor belts Methods of dust collection, Cyclones, Electrostatic precipitators. Extrusion processing of food- basic principles, cold extrusion and extrusion cooking in single and twin screw extruder.

**Module V: Solid –Liquid Separation:** Filtration - Filtration terminology (feed slurry, filtrate, filter medium, filter cake and filter), filtration methods/equipments - pressure filtration, vacuum filtration, & centrifugal filtration. Expression - Factors affecting efficiency of expression, methods of expressing the liquid from solid-liquid food system – hydraulic pressing, roller pressing and screw pressing. Centrifugation - sedimentation and sedimentation theory; thickeners and classifiers; flow through packed beds/ flow distribution packaging and pressure drop calculation; fluidization, solid-liquid separation using centrifugation Sigma value and scale-up; different types of centrifuges and their design; application to biological suspensions.

**Module VI:** Fluid Mechanics : Properties of fluids, nature of fluid and fluid flow, Flow of fluids pasta stationary particle for low, medium and high Reynolds numbers; Manometers, Mechanism of on Compressible fluid flow, Reynolds' no, Distribution of velocities, Viscosity,. Measurement of fluid flow, Orifice meter and Venturimeter, Pilot tube, Rotameter, Notches and weirs and other miscellaneous meters.

**Module VII:** Friction losses in pipe line, Losses in pipe fittings, transportation of fluids. Valve, pumps. Agitated vessels.

## Books

1. Earle, R.L. (1983) Unit Operations in Food Processing, 2nd Edition, Pergamon Press, Oxford,U.K.
2. Singh, R. P. and Heldman, D. R. (1984). Introduction to Food Engg., Academic Press, INC, London.
3. Lewis, M.J. (1987). Physical Properties of Foods &Foods Processing Systems, Ellis Horwood, England
4. Unit Operations in Chemical Engineering by Mc Cabe and Smith, McGraw Hill
5. Mass Transfer Operations by R E Treyba, Mc Grow Hill. 1
6. Absorption and Extraction by T.K. Sherwood and R.L. Pigford Mc grow Hill.

## **IMF 4003- Principles of Food Processing and Preservation**

**Module I :** Introduction to Process operations, principles, Good Manufacturing Practices., Principles of food preservation, Asepsis, removal of microorganisms, Maintenance of anaerobic conditions, Methods of food preservation.

**Module II :** Water Activity and Food Preservation, Free and Bound water, Effect of water activity on quality of food constituents during storage (proteins, lipids and carbohydrates) Effect on physical and nutritional quality, Water activity and food stability, Effect of packaging material on water activity.

**Module III :** Preservation through temperature reduction, Storage of food at chilling temperature - behaviour, Refrigeration Controlled Atmosphere Storage (CAS), Modified Atmosphere Storage (MAS), Chilling defects Freezing-principles, fundamental aspects of freezing process-technological aspects, Freezing damage-osmotic damage, solute Structural damage Preservation by use of High Temperatures Concentration of food Evaporation Freeze concentration, Membrane process for concentration

**Module IV:** Dehydration of food (Food Preservation through water removal), Transport of water in foods, Different methods of dehydration, Cabinet drying, sun / solar drying, Osmo drying, Osmo-vac drying, micro-vac drying, vacuum drying, Nutritional, physico-chemical changes during drying Quality aspects of dehydrated food. Recent advances in dehydration of food Freeze drying Introduction, principles, process and preservation Physico-chemical changes in food Nutritional changes during freeze drying Recent advances in freeze drying methods (industrial developments).

**Module V :** Evaporators- types & food applications, Preservation using high Sugar-Jam, Jellies, Squashes, syrups, marmalades, cordials, concentrate etc. Intermediate moisture fruits (candies / murabbas, tutti-frutti / glazed fruits) Processing of Tomato products Tomato juice, Ketchup, Sauce, Paste, Soup

Process technology and its quality evaluation Chutneys and allied traditional products Salting preservation Use of common salt, principle, process Fish salting Pickling Pickle salting ( sauerkraut, cucumber, Kim chi) Vegetable salting Acidified - brined pickles (vegetables-onion, garlic) Fermentation process (Beverages) Pickle making technology Wine making technology (grape and others) Beer making.

**Module VI:** Traditional fermented food products : Dhokla, Idli, Curd, Tempe, Soya sauce fish, meat and vegetable fermented products Various alcohol based products Yeast fermented Products.

**Module VII:** Industrial Applications Canning and bottling Commercial canning operation Containers for canning of vegetables and their products Canning of fruits and their products Machinery and equipment, processing Spoilage of canned food and its quality evaluation Irradiation (in brief Principle Commercial applications Quality / Technological aspects Wholesomeness of irradiated food Prospects for the future UV rays application Microwave technique, its application in food preservation (surface sterilization of food ) Food Packaging.

### **Books:**

1. Mircea Enachescu Dauthy (1997) 'Fruit and vegetable processing', FAO Agricultural Services Bulletin 119, International Book Distributing Co.

2. Brain J.B. Wood (1985) Microbiology of Fermented Foods, Vol.I, Elsevier Applied Science Publishers.
3. Diane M. Barrett, Laszlo Somogyi, Hoshahalli Ramaswamy Processing Fruits, II edition, Science and Technology, CRC Press.
4. Marcus Karel, Owen R. Fennema Physical principles Food Science, Part I and II Marcel Dekker inc.
5. IGNOU-2006 Food Processing and Engineering -II, Practical Mannual, [www.ignou.ac.in](http://www.ignou.ac.in).
6. Giridhari Lal, G.S. Siddappa and G.L. Tondon Preservation of Fruits and Vegetables, CFTRI, ICAR , New Delhi -12.



## **IMF 4005 - Food Analysis**

**Module I :** Introduction to Food Analysis :proximate analysis-chemical analysis, rules and regulations of Food analysis, safety in laboratory. Sampling and Sampling techniques. Sample preparation for analysis. texture analysis of foods, Colour measurements in raw and processed foods, Water activity measurements and its significance in food quality, Techniques for dough rheology and starch characterization, Surface tension and its significance in food analysis, Enzymatic methods of food analysis.

**Module II:** Basic principles of Spectroscopy, UV and visible molecular absorption spectrometry, atomic absorption spectrometry, emission spectrometry, fluorescence spectrometry, Atomic mass spectrometry, Infrared spectrometry.

**Module III :**Basic principles of Chromatography and its separation Techniques: Liquids, GC, TLC, Super critical fluid extraction chromatography Analysis of Carbohydrates.

**Module IV :**Analysis of liquids – Total liquids concentration – Solvent extraction; Non-solvent liquid extraction methods; instrumental methods. Determination of liquid composition - Separation and Analysis by Chromatography; Chemical techniques. Analysis of Liquid oxidation.

**Module V:** Electrophoresis methods, Chemical methods; enzymatic methods; physical methods; immunoassays; analysis of polysaccharides fiber. Analysis of proteins Determination of overall protein concentration; protein separation and characterization; methods based on different adsorption characteristics separation due to size differences; separation by electrophoresis.

**Module VI:** Radiochemical Methods: Use of radio isotopes. Viscosity and Consistency measurements of Food, Measurements of Rheological properties.

**Module VII:** Microscopic techniques in food analysis (light microscopy, SEM, TEM,XRD, particle size analysis, image analysis etc.), Thermal methods in food analysis (Differential scanning colorimetry and others), Chromatographic methods in food analysis and separation, Extraction techniques in food analysis, Fluorimetric and polarimetric techniques in food analysis;

Application and operating parameters of Spectrophotometer, AAS, GC, HPLC, NMR, FTIR, GC-MS, LC-MS.

Books:

1. Food analysis - S.S. Neilson, Aspen publishers. Gaithery Berg Maryland
2. AOAC methods for Food Analysis.
3. Food Analysis, Theory and practice - Y. Pomeranz and C. EMeloan, A VI publishing company, INC West Port, Connecticut,USA.
4. Fung, D.Y.C. and Matthews, R. (1991): Instrumental Methodsfor Quality Assurance in Foods, Marcel Dekker, Inc. New York
5. Moskowitz, H. R. (ed) (1987): Food Texture: Instrumental andSensory Measurement: Marcel Dekker, Inc., New York.

## **IMF 4007 - Fruits and Vegetables Processing**

**Module I :** Fruits and vegetables as living products: Current status of production and processing of fruits and vegetables. Chemical composition; pre and post harvest changes, harvesting and maturity standards for storage, and desirable characteristics of fruits and vegetables of processing. Post harvest treatments to enhance shelf-life, conditions for transportation and storage. Pre-cooling.

**Module II:** Cold chain & low temperature preservation: Types of cold preservation; Types of freezers and freeze concentrators, Cooling above freezing point, Cooling below freezing point. Control & modified atmosphere storage, Refrigerated transportation.

**Module III:** Thermal processing: Canning and bottling, effect of canning and bottling on nutritive value, spoilage of canned foods, detection and control. UHT processing; Aseptic processing and packaging. Dehydration of Fruits & Vegetable: Thermal, Osmotic.

**Module IV:** Products processing: Juice extraction and preparation of syrups, squashes, cordials, nectars; Jam, jelly, marmalade, preserves and candies; ketchup, pickles, chutneys and sauces; dehydrated products;

**Module V:** Product processing :fruit juice concentrates and powders; fortified soft drinks, tomato product, vinegar; cut fruits and vegetable, fruit toffee; fruit flavors and essences; Minimally processed fruits and vegetables.

**Module VI:** Basics of Packaging materials & containers: Tin, glass, plastic and other packaging materials used in fruits and vegetables preservations. Modified atmosphere and active packaging.

**Module VII:** By-products utilization: Fruit & vegetable processing industry waste treatment, disposal and reuse. Emerging technologies for fruit and vegetable processing.

Books:

1. Fruits and Vegetables. A.K Thompson. Blackwell publishing
2. S. Ranganna, Hand Book of Analysis and Quality Control for Fruits and Vegetable Products, Tata McGraw Hill, 2002.
3. S. Ranganna, Hand Book of Canning and Accepting Packaging, Tata McGraw Hill, 2000.
4. L. Somogyi, Processing Fruits: Science and Technology, Vol I :Biology Principles and Applications, Woodhead Publishing, 1996.
5. L. Somogyi, D.M. Barette and Y.H. Hui, Processing Fruits: Science and Technology, Vol II: Major Processed Products, Woodhead Publishing, 1996.
6. Y. H. Hui, S. Ghazala, D.M. Graham, K.D. Murrell and W.K. Nip, Handbook of Vegetable Preservation and Processing, Marcel Dekker, 2003.

## **IMF 5001 -Food Packaging Technology**

**Module I :** Active and intelligent packaging, Active packaging techniques, Intelligent packaging techniques, Factors affecting the effectiveness of antimicrobial packaging.

**Module II:** Non-migratory bioactive polymers (NMBP) in food packaging, Advantages of NMBP, limitations, inherently bioactive synthetic polymers: types and applications, Polymers with immobilized bioactive compounds.

**Module III:** Time-temperature indicators (TTIs), Defining and classifying TTIs, Requirements for TTIs, The development of TTIs, Current TTI systems, Maximizing the effectiveness of TTIs, Using TTIs to monitor shelf-life during distribution, Using TTIs to optimize distribution and stock rotation..

**Module IV:** Packaging-flavour interactions, Factors affecting flavour absorption, role of the food matrix, role of differing packaging materials, Case study: packaging and lipid oxidation, Modeling flavour absorption, Packaging– flavour interactions and active packaging, Novel MAP applications for fresh-prepared produce, Novel MAP gases, Testing novel MAP applications, Applying high O<sub>2</sub> MAP.

**Module V:**Modern packaging systems: Green plastics for food packaging, The problem of plastic packaging waste, The range of biopolymers, Developing novel biodegradable materials, Legislative issues, Current applications, Integrating intelligent packaging , role of packaging in the supply chain,

**Module VI:** Creating integrated packaging, storage and distribution: alarm systems and TTIs, Traceability: radio frequency identification,

**Module VII:** Recycling packaging materials: The recyclability of packaging plastics, improving the recyclability of plastics packaging, Testing the safety and quality of recycled material, Using recycled plastics in packaging.

### **Suggested Readings**

1. Ahvenainen R. 2001. Novel Food Packaging Techniques.CRC.
2. Crosby NT. 1981.Food Packaging Materials. App. Sci. Publ.
3. Mahadeviah M & Gowramma RV. 1996. Food Packaging Materials. Tata McGraw Hill.
4. FAPaine & H Y Paine, 1992, springer A Handbook of Food Packaging. Blackie.
5. Palling SJ. 1980. Developments in Food Packaging. App. Sci. Publ.
6. Rooney ML. 1988. Active Food Packaging.Chapman & Hall.
7. Sacharow S & Griffin RC.1980.Principles of Food Packaging. AVI Publ.
8. Stanley S & Roger CG. 1998. Food Packaging. AVI Publ

## **IMF 5003- Agricultural Practices**

**Module I:** Ecology and its relevance to man, natural resources, their sustainable management and conservation. Physical and social environment as factors of crop distribution and production. Agro ecology; cropping pattern as indicators of environments. Environmental pollution and associated hazards to crops, animals and humans. Climate change at 'International convention and global initiatives'. Green house effect and global warming. Advance tools for ecosystem analysis –“Remote sensing (RS) and Geographic Information Systems (GIS).

**Module II :**Cropping patterns in different agro-climatic zones of the country. Impact of high-yielding and short-duration varieties on shifts in cropping patterns. Concepts of various cropping and farming systems. Organic and Precision farming. Package of practices for production of important cereals, pulses, oil seeds, fibres, sugar, commercial and fodder crops. Agro forestry and value addition.

**Module III:** Seeds: Seed production and processing technologies. Seed certification, seed testing and storage. DNA fingerprinting and seed registration. Role of public and private sectors in seed production and marketing. Intellectual Property Rights (IPR) issues, WTO issues and its impact on Agriculture.

Weeds, their characteristics, dissemination and association with various crops; their multiplications; cultural, biological, and chemical control of weeds.

**Module IV:** Soil - physical, chemical and biological properties. Processes and factors of soil formation. Soils of India.

Mineral and organic constituents of soils and their role in maintaining soil productivity. Essential plant nutrients and other beneficial elements in soils and plants.

**Module V:**Principles of soil fertility, soil testing and fertilizer recommendations, integrated nutrient management.

Bio-fertilizers. Losses of nitrogen in soil, nitrogen-use efficiency in submerged rice soils, nitrogen fixation in soils. Efficient phosphorus and potassium use. Problem soils and their reclamation. Soil factors affecting greenhouse gas emission.

**Module VI:** Soil conservation, integrated watershed management. Soil erosion and its management. Dry land agriculture and its problems. Technology for stabilizing agriculture production in rain fed areas.

**Module VII:** Water - use efficiency in relation to crop production, criteria for scheduling irrigations, ways and means of reducing run-off losses of irrigation water. Rain water harvesting. Drip and sprinkler irrigation. Drainage of waterlogged soils, quality of irrigation water, effect of industrial effluents on soil and water pollution. Irrigation projects in India.

### **Books:**

Handbook of Postharvest Technology edited by Amalendu Chakraverty Arun S. Mujumdar G. S. Vijaya Raghavan Hosahalli S. Ramaswamy. CRC Press.

## **IMF 5005 - CEREAL TECHNOLOGY**

**Module I :**Importance of cereals and legumes, Post-harvest quality and quantity losses. Recommended pre-processing practices for handling of cereals and pulses for their safe storage, including control of infestation, National and International quality and grading standards.

**Module –II:** Composition, structure and characteristics of wheat, paddy and corn. Physical properties : Shape and size, density, porosity , frictional properties, Aerodynamic properties, thermal properties of grains: Specific heat, thermal conductivity, thermal diffusivity. Structure, types, composition, quality characteristics and physicochemical properties of wheat. Cleaning, tempering and conditioning, and milling processes for different wheat's. Turbo grinding & Air Classification. Blending of flours. Milling equipments and milling products(Dalia, Atta, Semolina and flour). Flour grades and their suitability for baked goods. Quality characteristics and rheological properties of wheat milling products and its assessment. Byproduct utilization.

**Module – III:** Structure, types, composition, quality characteristics and physicochemical properties of rice. Milling and parboiling of paddy, Curing and ageing of paddy and rice. Criteria in and assessment of milling, cooking, nutritional and storage qualities of raw & parboiled rice. Processed rice products (flaked, expanded and puffed rice). By-product (husk and rice bran)utilization.

**Module-IV:** Structure, types and composition of corn. Dry and wet milling of corn. Starch and its conversion products. Processed corn products (popped corn, corn flakes etc.)Structure and composition of barley, bajra, jowar and other cereal grains and millets. Malting of barley. Pearling of millets. Parched and snack products.

**Module V :**Baking: Technology of manufacturing Bread, Biscuits etc quality control procedures for flour, fat, bakers yeast, sugar and salt, I.S.I. standards for flour, fat, Baker's yeast.

**Module VI:** Structure, composition and properties of legumes. Cleaning, grading, pretreatments for difficult-to-mill (urad, arhar, moong, moth) and easy-to-mill (chana, masoor and pea) legumes, milling practices and actual milling of different legumes. Sweet and savory products from legumes in India.

**Module VII: special topics:** Processing and utilization of soya bean for value added products. Extrusion technology for cereals. Extrusion: extruded food products, Technology of Macaroni and pasta products, extrusion cooking.

### **Books Recommended**

1. Cereals Technology by Samuel A.Matz. CBS Publications.
2. Technology of Cereals by N.L.Kent. pergaman Press,1966
3. Food Facts and Principles by Mannay;New age International (P) Ltd.
4. Food Science by Norman N.Potter;CBS Publications.
5. Chemistry and Technology of Food and Food Products by M.B. Jacobs
6. Manuals on Rice and its Processing by CFDRI.
7. Cereals & Cereals Products-Chemistry & Technology by DAV Dendy & B.J.Dobraszezsk, Aspen Publication.
8. Development in Milling & Baking Technology by AFST (I), CFDRI, Mysore, India.
9. Food Industries of CEEDC, IIT, Madras.
10. Articles on Pulse Milling in India Food Industry & JFST,both Publications of AF

## **IMF 5007- FERMENTED FOOD PRODUCT TECHNOLOGY**

**Module I:** Fermentation process, Food fermentation, Microbiology of fermentation. Importance of Fermented products. Isolation and maintenance of pure culture. Preparation of substrates/media, inoculums.

**Module II :** Features of different types of Fermenter. Rate of microbial growth and death. Fermentation kinetics. Fermenter design, operation, measurement and control in fermentation. Types of fermentation. Aeration and agitation in fermentation: Oxygen requirement, measurement of adsorption coefficients, bubble aeration, mechanical agitation

**Module III:** Process variables and its control, Recovery of fermentation products and conversion into marketable /storage forms, Packaging of fermented foods.

**Module IV:** Sterilization of fermenters- Batch and continuous. Production of Industrial alcohol: raw materials micro-organisms, Neutral spirits.

**Module V :** Production of baker's yeast, food yeast, SCP, beer, wine, cider, vinegar, organic acids (eg. Citric ,lactic, Acetic acids, Fumaric and Gluconic acid ) and enzymes (eg. Amylases, protease, lipases, pectinases, celluloses, hemicellulose etc.). IMFL/ distilled spirits (eg. Rum, gin, whisky). Mushroom cultivation

**Module –VI:** Oriental Fermented Products, soy sauce, pickles, fermented milks & cheeses. Microbial fats.

**Module – VII:** Indian traditional sweet, savory and snack food products: Sweetmeats, Namkins, Papads, wari, Idli, Dosa, Dhokla etc.

### **Books Recommended:**

1. Industrial Microbiology - Prescott & Dunn
2. Industrial Microbiology - L.E. Casida
3. Principle of Fermentation Technology - Whittaker and Stanbury
4. Handbook of Indigenous Fermented Foods - K.H. Steinkrus
5. Food Microbiology - Adams and Moss
6. Mushroom Cultivation - J. N. Kapoor, ICAR
7. Food fermentation by V.K.Joshi and Ashok Pandey.

## **IMF 5009–Food Engineering – II – Heat and Mass transfer**

### **Module I:** Heat transfer:

Conduction : Nature of heat flow, modes of heat transfer steady state heat conduction equation, heat conduction in slabs, cylinders & Spheres, thermal insulation and their selection, Optimum and economic thickness of insulation. Unsteady state condition: lumped capacity  
Convection: Free & forced convection, Individual and over all heat transfer coefficients. Dimensionless numbers in heat transfer, expressions for calculating heat transfer coefficients, Laminar and turbulent heat transfer inside and outside tubes, annuli finned tubes, Natural convection and its applications. Film condensation and drop condensation, Heat transfer to boiling liquids, pool boiling, forced convection boiling. Unsteady state heat transfer in batch vessels, Lumped heat capacity systems. Radiation: Kirchoff's laws, Stefan's Law, Heat flux by radiation, View factor

**Module II:** Heat exchanger, Classification, applications mode of operation, Shell and tube Heat exchangers, Plate Heat Exchanger, Application in Dairy and Food Processing. Evaporators, vaporizers, reboilers, reaction kettles, Classification operation and design.

Heat transfer in agitated vessels, coils, Heat transfer in boilers, furnaces and their operation. Heat recovery methods, recuperative, regenerative heat transfer in packed and fluidized beds.

**Module III:** Diffusion- Molecular diffusion of fluids, Diffusion in solids. Interphase mass transfer, Mass transfer in packed and fluidized beds, Concept of effective diffusivity, Diffusion through membranes and applications.

Distillation- Vapour liquid equilibrium for ideal and non ideal binary systems, Estimation of VLE using vapour pressure data and relative volatility. Vapour liquid equilibrium for multi-component mixtures.

**Module IV:** Gas Absorption - Equilibrium relationship, mass transfer theories, concept of driving force, individual and overall mass transfer coefficients. Plate column for adsorption. Humidity and air conditioning, wet and dry bulb, Wet and dry bulb hygrometry, Humidity charts, Methods of humidification and dehumidification, Air conditioning, Cooling towers and spray ponds.

**Module V:** Liquid- Liquid Extraction - Equilibrium for immiscible and partially miscible systems, Use of triangular diagram. Calculation of number of stages for concurrent and counter current contacting.

Crystallization: Miers theory, Nuclei formation, Crystal growth, Theory of crystallization, Batch and continuous crystallization, Fractional crystallization.

Adsorption - Gas solid isotherms for one and more sorbates, Chemisorption, Liquid and solid isotherm, Adsorption Unit- Fixed bed equations, Isothermal operation, Non isothermal operation, pressure swing adsorption, Solid liquid extraction.

### **Module VII: Drying : Principle rate of drying . Psychrometry**

Food Processing applications: Heat balance calculations; Properties of dry-air: composition of air, specific volume of air, specific heat of dry air, enthalpy of dry air, dry bulb temp.

Thermodynamic properties of food in dehydration Introduction, Thermodynamic food-water system, sorption energetic, dehydration principles and process.

Preservation unit operations (High Temperately Operations).

Pasteurization - Basic concept, pasteurization of unpackaged and packaged foods, effects of pasteurization on foods.

### **Books**

1. Earle, R.L. (1983) Unit Operations in Food Processing, 2nd Edition, Pergamon Press, Oxford,U.K.
2. Singh, R. P. and Heldman, D. R. (1984). Introduction to Food Engg., Academic Press, INC, London.
3. Lewis, M.J. (1987). Physical Properties of Foods &Foods Processing Systems, Ellis Horwood, England
4. Unit Operations in Chemical Engineering by McCabe and Smith, McGraw Hill
5. Mass Transfer Operations by RE Treybal, McgrawHill.
6. Absorption and Extraction by T K Sherwood and R.L.Pigford McgrawHill



## **IMF 6001 -Dairy Technology**

**Module I** :Milk : Present status of dairy industry- India and Abroad. Operation flood, NDDDB. Definition, Physical, chemical & microbiological properties of milk and nutritive value of milk . Colostrum or Beestings and their Physical, chemical and nutritive value. Procurement of milk and transportation and distribution of milk,

**Module II**: Testing the authenticity of milk and milk products: Detection of foreign materials and chemicals as per appropriate methods..

**Module III** :Good hygienic practice in milk processing: Homogenization, pasteurization ,sterilization and UHT. Technology of cream, butter, ghee, margarine. Sources of Contaminants of milk., Processing of market milk. Standardization, toning of milk., storage. Cleaning and disinfection in a dairy industry, definitions of cleaning and disinfection agents and processes..

**ModuleIV** : Technology of special milk- Toned milk , double toned milk, flavored milk, humanized milk, skim milk, Sterilized flavored milk, UHT milk and their physical and chemical properties and their nutritive value,. Aseptic packaging and storage

**Module V** :Technology of fermented milk like yoghurt, dahi, shrikhand, probiotics and prebiotics. Their Judging and grading . Technology of desiccated products like khoa, rabri

**Module VI**: Technology of acid coagulated products viz chhana, paneer and cheese and cheese spread, Techniques involved for manufacturing of ice cream and kulfi. Judging and grading of milk

### **ModuleVII** :

Techniques involved for manufacturing of cereal, fruit & vegetable based by products and their judging and grading.

Book:

1. Smit, G. (2003) Dairy processing - improving quality. Woodhead Publishing.
2. Walstra P., Geuits T.J., Noomen A., Jellema A. and Van Boekel M.A.J.S. (1999) Dairy technology- Principles of milk properties and processes. Marcel Dekker Inc.
3. Spreer E. (1998) Milk and dairy product technology. Marcel Dekker Inc.
4. Gupta R.P. (2003) Dairy India year Book 2007
5. Robinson R.K. Modern dairy Technology, Vol I Advances in Milk processing.
6. Outlines of Dairy Technology by Sukumar Dey, 1990, Oxford Univ. Press..

## **IMF 6003– Food Engineering- III –Thermodynamics and Refrigeration**

**Module -I :** Zeroth & First law of thermodynamics-concept of temperature, Energy balance for closed system. Thermodynamic state and state functions. The reversible process. The adiabatic process. The constant volume and constant pressure process. Enthalpy, heat capacity. Mass and energy balance for open systems.

**Module - II:** Second law of thermodynamics and its application: Limitations of the first law of thermodynamics, statements of the law. Heat engine and heat pump / refrigerator. Mathematical statement of second law. Carnot cycle and Carnot Theorems. criterion of irreversibility, clausius inequality, entropy and its change calculation for ideal gases. Liquefaction process.

**Module III :**Refrigeration : Basic refrigeration cycles and concepts: Elementary vapour compression refrigeration cycle with reciprocating, rotary and centrifugal compressor. Theoretical vapour compression cycle, Departure from theoretical vapour compression cycle, representation on T-S and P-H diagrams, Mathematical analysis of vapour compression refrigeration system. Refrigerants : Primary and secondary refrigerants, common refrigerant, Brine, their properties and comparison Multiple evaporation and compressor system: Application, on compressor system: dual compression, comparison of systems, control of multiple evaporator system.

**Module IV:** Refrigeration equipments : Compressor, condenser, evaporator, expansion valve, cooling tower. Basic elements of design, construction, operation and maintenance. Balancing of different components of the system, ice-bank –tank system. Refrigeration control: low and high side float valves, capillary tube, thermostatic expansion valve, automatic expansion valve, solenoid valve, high pressure and low pressure cutouts. Thermostat, overload protector, common defects and remedies. Refrigeration piping: Purpose, material, joints and fittings, water and brine pipe size selection. Refrigerated vehicle: truck, trawler. Working principle of Ice-flaker.

**Module V :**Ultra low temperature refrigeration. Production of dryice. Absorption refrigeration system: simple vapour absorption refrigeration systems, Practical absorption system, refrigerant combinations, Absorption cycle analysis. Cooling load calculation: Types of load, design conditions for air cooling, air conditioning loads. Cold storage: Types of cold storage, types of load in cold storage, construction and maintenance of cold storage, insulating materials and vapour barrier. Cold storage: Types of cold storage, types of load in cold storage, construction and maintenance of cold storage, insulating materials and vapour barrier.

**Module VI :** Rheological properties of fluid and solid foods: Rheological classification of food. Rheological models for viscous and visco-elastic food, measurement of flow properties of fluid foods, (Fundamental methods, empirical methods and imitative methods). Rheological properties of solid food: Quasistatic tests for solid food. Dynamic testing of solid food and other testing methods.

**Module VII:** Thermal properties of frozen and unfrozen food: Introduction to thermal properties, importance of thermal properties, experimental approach to measure thermal properties, modeling of thermal properties of frozen and unfrozen foods.

## Books

1. Brennan JG, Butter JR, Corell ND & Lilly AVE. 1990. *Food Engineering Operations*. Elsevier.
2. Charm SE, McCabe WL, Smith JC & Harriott P.1993. *Unit Operations of Chemical Engineering*.McGraw Hills.
3. Earle RL. 1985. *Unit Operations in Food Processing*. Pergamon Press.
4. Fellows P. 1988. *Food Processing Technology*. VCH Ellis Horwood.
5. Heldman DR & Singh RP.1995. *Food Process Engineering*. AVI Publ.
6. McCabe WL & and Smith JC. 1971. *Fundamental of Food Engineering*. AVI Publ.
7. Sahay KM & Singh KK. 1994. *Unit Operation of Agricultural Processing*. Vikas Publ. House.
8. Singh RP & Heldman DR. 1993. *Introduction to Food Engineering*. Academic Press.
9. Refrigeration and air-conditioning. Richard C Jordan and Goyle B. Prirster (1956), Prentice Hall, Engle wood.
10. Refrigeration and air-conditioning. Dr. Manohar Prasad, (1993), Wiely Estern, New Delhi.

## **IMF 6005 – Agricultural and Rural Economics**

**Module I** - Introduction - Nature of Rural Economy. Structure of Rural Economy. Concept of Rural Development. Scope and Importance of Rural Development V.M. Dandekar's Approach to Rural Development.

Agricultural extension, its importance and role, methods of evaluation of extension programmes, socio-economic survey and status of big, small and marginal farmers and landless agricultural labourers.

**Module II** -Dimensions of Rural Development: Agricultural Growth in India, Irrigation Green Revolution, Agrarian Reforms, Rural Electrification Rural Transport

Poverty and Unemployment : Rural Poverty – Nature, Causes and Remedies, Rural Unemployment - Nature, Causes and Remedies Rural Indebtedness – Magnitude, Causes, Relief Measures Role of SHGs and Micro Finance in this context. Rural Industrialization. Employment in unorganized sector.

**Module III** -Agricultural labour : Problems of Agricultural labour. Efficiency of Agriculture labour. Impact of mechanization on Agricultural labour. Unemployment Problem. Employment Guarantee Scheme. Recent Agricultural Problems in India.

**Module IV** -Agricultural policy and impact : State Policies & Central Policies. Central policies comparison with world. Recent Indian Agricultural Labour Policy & its comparison with World. Ceiling on land holding policy. Past and Present SEZ policy.

**Module V**-Agricultural Export- Import Policies – history, recent changes & problems: Vegetables, Fruits, Spices, Flowers, Medicine, ornamental plants, Grain crops, Milk, Silk, Meat., EXIM Policy.

**Module VI** - Programmes of Rural Development - Objectives and Assessment of Programmes / Schemes: Food for Works Programme, Employment Guarantee Scheme, Small Farmers, Development Agency, Marginal Farmer and Agricultural Labour, National Rural Employment Guarantee Programme, TRYSEM (Training Rural Youth for Self Employment), Special Component Plan for SCs, Tribal Development Programme, Employment Assurance Scheme Swarn Jayanti Gram Swarozgar Yojana

**Module VII-**

Training programmes for extension workers. Role of Krishi Vigyan Kendra (KVK) in dissemination of Agricultural technologies. Non Government Organization (NGO) and self-help group approach for rural development

### **Books:**

1. Government of India – Evolution of Community Development Programme in India
2. Desai, Vasant - Study of Rural Economics, Himalaya Publishing Company, New Delhi.
3. Jain P.C. – Agricultural Reforms in India
4. Shakuntala Devi – Rural Credit and Agricultural Development, Scrap & Sons, New Delhi 1996.
5. Patodiya Mohan S. - Rural Economics for C.A.I.I.BPart – I

## **IMF 6007 - FOOD ADDITIVES AND INGREDIENTS**

**Module I:** Additives in food processing and preservation - classification and their functions. Safety and quality evaluation of additives and contaminants, acute and chronic studies, NOAEL, ADI, Ld50. Indirect food additives.

**Module II :** Various additives such as preservatives, antioxidants, antimicrobials, colors, flavor, emulsifiers, sequesterants, humectants, hydrocolloids, sweeteners, acidulants, anticaking agents, buffering salts, stabilizers, thickeners etc. with respect to chemistry, food uses and functions in food formulations Acids, bases and buffers.

**Module III:** Flavor Technology: Types of flavors, flavors generated during processing - reaction flavors, flavor composites, stability of flavors during food processing, analysis of flavors, extraction techniques of flavors, flavor emulsions, essential oils and oleoresins, authentication of flavors etc.

**Module IV :** Ingredients used in food production e.g. sugar, starches/modified starches, fibres, proteins/protein hydrolysates and fats etc and their technology of production and application. Sugars and Sweeteners: Sugars, syrups, sugar alcohols, potent sweeteners, sugar products, caramelization. Sweetener chemistry related to usage in food Products.

**Module V:** Proteins and Lipids as functional ingredients isolation, modification, specifications, functional properties and application in foods and nutraceuticals

**Module VI:** Food Colors: Food colours - Types and properties, regulatory aspects, safety issues - natural food colours - pigments, chlorophylls, carotenoids, anthocyanins and flavonoids, tannins, caramel and others Artificial food colours.

**Module VII:** Manufacturing and applications of fibres from food sources, fructooligosaccharides.

### **Books:**

1. Branen, A. F. et al (2001). Food Additives, 2nd Edition, Marcel Dekker.
2. George, A. B. (1991). Encyclopedia of food and color additives, Vol III, CRC Press.
3. Nakai, S. and Modler, H. W (2000). Food proteins. Processing Applications, Wiley
4. Food Quality Assurance-Principles and Practices - Inteaz Ali, CHIPS, Texas.

## **IMF 6009 - FOOD INDUSTRY WASTE MANAGEMENT**

**Module -I: By products of and their utilization from** Cereal (Corn, wheat, rice), Oil-seeds (Groundnut, Mustard, Sunflower, coconut, cottonseed, etc. Pigion pea, black and green gram, bengal gram etc.)

**Module - II: By Product of and their utilization from :**1. Fruits (Apple, grape, papaya, orange, citrus, mango), Dairy (Cream/Butter, Chees/Paneer), Tea leaves, coffee beans, shewnut.

**Module III:** Other important by products : Leather, Gelatin, Adhesives- animal gues, protein based, starch based

**Module IV:** Introduction to Environmental Engineering. Air and Water Pollution and control methods. Solid waste disposal.

**Module -V: Characterization of food industry waste**

BOD, COD, TOD, pH, dissolved O<sub>2</sub>, O<sub>3</sub>, total organic content, types of solids (Floatable, suspended settable), Froth floatation & floatation techniques, sedimentation & screening, types of sedimentation.

**Unit-VI: Biological Oxidation**

Various types of biological reactions occurring in biological oxidation (Methano-genesis, nitrification, denitrification, blame, synthesis, endogenous respiration, photosynthesis type of air diffusers, lagoons, oxidation ditches, rotating biological contactor, trickling filters.

**Unit-VII: Advanced (Tertiary treatment)**

Polishing ponds/ lagoons, DAF techniques, micro filters/strainers, removal of nitrogen, phosphorus, sulphur.

**Books Recommended:-**

1.Environmental Engineering, H. S. Peavy, D.R. Rowe, G. Tchobanoglous Mcgraw Hill.

## **SAF1001 – Advanced Food Microbiology**

**Module I :** Growth and survival of microorganisms in foods; spoilage organisms of milk, fruits, vegetables, grains and oilseeds, meat and poultry; [6]

**Module II:** Physical and chemical methods to control microorganisms. [6]

**Module III:** Biochemical changes caused by microorganisms; Microbes in food fermentation, putrefaction, lipolysis; Antagonism and synergism in microorganisms; [6]

**Module IV:** Food poisoning and food borne infections; Microbial toxins. [6]

**Module V:** Food hygiene and sanitation: Contamination during handling and processing and its control; indicator organisms; Rapid methods in detection of microorganisms.[6]

**Module VI:** Food Fermentations; Traditional fermented foods of India and other Asian countries; Probiotics and prebiotics; Fermented foods based on milk, meat and vegetables; Fermented beverages.

**Module VII:** Preparation and maintenance of cultures, media, reference standard; sterilization techniques; disposal of used cultures and media Detection and detection techniques of microorganism in foods: culture, microscopic examinations, physical, chemical and immunological methods of microbial detection. Bio-burden.

### **Suggested Readings**

1. Banawart GJ. 1989. *Basic Food Microbiology*. 2<sup>nd</sup> Ed. AVI Publ.
2. Frazier J & Westhoff DC. 1988. *Food Microbiology*. 4<sup>th</sup> Ed. McGraw Hill.
3. Garbutt J. 1997. *Essentials of Food Microbiology*. Arnold Heinemann.
4. Jay JM, Loessner MJ & Golden DA. 2005. *Modern Food Microbiology*. 7<sup>th</sup>Ed. Springer.
5. Ray B. 2004. *Fundamentals of Food Microbiology*. 3<sup>rd</sup> Ed. CRC.
6. Robinson RK. (Ed.). 1983. *Dairy Microbiology*. Applied Science.
7. Steinkraus KS. 1996. *Handbook of Indigenous Fermented Foods*. MarcelDekker.

## **SAF1003– Advanced Food Chemistry and Nutrition**

**Module I :** Definition and importance; major food constituents and their physicochemical properties; role of water in food.

**Module II:** Carbohydrates, proteins and lipids: classification, physical, chemical, nutritional, and functional properties and their structural correlations; auto-oxidation of lipids and rancidity.

**Module III:** Properties of minerals, vitamins, pigments, anti-oxidants, flavor components, allergens, toxins and anti-nutritional factors in foods;

**Module IV:** Interaction of constituents in food systems; Changes during storage and processing; Browning reactions in foods.

**Module V:** Food groups and their typical composition; essential nutrients- sources, functions, deficiency diseases; requirements and recommended dietary allowances; Digestion, absorption, transport and metabolism of nutrients in human system; protein quality evaluation.

**Module VI:** Factors affecting bio-availability of nutrients example, nutrient interactions, food components like anti-nutrients etc. Principles of meal planning. Ways to increase nutritional quality of food such as enrichment, fortification, fermentation and mutual supplementation

**Module VII:** Best cooking and processing procedures to reduce cooking losses of nutrients. The nutrition transition in India –Malnutrition-concurrent under and over nutrition. Common nutritional deficiencies such as PEM, iron, vitamin A, iodine, calcium and vitamin D, zinc etc. Emerging common degenerated disorders.

### **Books**

1. Bamji MS, Rao NA & Reddy V. 2003. *Textbook of Human Nutrition*. Oxford & IBH.
2. Belitz HD.1999. *Food Chemistry*. Springer Verlag.
3. DeMan JM. 1976. *Principles of Food Chemistry*. AVI.
4. Fennema OR.1996. *Food Chemistry*. Marcel Dekker.
5. Meyer LH. 1987. *Food Chemistry*. CBS.
6. Swaminathan M. 1974. *Essentials of Foods and Nutrition*. Vol. II. Ganesh & Co.



## **SAF 1005- ADVANCED FOOD ENGINEERING**

**Module I:** Fluid flow in food processing-Newtonian and Non-Newtonian fluids. Measurement of viscosity – Capillary viscometer, rotational viscometer, Fluid moving machinery, Fluid flow measurement, Mixing of liquids

**Module II:** Application of Heat Transfer in Food Processing - Heat transfer by conduction convection and radiation. Steady state and Unsteady state Heat transfer. Heat exchangers. Microwave heating. Food freezing – freezing systems,

**Module III:** Psychrometry principles of drying. Types of Dryers - Tray, tunnel, Puff, Fluidized bed Spray Freeze drying .etc. Evaporation – Boiling point elevation. Types of evaporation.

**Module IV:** Mass Transfer. Diffusion process, Unsteady state Mass transfer. Distillation. Membrane separation, Electro-dialysis, Reverse Osmosis, Ultra filtration- Principles and types of systems

**Module VI:** Supplemental Processes, Filtration, dry and wet methods of solid separation , particle size analysis, screening processes, Sedimentation, Mixing of pastes

**Module VII:** Extrusion processes for foods- principles of extrusion, Extrusion systems – cold extrusion, extrusion cooking, single and twin screw extruders.

### Books:

1. Introduction to Food Engineering,, R. Paul Singh, Dennis R. Heldman, Academic Press, 2009
2. Fundamentals of food process engineering / Toledo, Romeo T. : Aspen Publication, 1999

## **SAF1007-ADVANCED FOOD PROCESSING**

**Module I** :Scope of food processing; historical developments; principles of food processing and preservation

**Module II**: Processing and preservation by heat – blanching, pasteurization, sterilization and UHT processing, canning, extrusion cooking, dielectric heating, microwave heating, baking, roasting and frying, etc.

**Module III**: Processing and preservation by low-temperature- refrigeration, freezing, CA, MA, and dehydro-freezing.

**Module IV**: Processing and preservation by drying, concentration and evaporation-types of dryers and their suitability for different food products; ultra- filtration, reverse osmosis.

**Module V**: Processing and preservation by non-thermal methods, irradiation, high pressure, pulsed electric field, hurdle technology.

**Module VI**: Use and application of enzymes and microorganisms in processing and preservation of foods; food fermentations, pickling, smoking etc;

**Module VII** : Food additives: definition, types and functions, permissible limits and safety aspects.

### **Books**

1. Arsdel WB, Copley MJ & Morgan AI. 1973. *Food Dehydration*. 2<sup>nd</sup> Ed. Vols.I, II. AVI Publ.
2. Desrosier NW & James N.1977. *Technology of Food Preservation*. 4<sup>th</sup> Ed. AVI.Publ.
3. Fellows PJ. 2005. *Food Processing Technology: Principle and Practice*. 2<sup>nd</sup> Ed. CRC.
4. Jelen P. 1985. *Introduction to Food Processing*. Prentice Hall.
5. Potter NN & Hotchkiss 1997. *Food Science*. 5<sup>th</sup> Ed. CBS.
6. Potty VH & Mulky MJ. 1993. *Food Processing*. Oxford & IBH.
7. Ramaswamy H & Marcotte M. 2006. *Food Processing: Principles and Applications*.Taylor & Francis.

## **SAF 2001- CEREALS PULSES AND OIL SEED TECHNOLOGY**

**Module I :**Status, production and major growing areas of cereals, in India and world, Structure and chemical composition of cereals, pulses and oilseeds, Nutrition and anti-nutritional factors.

**Module II:** Wheat Processing: Wheat classification, wheat grain structure quality and milling Functionality of wheat flour components and bakery ingredients.

Rice Processing: Classification, paddy Processing and treatment for quality improvement, Milling and sorting.

**Module III:** By product utilization e.g. Bran: Novel product development – Instant Rice, puffed products etc.

**Module IV:** Coarse Cereals Products: Maize, sorghum, pearl millet and small millets processing and value addition.

Pulses: Pretreatment of pulses for milling, milling of major pulses. Methods to improve recovery.

**Module V:** Oil seeds Processing: Groundnut, Mustard, Soybean, Sunflower, Safflower, Sesame and other oil bearing materials Special Topics: Processing &Utilization of Soya bean for value added products, Sources; chemical composition; physical and chemical characteristics; functional and nutritional importance of dietary oils and fats. Post-harvest handling storage and processing of oil seeds for direct use and consumption.

**Module VI:** Extraction of oil by mechanical expelling and solvent extraction and obtaining de-oiled cakes suitable for edible purposes. Processing of other plant sources of edible oils and fats like coconut, cottonseed, rice bran, maize germ, etc.

Refining: Clarification, degumming, neutralization (alkali refining), bleaching, deodorization techniques / processes. Blending of oils.

Processing of refined oils: Hydrogenation, fractionation, winterization, inter-esterification etc .for obtaining tailor-made fats and oils

**Module VII:** Innovative products from cereals, pulses and oilseeds. Extrusion technology for cereals

### **Books:**

1. Cereal Technology by Kent, CBS
2. Wheat Chemistry and Technology by Y. Pomeranz
3. Post Harvest Technology of Cereals by Chakraborty AC, CRC Press.
4. Cereals and Cereal Processing: Chemistry and Technology DAV Dendy and BJ Dobraczyk
5. Chemistry and Technology of Cereal Food and Feed by S A Matz

## **SAF 2003- NOVEL FOOD PROCESSING AND PACKAGING**

**Module I :** Membrane technology: Introduction to pressure activated membrane processes: micro- filtration, UF, NF and RO and their industrial application. Supercritical fluid extraction: Concept, property of near critical fluids NCF and extraction methods.

**Module II:** Microwave and radio frequency processing: Definition, Advantages, mechanism of heat generation, application in food processing: microwave blanching, sterilization and finish drying. Hurdle technology: Types of preservation techniques and their principles, concept of hurdle technology and its application. Freeze Drying

**Module III:** High Pressure processing: Concept, equipments for HPP treatment, mechanism of microbial inactivation and its application in food processing. Ultrasonic processing: Properties of ultrasonic, application of ultrasonic as processing techniques.

**Module IV:** Newer techniques in food processing: Application of technologies of high intensity light, pulse electric field, ohmic heating, IR heating, inductive heating and pulsed X-rays in food processing and preservation. Nanotechnology: Principles and applications in foods.

**Module V:** Objectives and importance of extrusion in food product development; Components and functions of an extruder; Classification of extruder; Advantages and disadvantages of different types of extrusion; Change of functional properties of food components during extrusion; Pre and post extrusion treatments; Use of extruder as bioreactor; Manufacturing process of extruded products; Application of extrusion technologies in food industries.

**Module VI:** Packaging material and their selection – paper, polymers, metallic glass. Types of packaging. Current use of novel packaging techniques, Oxygen, ethylene and other scavengers, Oxygen scavenging technology, Ethylene scavenging technology, Carbon dioxide and other scavengers, Antimicrobial food packaging: Constructing an antimicrobial packaging system,

**Module VII:** Novel MAP applications for fresh-prepared produce, Novel MAP gases, Testing novel MAP applications, Applying high O<sub>2</sub> MAP.

### **Suggested Readings**

1. Barbosa-Canovas 2002. *Novel Food Processing Technologies*. CRC.
2. Dutta AK & Anantheswaran RC.1999. *Hand Book of Microwave Technology for Food Applications*.
3. Frame ND. (Ed.). 1994. *The Technology of Extrusion Cooking*. Blackie
4. Gould GW. 2000. *New Methods of Food Preservation*. CRC.
5. Shi J. (Ed.). 2006. *Functional Food Ingredients and Nutraceuticals: Processing Technologies*. CRC.

## **SAF 2005 - FOOD LAWS, STANDARDS AND REGULATIONS**

**Module-I:** Introduction, concept of food safety and standards, food safety strategies. Food hazards and contaminations - biological (bacteria, viruses and parasites), chemical (toxic constituents / hazardous materials) pesticides residues / environmental pollution / chemicals) and physical factors. Preventive food safety systems -monitoring of safety, wholesomeness and nutritional quality of food.

**Module – II:** Prevention and control of microbiological and chemical hazards. Food safety aspects of novel methods of food processing such as PEF, high pressure processing, thermal and non thermal processing, irradiation of foods.

**Module – III:** Indian and Food Regulatory Regime (Existing and new), PFA Act and Rules, Food Safety and Quality Requirements, Additives, Contaminants and Pesticide Residue. Food Safety and Standards Act, 2006, Essential Commodities Act, 1955, Global Scenario, Codex Alimentarius, WHO/FAO Expert Bodies (JECFA/JEMRA/JMPR) WHO/FAO Expert Bodies (JECFA/ JEMRA/JMPR).Food safety inspection services (FSIS) and their utilization.

**Module IV:** Introduction to OIE & IPPC, Other International Food Standards (e.g. European Commission, USFDA etc). WTO: Introduction to WTO Agreements: SPS and TBT Agreement, Export & Import Laws and Regulations, Export (Quality Control and Inspection) Act, 1963.

**Module V:** Customs Act and Import Control Regulations, Other Voluntary and mandatory product specific regulations, Other Voluntary National Food Standards: BIS Other product specific standards; AGMARK. Nutritional Labeling, Health claims.

**Module VI:** Risk assessment studies: Risk management, risk characterization and communication.

**Module VII:** Voluntary Quality Standards and Certification GMP, GHP, HACCP, GAP, Good Animal Husbandry Practices, Good Aquaculture Practices ISO 9000, ISO 22000, ISO 14000, ISO 17025, PAS 22000, FSSC 22000, BRC, BRCIOP, IFS, SQF 1000, SQF 2000. Role of NABL, CFLS.

### **Books:**

1. Singal RS (1997). Handbook of indices of food quality and authenticity. Woodhead Publ. Cambridge, UK.
2. Shapton DA (1994). Principles and practices of safe processing of foods. Butterworth Publication, London. Winton AL (1999)Techniques of food analysis, Allied Science Publications NewDelhi.
3. Pomeranze Y (2004). Food analysis - Theory and Practice CBS Publications, New Delhi.
4. Jacob MB (1999). The chemical analysis of foods and food products. CBS Publ. New Delhi

## **SAF 2007 -FOOD STORAGE AND TRANSPORTATION**

**Module I :** Food science and the transport of food : Composition of food, Chemical reactions in foods, Physical changes in foods: crystallization phenomena, Microbiology and food transportation.

Characteristics of bacterial growth - the use of modeling, Controlled and modified atmosphere transportation, Taints, Transport of animals.

Logistics of food transport: Importance of logistics, The food industry, Key logistics trends and supply chain relationships in the food industry. Food transport case studies.

Land transport of food: principal elements and current practice: Brief history, The transport medium-decision making parameters, The supply chain, In-transit refrigeration, Refrigeration developments, Beyond refrigeration, Loading vehicles and containers, Selecting transport.

**Module II:** Transport of food stuffs by sea: Cooling of cargo in transit, Conventional refrigerated ships, Containerships, Need for refrigeration.

Air transport of perishables: Cargo space, Unit load, devices: containers and pallets, Temperature regulation within the cargo, Expendable refrigerants: dry ice and water ice, Carton design, Temperature protection, Documentation, temperature monitoring Recommendations.

Transport of fruit and vegetables: Post-harvest behavior of fruit and vegetables, Pre-cooling and the cold chain, Product requirements during transport, Storage temperature management.

Transport of oils and fats: Quality problems arising in transport, Transport at sea, Transport on land.

Transport of dairy product: Main dairy product types, Packaging, Manufacture and storage, Product deterioration, Land transport, Shipping, Air freight. Insurance,

**Module III:** Hygiene in food transport: Basic hygiene requirements, Shipping container loading, Inspection of incoming carriers, Quality systems in food transportation, Quality and safety in food transportation, History of quality management in food transportation, Standards for quality systems, Benefits of implementing a quality management system, Clauses of ISO9002,HACCP: A food safety management system.

Legislation and food transport: Legislation-food, Legislation-transport

**Module IV:** Distribution of chilled and frozen foods : Loading disciplines, Overnight standing and noise difficulties, Thermographs and temperature monitoring equipment, Temperature measurement, Calibration, Refrigerated vehicles, Foodstuffs carried, Transport refrigeration requirements, Refrigeration methods, Insulation, Pre-cooling the product, Design and specification,

**Module V:** Stored Product Quality : Open Dating and Temperature Monitoring. Quality Management during Storage and Distribution. Freezing Preservation of Fresh Foods: Quality Aspects. Quality Changes During Distribution of Deep Frozen and Chilled Foods : Distribution Chain Situation and Modeling Considerations. Technologies to Extend the Refrigerated Shelf-Life of Fresh Fruits and Vegetables. Ambient Storage. Toxicological Implications of Post-Processing In-Storage or Shipped Foods. Consumer Attitudes and Perceptions.

Facilities for the Cold Chain: Freezing Methods and Equipment, Cold Store Design and Maintenance, Transportation of Frozen Foods, Retail Display Equipment and Management, Household Refrigerators and Freezers, Monitoring and Control of the Cold Chain.

**Module VI:** Food Transport: Controlled Atmosphere: The Biology of Controlled Atmospheres, Techniques in Controlled Atmosphere Storage, Modified Atmosphere Packaging. Food Storage, Handling & Transportation: Bulk storage system: Metallic bins,

silos, intermediate bulk containers - fabrication, types, functional properties, its application, impact of storage condition on quality of food products, cold storage of fresh produce.

**Module VII:** Handling and transportation: Mechanical handling system, palletisation, containerization, ULD, different mode of transportation-its advantages and disadvantages, cool chain of food products, requirement of marking on transport packages.

Testing of package durability and compatibility for physical distribution. Modes of transportation.

Refrigerated storage: Factors of importance in refrigerated storage. Food storage requirement Cold storages and frozen storage for food products and vapour barriers for cold stores. Refrigerated warehouse, refrigerated trucks, trailers and containers. Railways refrigerated cars, marine refrigeration, and refrigeration in air transport

**Books:**

1. Fruits and Vegetables. A.K Thompson. Blackwell publishing
- S. Ranganna, Hand Book of Analysis and Quality Control for Fruits and Vegetable Products, Tata McGraw Hill, 2002.
2. S. Ranganna, Hand Book of Canning and Accepting Packaging, Tata McGraw Hill, 2000.
3. L. Somogyi, Processing Fruits: Science and Technology, Vol I : Biology Principles and Applications, Woodhead Publishing,1996.
4. L. Somogyi, D.M. Barette and Y.H. Hui, Processing Fruits: Science and Technology, Vol II: Major Processed Products, Woodhead Publishing, 1996.
5. Y. H. Hui, S. Ghazala, D.M. Graham, K.D. Murrell and W.K.Nip, Handbook of Vegetable Preservation and Processing, Marcel Dekker,2003.

**SAF2009- SAF2027-- Elective I**



## **SAF 3001- Food Business Management**

**Module I:** introduction to Business Organisation, Overview of Basic Management Functions & Executive Functions.

**Module II:** Human Resource Management: Manpower Planning, Recruitment, Selection & Training manpower for Food Businesses.

Consumer Behavior: Food Consumption Behavior, Marketing research for Food Market, Secondary data sources for Food Market and Food Industry

**Module III:** International trade; Basics, classical theory, theory of absolute advantage. theory of comparative, modern theory, free trade- protectionism, methods of protection, quotas, bounties, exchange control, devaluation, commercial treaties, terms of trade, balance of payments, EXIM policy, foreign exchange, mechanics of foreign exchange, GATT, WTO, role of WTO, International Trade in agriculture.

**Module IV:** World trade agreements related with food business, export trends and prospects of food products in India.

**Module V:** World consumption of food; patterns and types of food consumption across the globe. Ethnic food habits of different regions. Govt. institutions related to International ad trade; APEDA, Tea board, spice board, wine board, MOFPI etc.

**Module VI:** Management of export import organization, registration, documentation, export import logistics, case studies. Export and import policies relevant to horticultural sector.

**Module VII:** Entrepreneurship Development: Assessing overall business environment in the Indian economy, Concept of Entrepreneurship, entrepreneurial and managerial characteristics; motivation and entrepreneurship development; importance of planning, Budgeting monitoring, evaluation and follow up; managing competition.

Entrepreneurship Development Programs (EDP). SWOT analysis; Generation, incubation and commercialization of ideas and innovations. Government schemes and incentives for promotion of entrepreneurship. Government policy on small and Medium Enterprises (SMEs)/ Small Scale industries (SSIs). Venture capital, contract farming and joint ventures. public-private partnership (PPP). Over view of Food Process Industry. Characteristics of Indian Food Processing Industry. Social Responsibility of Food Processing Business.

### **Books:**

1. Principles of Agri Business Management - D. David and S Erickson 1987. Mc Graw Hill Book Co., New Delhi.
2. Agricultural Marketing in India - Acharya S S and Agarwal N L 1987. Oxford & ISH Publishing Co., New Delhi.
3. Marketing in the International Environment - Cundiff Higler 1993, Prentice Hall of India, New Delhi.
4. GAD implications of Denkel proposals - G S Batra & Narindev kumar (1994) Azmol Publications Pvt., New Delhi.
5. Marketing Management - Phill Kotler 1994 Prentice Hall of India, New Delhi.

## **SAF 3003- AUTOMATION IN FOOD PROCESSING INDUSTRY**

**Module I :** Measurement system and error analysis, measurement of level, flow, temperature, strain pressure, vacuum, force, torque, power, displacement, vibration, acceleration, pH, colour viscosity, surface tension and composition. Indicating recording instruments, digital displays, transmitting and telemetering devices.

**Module II :** Introduction to control system- Feedback and feed forward control strategies, block diagrams, Mode of control and generation of control action; P, PI and PID control elements and valve positioners, Electronic, pneumatic and hydraulic control systems and their application in farm machinery, food processing industry, aquaculture and their applications milk processing plants.

**Module III:** Introduction: electronic nose, food quality evaluation, indication variables, Data acquisition, elastography, electronic nose, ultrasonic, Data analysis, intramuscular fat, wavelet, marbled meat, statistical textural feature extraction from, elastography, Sampling, concept and system for data acquisition, image acquisition, ultrasonic B- mode imaging. Data Analysis – Data processing, Dynamic data analysis, Image processing.

**Module IV:** Modeling system identification, Modeling strategy, linear statistical modeling, ANN Modeling,

**Module V :** F statistic, null hypothesis Prediction Levenberg-Marquardt algorithm, recurrent neural networks, gradient descent. Control objective function, neuro-fuzzy, membership functions Systems integration assembly language, high-level programming language.

**Module VI:** System integration, Robotics, Application of robotics and basic components of robotics, Features of II and II generation robots.

**Module VII:** Bottle Washing Machine Automaton, Bottling Plant Drive System, Demineralization Plant Control System, Labeling Machine Control system, Charger level automation, Reverse Osmosis plant automation, Thermal plant automation, Dehydration and freezing pant automation.

Automation in different units of food processing, preparation of raw food and materials, sorting, grading, size reduction, mixing an agitation, thermal processing, dehydration, packaging, CIP, quality control.

### **Books:**

1. Considine 2001. *Process Control*. AVI Publ.
2. Huang Y & Lacey RE. 2003. *Principles of Robotics*. CRC Press.
3. Huang Y, Whittaker AD & Lacey RE. 2001. *Automation for FoodEngineering*. CRC Press.

## **SAF 3005- FOOD PRODUCT DEVELOPMENT AND SENSORY EVALUATION**

**Module I :** New Food Products: Definition, Classification, Characterization, Factors shaping new product development- Social concerns, health concerns, impact of technology and market place influence.

**Module II :** Market Survey, Consumer survey to identify new products in terms of Line Extension Repositioning Existing Products New form/Reformulation. New packaging of existing products Innovative products, Creative Products. Tapping traditional foods and unconventional sources of foods. Minimizing post harvest losses. Identification of concept & product for development, Market research for the concept and selected product, Identification of products, selection of one product and its standardization improving success.

**Module III:** Bulk preparation of product, Packaging and Labeling of the product, Packaging design, graphics and labeling nutritional evaluation (estimation of relevant parameters), Shelf life testing of the product (testing for appropriate quality parameters- chemical, microbiological and nutrient content, acceptability studies), Product integrity and conformance to standard, Costing the product and determining the sales price, Advertising and test marketing the product, Report preparation.

**Module IV:** Overview of sensory principles and practices: General consideration in sensory testing, flowcharts of sensory evaluation. Anatomy, physiology and function of various senses.

**Module V:** Psychological methods Selection and screening of panel: Types of panel (Trained panel, discriminative and communicative panel). Methodology for sensory evaluation: Discriminative test - difference test: paired comparison, Duo-trio, triangle, ranking, Sensitivity Test, Descriptive test - category scaling, ratio scaling, flavor profile analysis, texture profile analysis, quantitative descriptive analysis.

**Module VI:** Effective Tests: paired performance test, ranking test, rating scale: hedonic rating, food action scale rating. Maintaining suitable environmental conditions: laboratory setup and equipment

**Module VII:** Sample preparation, Basic statistical concepts for sensory evaluation: Hypothesis testing and sensory inference, variation of T Test, Nonparametric and binomial based, Statistical methods, Chi-square test, analysis of variation, Correlation regression.

### **Books:**

1. Lyon, D.H.; Francombe, M.A.; Hasdell, T.A.; Lawson, K. (eds) (1992): Guidelines for Sensory Analysis in Food Product Development and Quality Control. Chapman and Hall, London.
2. Amerine, M.A.; Pangborn, R.M.; Roessler, E.B.(1965): Principles of Sensory Evaluation. Academic Press, New York.
3. Kapsalis, J.G. (1987): Objective Methods in Food Quality Assessment. CRC Press, Florida.
4. Martens, M.; Dalen, G.A.; Russwurm, H. (eds)(1987): Flavour Science and Technology. John Wiley and Sons, Chichester.
5. Moskowitz, H.R. (eds) (1987): Food Texture: Instrumental and Sensory Measurement. Marcel Dekker Inc. New York.

## **SAF 3007- ANIMAL PRODUCT TECHNOLOGY**

**Module I :** Sources of meat and meat products in India, its importance in national economy. Chemical composition and microscopic structure of meat. Effect of feed, breed and management on meat production and quality. Slaughtering of animals and poultry, inspection and grading of meat.

**Module II :** Factors affecting post-mortem changes, properties and shelf life of meat. Meat quality evaluation. Mechanical deboning, meat tenderization. Aging, pickling and smoking of meat. Meat plant sanitation and safety, Byproduct utilization.

**Module – III:** Poultry: classification, composition, preservation methods and processing. Structure, composition, nutritive value and functional properties of eggs and its preservation by different methods. Processing of egg products. Factor affecting egg quality and measures of egg quality

**Module – IV:** Types of fish, composition, structure, post-mortem changes in fish. Handling of fresh water fish. Canning, smoking, freezing and dehydration of fish. Preparation of fish products, fish sausage and home makings. Fish products - production of fish meal, fish protein concentrate, fish liver oil and fish sauce and other important byproducts; Quality control of processed fish; Fish processing industries in India

**Module – V:** Milk Processing Milk Processing flow sheet – Filtration / clarification, Storage of milk, Standardization – simple problems in standardization, Homogenization, Pasteurization – Types of pasteurization process. Equipments used in each process - Cream separating centrifuges, Pasteurizers (Heat Exchangers), Homogenizers, Bottle and pouch fillers, Milk Chillers, Plant piping, Pumps.

**Module – VI:** Manufacture of Dairy Products Manufacture of Cream, Butter, Ghee, Milk powder, Cheese – Types and Defects in cheese Quality aspects of these products. Equipments used for manufacture of each product like Butter churn, ghee boiler, Spray and Drum Dryers, Product in sanitizing equipment etc.

**Module – VII:** Manufacture of Ice Cream and other Dairy Products - Manufacture of Ice cream – Chemistry and technology – Microbiology of ice cream – Quality aspects. Manufacture of paneer, Toned Milk, Sweetened Condensed milk, Khoa.

Fermented dairy products: Fermented products – Yoghurt, Curd, acidophilus milk, butter milk. Dairy plant sanitization – Cleaning in place – bottle and can washing, cleaning of tankers and silos – Detergents and sanitizers used.

Energy use in Dairy plant - sources and cost of energy, Control of energy losses and Energy conservation. Quality control of milk and milk products; Milk plant hygiene and sanitation

### **Text Books:**

1. Lawrie, R.A. 1975. Meat Science, 2nd Ed. Pergamon Press, Oxford UK.
2. Vijaya Khader, 2001, “A Textbook of Food Science and Technology”, ICAR, New Delhi
3. Modern Dairy Products, Lampert LH; 1970, Chemical Publishing Company.

### **References:**

1. Developments in Dairy Chemistry – Vol 1 & 2; Fox PF; Applied Science Pub Ltd.
3. Milk & Milk Processing; Herrington BL; 1948, McGraw-Hill Book Company.
4. Portsmouth, J.I. 1979, Commercial Rabbit Meat Production. 2nd Ed. Saiga Survey, England

**SAF3009- SAF3027-- Electives-II**

## Electives-I

### SAF 2009-POST HARVEST TECHNOLOGY & COLD CHAIN MANAGEMENT

**Module – I:** Importance & scope of post harvest management of fruits and vegetables in Indian economy. Morphology, structure and composition of fruits and vegetables; maturity indices and standards for selected fruits and vegetables; methods of maturity determinations.

**Module - II :** Harvesting and handling of important fruits and vegetables, Harvesting tools and their design aspects ;Field heat of fruits and vegetables and primary processing for sorting and grading at farm and cluster level; factors affecting post harvest losses; Standards and specification for fresh fruits and vegetables.

**Module –III :** Post harvest physiological and biochemical changes in fruits and vegetables; ripening of climacteric and non-climacteric fruits; regulations, methods; Storage practices :CA and MA, hypobaric storage, pre-cooling and cold storage, Zero energy cool chamber; Commodity pretreatments- chemicals, wax coating, prepackaging, VHT and irradiation.

**Module - IV:** Physiology post harvest disorders – chilling injury and disease; prevention of post harvest diseases and infestation; Handling and packaging of fruits and vegetables; Post Harvest handling system for fruits and vegetables of regional importance citrus, mango, banana, pomegranate, tomato, papaya and carrot etc., packaging house operations; principles of transport and commercial transport operations.

**Module –V:** Fundamentals of Freezing: Glass transition in frozen foods and biomaterials, Microbiology of frozen food, thermo physical properties of frozen food, freezing loads and freezing time calculations, innovations in freezing process. Facilities for the cold chain: Freezing methods and equipment, cold storage design and maintenance, transportation of frozen foods, retail display equipment and management, house hold refrigerators and freezers, monitoring and control of cold chain.

**Module - VI:** Quality and safety of frozen foods: Quality and safety of frozen meat and meat products, quality and safety of frozen poultry and poultry products. Quality and safety of frozen fish, shell fish and related products, Quality and safety of frozen vegetables, Quality and safety of frozen fruits, Quality and safety of frozen dairy products, Quality and safety of frozen ready me a Quality and safety of frozen bakery products, Quality and safety of frozen eggs and egg products.

**Unit –VII:** Monitoring and measuring techniques for quality and safety: Chemical measurements, sensory analysis of frozen foods, food borne illnesses and detection of pathogenic microorganisms, shelf life prediction of frozen foods. Packaging of frozen foods.

#### **Text books:**

1. Lal, G., Siddappa, G. and Tondon G.L.: Preservation of Fruits and Vegetables, Indian Council of Agricultural Research, New Delhi. (1986).
2. Vijaya Khader, “Textbook of Food Science and Technology”, ICAR, New Delhi (2001).
3. S Cohen and J Roussel, Strategic Supply Chain Management : The five disciplines for top performance, McGraw-Hill Co, (2004).

#### **Reference books:**

1. N Lewis, The Cold Chain, Hamish Hamilton (1988).

## **SAF 2011-BEVERAGE & SNACK FOOD TECHNOLOGY**

**Module I :** Juice Processing: Present status of juice processing in India & Abroad. Types of beverages and their importance ; status of beverage industry in India; Manufacturing technology for juice- based beverages; synthetic beverages; technology of still, carbonated, low calorie and dry beverages; isotonic and sports drinks. Recent advances in juice processing technology. Fruits & its processing: Harvesting and pre-processing consideration, Post harvest processing, washing, skin removal, cutting and trimming, blanching, canning, freezing & dehydration of fruits, Fruit Processing: Freezing, blanching, ascorbic acid dip, SO<sub>2</sub> dip, sugar syrup preservation, salt preservation, vacuum dehydration, concentration and drying, Application of membrane technology in processing of juices, Juice Processing: Orange juice, Grape fruit juice, Lemon & Lime juice, Pine apple juice, Apple juice, Mango juice.

**Module II :** Fruits Beverages & other processing: Fruit Beverage, Orange squash, Grape fruit squash, Lemon squash, Orange squash, Pine apple squash, Syrups, Rose, Sandal, pine apple, orange, mulberry & apple, Carbonated beverage, Lemon, lime, pine apple, Fruit juice concentrate, Tamarind Juice Concentrate and Fermented Beverages, Miscellaneous, fruit juices, tropical fruit beverages, Nectars, pulpy juices, tropic blends, Beverages- Classification, Scope, Manufacture of carbonated non alcoholic beverages.

**Module III:** Equipments & tools for juice extraction: Equipments for fruit juices, Washing equipment, sorting equipment, extraction equipment, Halving & burring machine, Roller type Press, Crusher for grape berries, Pulping equipment, Straining & screening, filtration equipment, De-aerator & flash Pasteurizer.

**Module IV:** Role of various ingredients of soft drinks, carbonation of soft drinks. Specialty beverages based on tea coffee, cocoa, spices, plant extracts, herbs, nuts, dairy and imitation dairy –based beverages. Alcoholic beverages- type, manufacture and quality evaluation; the role of yeast in beer and other alcoholic beverages, ale type beer, lager type beer technology of brewing process, equipment used for brewing and distillation, wine and related beverages, distilled spirits.'

### **Unit -V**

Packaged drinking water- definition, types, manufacture and quality evaluation and raw and processed water, methods of water treatment, BIS quality standards of bottled water; mineral water, natural spring water, flavoured water, carbonated water.

### **Unit-VI**

Technology for snacks based on:

Grain: whole grains – roasted, toasted, puffed, popped, and flakes, coated grains- salted, spiced and sweetened.

Flour : – batter and dough products; savory and farsons; formulated chips and wafers, papads, instant premixes of traditional Indian snack foods.

Fruit and vegetable based snacks: Chips, wafers; Technology for coated nuts- salted, spiced and sweetened chikkis.

**Module VII:** Extruded snack foods: Formulated and processing technology, colouring, flavouring and packaging. Equipments for frying, baking and drying, toasting, roasting and flaking, popping, blending, coating, chipping .

### **Text books:**

1. Extrusion of Food, Vol 2; Harper JM; 1981, CRC Press
2. Bakery Technology & Engineering; Matz SA; 1960; AVI Pub.
3. Desrosier NW & JamesN. 2004. *The Technology of Food Preservation*. 4<sup>th</sup>Ed. CBS.

4. Lal G, Siddappa GS & Tandon GL. 1998. *Preservation of Fruits andVegetables*. ICAR.
5. Nelson PE & Tressler DK.1980. *Fruit & Vegetable Juice ProcessingTechnology*. Vol. III. AVI Publ.
6. Potter NN.1978. *Food Science*. 3rd Ed. AVI Publ



## **SAF 2013-RENEWABLE ENERGY FOR FOOD PROCESSING**

**Module I: Energy** for Food Processing: Concerns of the current millennium, Renewable Energy Utilization, desirability, feasibility and the niches. Integrated Renewable Energy Sources for Process heat availability.

**Module II:** Solar energy resources, solar thermal and solar photovoltaic technology for Electricity and process heat, Solar cell technologies for decentralized energy generation.

**Module III:** Elements of passive solar architectural and solar active system for refrigeration and cooling, Solar Cooker Solar drying of fruits and vegetables, Hybrid solar dryer for industrial applications, solar furnaces and concentrators.

**Module IV: Overview** of wind energy developments, wind turbine technology & its utilization for process heat and electricity generation.

**Module V:** Bio energy resource, Briquetting and incineration. Incinerator design.

**Module VI:** Biomass conversion sources viz Gasification systems for process heat, biogas for electricity and other industrial energy, ethanol fermentation, liquid fuel from biomass (process, chemistry and technologies), complete combustion technology, improved cook stoves & furnace technology.

**Module VII:** Energy Audit of Food Processing Industries.

### **Suggested Readings**

1. Hordeski MF. 2004. Dictionary of Energy Technologies. CRC Press.
2. Kreith F & Goswami D. 2007. Handbook of Energy Efficiency and Renewable Energy. CRC Press.
3. NIIR Board. 2001. Modern Technology of Agro Processing & Agricultural Waste Products. National Institute of Industrial Research Publ.
4. Rathore NS & Panwar NL. 2007. Renewable Energy for Sustainable Development. New India Publ. Agency.
5. Teri 1993. Rays of Hope: Renewable Energy for Sustainable Development. Tata Energy Research Institute, New Delhi.

## **SAF 2015-FOOD SCIENCE AND TECHNOLOGY**

**Module I :** Microbiology and its significance; Brief history of microbiology; Prokaryotes and Eukaryotes morphology; structure and function of microbial cells and their components; mode of reproduction in microorganisms. Major groups of microorganisms: Role of bacteria, fungi and viruses in foods; Growth cycles, growth patterns;

**Module II:** Physical and chemical factors affecting growth and destruction of microbes-aerobes and anaerobes, psychrophiles, psychrotrophs, mesophiles, thermophilic, thermophiles, halophiles osmophiles and spore formers.

**Module III:** Introduction to food chemistry; Definition, Proximate composition of foods; Functions of various food constituents in brief. Carbohydrates: Definition, classification, structure of monosaccharides, disaccharides, oligosaccharides polysaccharides (starch, glycogen, cellulose, hemi-cellulose, lignins, pectins, gums and mucilages);

**Module IV:** Lipids: Definition, classification, structures, physical and chemical properties of lipids and fatty acids, Proteins: Amino-acids - definitions, classification, essential and non-essential amino-acids, structures and properties; peptides - peptide bonds and some important peptides;

Vitamins: structures and functions in brief. Minerals: Occurrence and functions in brief. Enzymes - general characteristics, enzymes in food processing.

**Module V:** Concepts and trends in food legislation. International and federal standards: Codex alimentations, ISO series,

Quality factors: appearance, texture and flavor, Appearance factors – size and shape, colour , consistency. Textural Factors – measuring texture, texture changes. Flavour Factors – influence of colour and texture on flavor.

**Module VI:** Food – related hazards – biological, chemical and physical hazards, trace chemicals. Microbiological considerations in food safety.

Prevention of Food Adulteration Act-1954.Food safety and Standards Act-2006.Food Safety and Management Systems- FSMS-22000.

**Module VII :**International Food, Standards and Codex Alimentarius, HACCP and ISO 9000 series ,FPO, Agmark ,BIS,FAO, WTO. History and evaluation of IPR; Patent rights/protection and procedure; Infringement or violation; Remedies against infringement; Indian Patent Act 1970

### **Books:**

- 1.Black, JG. 2005. *Microbiology: Principles and Explorations*.
2. John Wiley Frobisher M. 1968. *Fundamentals of Microbiology*.
3. Hans G. 1986. *General Microbiology*. Cambridge Univ. Press.
4. Fennema, OR. Food Chemistry, McGraw Hill.
5. Belitz, HD and Grosch, W (1987), Food Chemistry, Springer Verlag.
6. Meyer LH (1960), Food Chemistry, AVI, New York.
- 7.Santaniello, Evenson, Ziberman, Carlson – Agriculture and Intellectual Property Rights, Univ. Press, 1998
8. S. K. Chakraborty : Values and Ethics in Organization, OUP
9. A. N. Tripathi : Human Values, New Age International

## **SAF 2017-NUTRACEUTICALS & HEALTH FOODS**

**Module I:** Introduction to Nutraceuticals: definitions, synonymous terms, basis of claims for a compound as a nutraceutical, regulatory issues for Nutraceuticals including CODEX.

**Module II :**Concept of angiogenesis and the role of Nutraceuticals/functional foods; Nutraceuticals for cardiovascular diseases, cancer, diabetes, cholesterol management, obesity, joint pain, immune enhancement, age-related macular degeneration, endurance performance and mood disorders – compounds and their mechanisms of action, dosage levels, contraindications if any etc.

**Module III:** Manufacturing aspects of selected Nutraceuticals such as lycopene, isoflavonoids, prebiotics and probiotics, glucosamine, phytosterols etc.; formulation of functional foods containing Nutraceuticals – stability and analytical issues, labeling issues.

**Module IV:** Clinical testing of Nutraceuticals and health foods; interactions of prescription drugs and nutraceuticals; adverse effects and toxicity of nutraceuticals; nutrigenomics – an introduction and its relation to nutraceuticals.

**Module V:** Value addition in food products using secondary metabolites of therapeutic importance- alkaloids, steroids ,isoflavones etc.

**Module VI:** Nutraceuticals preservation. Evaluation and standardization.

**Module VII:** Toxicity in food products. Stability and evaluation of toxicity.

### **Suggested Readings**

1. Brigelius-Flohé, J & Joost HG. 2006. *Nutritional Genomics: Impact on Health and Disease*. Wiley VCH.
2. Cupp J & Tracy TS. 2003. *Dietary Supplements: Toxicology and Clinical Pharmacology*. Humana Press.
3. Gibson GR & William CM. 2000. *Functional Foods - Concept to Product*
4. Goldberg I. 1994. *Functional Foods: Designer Foods, Pharma Foods*.
5. Losso JN. 2007. *Angi-angiogenic Functional and Medicinal Foods*. CRC Press.
6. Manson P. 2001. *Dietary Supplements*. 2<sup>nd</sup> Ed. Pharmaceutical Press.
7. Campbell JE & Summers JL. 2004. *Dietary Supplement Labeling Compliance*.
8. Neeser JR & German BJ. 2004. *Bioprocesses and Biotechnology for Nutraceuticals*. Chapman & Hall.
9. Robert EC. 2006. *Handbook of Nutraceuticals and Functional Foods*. 2<sup>nd</sup> Ed. Wildman.
10. Shi J.(Ed) 2006. *Functional Food Ingredients and Nutraceuticals: Processing echnologies..* CRC.
11. Webb GP. 2006. *Dietary Supplements and Functional Foods*. Blackwell Publ.

## **SAF 2019- OILS AND FATS TECHNOLOGY**

**Module –I :** Sources and Biological significance of lipids, classification, occurrence, chemical and physical characteristics of lipids: Triglycerides and phospholipids; emulsions and emulsifiers; Inter-esterifications. Industrial fats and oils, shortenings, salad oils, margarine, non-caloric fats; standard and quality control, packaging and storage of fats and fatty foods. Changes during processing and storage of oils and fats, polymorphism, rancidity and reversion.

**Module -II:** Post-harvest handling storage and processing of oil seeds for direct use and consumption. Extraction of oil by mechanical expelling and solvent extraction and obtaining deoiled cakes suitable for edible purposes. Processing of other plant sources of edible oils and fats like coconut, cottonseed, rice bran, maize germ, etc.

**Module –III:** Refining: distillation for separation of oil and solvent, design concept for solvent extraction system for oil bearing material, physical and chemical refining of oils, hydrogenation. Clarification, degumming, neutralization (alkali refining), bleaching, deodorization techniques / processes. Blending of oils.

**Module – IV :** Processing of refined oils: Hydrogenation, fractionation, winterization, inter-esterifications etc. for obtaining tailor-made fats and oils. Special uses of fat for several foods, like chocolate, bread, biscuit, mayonnaise, salad, frying, etc. Non conventional edible oils, oil seed cakes and meal utilization:

**Module—V:** Production of butter oil, lard, tallow, Margarine, Cocoa butter equivalents, shortenings, low fat spreads, peanut butter etc. Speciality fats and designer lipids for nutrition and dietetics, especially by biotechnology.

**Module VI:** By-products of oils and fats processing industries, manufacturing techniques for glycerin, soaps, detergents, polishes and paints. Oleoresins and essential oils-its physical and chemical characteristics, extraction methodology and down-stream processing, application, storage, packaging and analysis of oleoresin and essential oils;

**Module VII:** Toxicity and safety of Fats and oils

### **Books:**

1. Bailey's Industrial Oil & Fat Products, 4th ed. John Wiley & Sons.
2. The Industrial Chemistry of Fats & Waxes 3rd. by Balliere, Tindall & Cox.
3. Handling & Storage of Oilseeds, Oils, Fats & Meal by Paterson, HBW.
4. Modern Technology in the Oils & Fats industry by S.C. Singhal, OTA (I).

## **SAF 2021-FOOD BIOTECHNOLOGY**

**Module I :** Basic principles of Gene cloning, Food safety and biotechnology- Impact of Biotechnology on microbial testing of foods, New challenges, Immunological methods, DNA based methods in food authentication, Real time PCR based methods. Biological role of DNA in cell metabolism, Molecular genetics i.e. fundamentals of molecular biology with special reference to chemistry and biology and DNA, (Primary secondary and tertiary) structures. Genetic recombination mechanisms and technique used for improvement in microbial strains. Recombinant-DNA technology (plasmids and cloning), Expression of foreign genes, Promoters (Enzyme),

**Module II :** Transgenic Plants - Current status, methods, prospects, risks and regulation. Transgenic Animals - Methods and applications, ethical issues.

**Module III:** Control Of Micro-Organisms – Bacteriocins of Lactic acid bacteria, applications of bacteriocins in food systems. Aflatoxins –production, control and reduction using molecular strategies, antagonistic microbes. Biomass production by using various micro organisms.

**Module IV:** Protein Engineering In Food Technology – Methods, objectives, limitations and applications of protein engineering (e.g. Glucoseisomerase, Lactobacillus  $\alpha$ -galactosidase and peptide antibiotic nisin).

**Module V :** Biotechnology And Food Ingredients – Biogums, fats, oils, fatty acids and oilseed crops, fat substitutes, citric, fumaric and malic acids, Bioflavors and biocolors,

**Module VI:** Traditional fermented foods, Soya based oriental fermented foods. Applications of genetically control mechanism in industrial fermentation process, (Induction, manipulation and recombination).

**Module VII:** Cell and tissue culture, Continuous cultures, Secondary metabolites synthesis. Transducers And Biosensors In Food - Principle, types and applications in food processing.

Books:

1. Lee, B.H. (1996). Fundamentals of Food Biotechnology, VCH Publishers.
2. Tombs, M.P. (1991). Biotechnology in Food Industry, Open University Press, Milton Keynes.
3. V. K. Joshi and Ashok Pandey ( 1999 ) . Biotechnology- Food fermentation, Volume 1&2 Educational publishers and Distributors.
4. Schwartzberg, A & Rao (1990). Biotechnology & Food Process Engineering, Marcel Dekker, INC, New York

## **SAF 2023-AGROCHEMICALS AND RESIDUES IN FOOD**

**Module I** : Agrochemicals in Agriculture including growth regulators – purpose, classification and methods of dispensing them, characteristics, and estimations

**Module II** : Agrichemicals – Pesticide, Insecticides, Attractants and Repellent, Fumigants, Nematocides, Miticides, rodenticides, Fungicides, Analysis of Residues in foods.

**Module -III** : Agrochemical residues – Pesticides, fungicides, herbicides, permitted levels and toxicity details, methods to remove these residues.

**Module – IV** : Fumigants other chemicals used in grain/spices storage – purpose, chemicals used and toxicity, Ripening agents- types, uses, effects and residue evaluation.[6]

**Module - V** : Veterinary drugs including antibiotics and hormones- purpose of use, classification, residue levels and its associated hazards and toxicity.

**Module - VI** : Uptake of agrochemicals from soil, water, environment, packaging by plant foods,

**Module –VII:** Concept of organic farming and systems.

### **Books:**

1. GT (Ed) 1999. Pesticide Chemistry and Bioscience. Woodhead
2. Felix D’Mello JP (Ed) 1991. Toxic Substances in Crop Plants. Woodhead
3. Watson DH (Ed) 2001. Food Chemical Safety Vol I Woodhead
4. Watson DH (Ed) 2004. Pesticide, Veterinary and other residues in Foods. CRC Press

## **SAF 2025-FOOD TOXICOLOGY**

**Module -I :** Definition scope and general principles of food toxicology; manifestation of toxic effects; classification of food toxicants; factors affecting toxicity of compounds; methods used in safety evaluation-risk assessments. [4]

**Module - II :** Toxicants and allergens in foods derived from plants, animals, marine, algae & mushroom; Microbial toxins; Food Poisoning; Food borne infections and disease. [6]

**Module-III :** Derived Food toxicants- Processing & Packaging; Toxicants generated during food processing such as nitrosamines, acryl amide, benzene, dioxins and furans; persistent organic pollutants. [4]

**Module -IV :** Toxicology & food additives; Toxicological aspects of nutrient supplements; Chemicals from processing such as fumigants, chlorinated solvents, autoxidation products, carcinogens in smoked foods and pyrolysis, agrochemicals; heavy metals; intentional and unintentional additives [8]

**Module -V :** Food borne disease agents among the major microbial groups: bacteria, algae, viruses, protozoa and worms. Spores and food processing micro- organisms. Food toxicants; Bacteriotoxins (botulinm and other bacterial exotoxins). Mycotoxins (Aflatoxins, trichothecenes, ochratoxins )their production, properties and regulation .(4)

**Module -VI :** Toxicants formed in processed foods(food mutagens, carcinogens); Toxicants formed in processed foods. Hazardous chemical compounds arising from processing and storage of foods. Heating and chemical changes to Frying food. Conservation , Radiation and Microwave energy. Polycyclic aromatic hydrocarbons.(4)

**Module -VII:** Environmental Toxicants ( heavy metals. Pesticides, industrial contaminants): Dose effect relationship. Toxicity testing. Health effects of nitrates, nitrites and N- nitroso compounds. Heavy metals and other toxic elements (lead, mercury, cadmium and others) Radionuclide. Diphenyls, dioxins and pentachlorophenol. (4)

### **Books:**

1. Branen AL, Davidson PM & Salminon S. 1990. *Food Additives*. Marcel Dekker.
2. Concon JM.1988. *Food Toxicology - Principles & Concepts*. Marcel Dekker.
3. Hathcock JN. (Ed.). 1982. *Nutritional Toxicology*. Vol. I. Academic Press.
4. Rechcigl M Jr. 1983. (Ed.). *Handbook of Naturally Occurring Food Toxicants*. CRC Press.
5. Shabbir S. 2007. *Food Borne Diseases*. Humana Press.
6. Steven T. 1989. *Food Toxicology: A Perspective on Relative Risks*.
7. Tweedy BG.1991. *Pesticide Residues and Food Safety*. Royal Society of Chemistry.

## **SAF 2027-FOOD MICROSTRUCTURE AND TEXTURE**

**Module - I:** Examining food microstructures: history of food microstructure studies, light microscopy, transmission electron microscopy, scanning electron microscopy, other instrumentation and techniques, image analysis: image acquisition, image processing, measurement analysis. [7]

**Module - II:** Fundamentals of structuring: polymer, colloid, and materials science; food polymers, polymer solutions, phase transitions, colloids and surface chemistry,

**Module III:** Mechanical and rheological properties, rheology of foods, mechanical properties of food solids, food structure in the mouth and beyond. [7]

**Module - IV:** Micro-structural components and food assemblies, water and ice, proteins, lipids, carbohydrates, cells and cell membranes, structural aspects of animal tissue, structural aspects of plant tissue. [5]

**Module V :**Food structuring: traditional food structuring and texture improvement, approaches to food structuring, extrusion and spinning, structuring fat products, structure and stability, gels, gelation mechanisms, mixed gels, the microstructure of gels, structure-property relations in gels.[5]

**Module – VI:** Food microstructure and quality: measurement of texture, structural aspects of food texture, quality and structure. [4]

**Module – VII :**Microstructure and mass transfer: solid-liquid extraction; fundamental aspects of extraction, extraction process, extraction of food materials, modifying microstructure, modeling the extraction process, simultaneous heat and mass transfer: dehydration basic concepts, drying process, osmotic dehydration, influence of drying on structural properties, frying of foods, the micro-structural approach: structure-property relationships, micro structural approach. [7]

### **Books**

1. Aguilera JM. 2001. Micro Structure: Principles of Food Processing Engineering.
2. Barbosa-Cánovas GV. 2000. Dehydration of Foods. Chapman & Hall.
3. Bechtel DB. 1983. New Frontiers in Food Microstructure. American Association of Cereal Chemists.
4. Glasbey CA. 2004. Image Analysis for Biological Sciences.
5. Hartel RW. 1988. Principles of Food Processing.
6. Moskowitz 1999. Food Texture. AVI Publ.
7. Russ JC. (Ed.). Journal of Computer-Assisted Microscopy.



## ELECTIVE- II

### **SAF 3009-PHYTOCHEMICALS AND HERBAL MEDICINES**

**Module -I:** Crude Drugs - Crude Drugs- Scope and Importance, Classification (Taxonomical, Morphological, Chemical, Pharmacological); Cultivation, Collection & processing of Crude Drugs.

**Module -II:** Medicinal and Aromatic Plants Cultivation and utilization of medicinal & Aromatic Plants in India. Genetics as applied to Medicinal Herbs.

**Module -III:** Analysis of Phytochemicals Methods of Drug evaluation (Morphological, Microscopic, Physical and Chemical).Preliminary screening, Assay of Drugs- Biological evaluation / assays, Microbiological methods.

**Module IV:** Chemical Methods of Analysis and analysis and detection of adulterants: Chemical estimation, spectrophotometry & Fluorescence analysis. Drug adulteration – Types of adulterants.

**Module -V:** Types of Phytochemicals - Carbohydrates and derived products; Glycosides-extraction methods (Digitals, Aloe, Dioscorea); Tannins (Hydrolysable & Condensed types); Volatile Oils – Extraction methods(Clove, Mentha).

**Module VI:** Alkaloids- extraction methods (Taxus, Papver, Cinchona); Flavonoids – Extraction Methods,  
Resins- extraction Methods.

**Module VII:** Application of Phytochemicals Application of phytochemicals in industry and healthcare; Biocides, Biofungicides, Biopesticides. Evaluation of pesticides residues and aflatoxins.

#### Books:

1. Pharmacognacy, C K Kokate, A P Purohit, S P Gokhale (1996), Nirali Prakashan, 4th edition.
2. Natural Products in medicine: A Biosynthetic Approach (1997), Wiley.

## **SAF 3011-FLAVOUR CHEMISTRY AND TECHNOLOGY**

**Module – I :**Food flavor and its importance to consumers and food processors. Flavor and nutrition. Sources, extraction, delivery systems, and analyses (chemical, instrumental, and sensory) of flavors and flavorings in foods.

**Module II:** Sensory perception of flavor: Senses of taste and smell, tasting versus sniffing, astringency, pungency, interaction of senses in flavor perception; taste, odor, and acceptance of flavor stimuli.

**Module III:** Chemistry of substances responsible for taste and flavor-taste sensations, flavour enhancers, flavour potentiators or modifiers. Methodology of sensory evaluation and determination of threshold levels as specified by BIS.

**Module IV:** Flavoring constituents of various foods like meat, fish, milk, vegetables, fruits, fats & oils, spices & herbs, cereals and pulses. Flavor changes during processing, preservation, packaging, and storage of foods. Roles of sulfur compounds, fatty acids, amino acids, terpenoids, lactic acid-ethanol in food flavors. Process and reaction flavors/volatiles in foods.

**Module V:** Spices and herbs as food flavorings: Processing of basil, mint, saffron, cloves, tamarind, ginger, cardamom, chilies, pepper etc. for essential oils, extracts and oleoresins as the case may be.

**Module VI:** Determination of hygroscopic nature and shelf life/acceptance of foods. Natural, Nature identical and Synthetic flavors: Definitions, chemical composition/constituents, extraction and preparation of flavors, Stability and utility of flavor preparations.

**Module VII:** Methods used in flavor evaluation. BIS Specifications/PFA restrictions for use of certain constituents in flavoring materials.

Books:

1. Food Chemistry by Fennema, Marcel Dekker.
2. Spices & Flavor Technology by Pruthi, J.s.
3. Ashurst PR. 1994. *Food Flavorings*. 2<sup>nd</sup> Ed. Blackie.
4. Burdock GA. 2004. *Fenaroli's Handbook of Flavor Ingredients*. 5<sup>th</sup> Ed. CRC Press.
5. Deibler D & Delwiche J. 2004. *Handbook of Flavor, Characterization:*
6. *Sensory Analysis, Chemistry and Physiology*. Marcel Dekker.
7. Heath HB & Reineccius G. 1986. *Flavor Chemistry and Technology*. AVI Publ.
8. Taylor A. 2002. *Food Flavour Technology*. Sheffield Academic Press.

## **SAF 3013-GRAIN STORAGE TECHNOLOGY**

**Module I :** Physico-chemical and thermal properties of grains - grain dimensions, bulk density, true density, porosity, coefficient of friction, angle of repose, thermal conductivity and aerodynamic properties. Psychrometry: humidity, % relative humidity, humid heat, deterioration index, wet bulb temperature, use of psychrometric charts.

**Module II :** Grain drying - moisture content, equilibrium moisture content; free and bound water, rate of drying, constant and falling rate of drying rate; factors affecting rate of drying process, types of dryers used for drying of grains.

**Module III:** Grain storage – principles, moisture movement during bulk storage of grains, pressure distribution in storage bins, methods of aeration, various theories,

**Module IV:** Physical, chemical, microbiological and sensory changes occurring during storage, Grain storage structures - location and material selection for storage building, Types - traditional, modern; temporary and permanent storage structures; design considerations.

**Module V:** Insects and pests – types, extent of losses during storage, causes and control measures, Insecticides- principles, scope of application in warehouses; requirements, group of active ingredients, choice, toxicity, resistance, application techniques,

**Module VI:** Fumigants - chemicals, areas of application, choice, toxicity, application rates, exposure time and resistance. Rodenticides -Types and effectiveness and limitations, important moulds and bacteria involved in spoilage of grains; effect on physico- chemical and sensory quality of grains; Mycotoxins

**Module VII:** Air tight, controlled atmosphere and modified atmospheric storage; differences, principles, optimization of storage gas composition, rate of supply, control systems for oxygen and carbon dioxide- their effect on microbes and limitations.

### **Books**

1. AACC. 2004. *Storage of Cereal Grains and their Products*.
2. Chakraverty & De *Post Harvest Technology of Cereals, Pulse and Oilseeds*. IBH Publ.
3. Mahajan & Goswami. 2005. *Food and Process Engineering*.
4. Ojha TP & Michael AM. 2006. *Principles of Agricultural Engineering*. Jain Brothers.

## **SAF 3015- ENZYMES IN FOOD PROCESSING**

**Module - I:** Enzymes–classification, properties, characterization, kinetics and immobilization;

**Module – II:** fermentative production of enzymes (amylases, proteases, cellulases, pectinases, xylanases, lipases) used in food industry and their downstream processing.

**Module -III :** Enzymes for production of protein hydrolysates and bioactive peptides, maltodextrins and corn syrup solids (liquefaction, saccharification, dextrinization, isomerization for production of high-fructose-corn-syrup), fructose and fructo-oligosaccharides.

**Module - IV :** Enzymes as processing aids: Role of enzymes in cheese making and whey processing; fruit juices (cell wall degrading enzymes for liquefaction, clarification, peeling, debittering, decolourization of very dark coloured juices such as anthocyanases); **Module – V:**Role of enzymes in baking (fungal  $\alpha$ -amylase for bread making; maltogenic  $\alpha$ -amylases for anti-staling; xylanases and pentosanases as dough conditioners; lipases or dough conditioning; oxidases as replacers of chemical oxidants; synergistic effect of enzymes); meat and meat processing (meat tenderization); egg processing.

**Module – IV:** Enzyme processing for flavors (enzyme-aided extraction of plant materials for production of flavors, production of flavour enhancers such as nucleotides; flavors from hydrolyzed vegetable/animal protein);

**Module – VII:** enzymatic approach to tailor- made fats.

### **Books:**

1. Flickinger MC & Drew SW. 1999. *Encyclopedia of Bioprocess Technology*. A Wiley-Inter Science Publ.
2. Kruger JE *et al.* 1987. *Enzymes and their Role in Cereal Technology*. American Association of Cereal Chemists Inc.
3. Nagodawithana T & Reed G. 1993. *Enzymes in Food Processing*. Academic Press.
4. Tucker GA & Woods LFJ. 1991. *Enzymes in Food Processing*, Springer.S
5. Whitehurst R & Law B. 2002. *Enzymes in Food Technology*. Blackwell Publ.

# **SAF 3017- STATISTICAL QUALITY CONTROL**

## **Module I**

Measures of central tendency- Average, Mean, Mode, Median, Standard Deviation, Measures of dispersion coefficient of variation skewness, standard error of mean. Simple correlation and regression, Multiple-regression, Multiple & partial- correlation/variability- range, variance, standard deviation, standard error.

## **Module II**

Theory of Probability: equally likely, mutually exclusive events, definition of probability, addition & Multiplication theorems of probability & problems on theorems of probability & problems based on them. Normal & Binomial Distributions.

## **Module III**

Testing of Hypothesis: Concepts of Hypothesis, Degrees of freedom, Level of significance, Type I & Type II errors. Chi square  $\chi^2$  (X<sup>2</sup>), Student - t test, F- tests definition, applications & problems based on these tests). SND test when population's SD is known and SD is unknown Analysis of variance (ANOVA) techniques, Definitions and assumptions, One way classification, two way classification with more than one Observation per cell.

## **Module IV**

Designs of experiment, principles of experimental design, randomized block design (R.B.D), Latin square design (L.S.D.), missing plot technique in R.B.D. and L.S.D., critical difference (C.D.), split plot design. Factorial experiment  $2 \times 2 \times 3$  and  $3 \times 2$ , factorial design (Yates method of analysis)  $2 \times 3$  &  $2 \times 4$  factorials, Durcan's multiple range test, Newman's kuel test.

## **Module V**

Sampling techniques, simple random sampling, stratified random sampling and Systematic sampling. Data Management Analysis: Data Analysis- Coding of data Parametric and non-parametric tests Use of statistical tools.

## **Module VI**

Quantitative analysis, descriptive statistics, inferential statistics : Uses and limitations Statistics : Uses and limitations Summation sign and its properties Summation sign and its properties. Grouped data- frequency distribution, histogram, frequency polygons, percentiles, quartiles, tertiles, ogive.

## **Module VII**

Tabulation and Organization of data frequency distributions, cumulative frequency distribution, contingency tables Graphical presentation of data- histogram, frequency polygon, ogive, stem and leaf plot, box and whiskers plot, Graphs for nominal and ordinal data- pie diagram, bar graphs of different types, graphs for relation between two variables, line diagram.

## **Books:**

1. Statistical Methods for Biological Workers-Pillai and Sinha HC 1968. Ram Prasad and Sons, Agra.
2. Statistical Methods – Snedecor GW and Cochran W 1968. Oxford & IBM Publishing Cop. New Delhi
3. Hand Book of Agricultural Statistics – Chandel SRS 1972. Anchal Prakashan Mandir, Kanpur.
4. Statistics for Agricultural Sciences – Nageshwara Rao G 1983. Oxford & IBH Publishing Co., New Delhi.
5. Statistical Procedure of Agricultural Research – Gomez K A and Gomez AA 1995. John Wiley & Sons, New York and Singapore.

## **SAF 3019-COMPUTER APPLICATIONS IN FOOD INDUSTRY**

**Module I:** Fundamentals of Computer including Devices and Internet Overview of operating Systems:- Windows, LINUX,MS-Office, MS-Excel, MS-PPT, MS-SQL

**Module II :** Introduction to Programming: Concepts of Algorithm ,Flow Chart, Pseudo code. Features of Programming Language: Character Set, Identifiers, Keywords, DataTypes, Variables, Declarations, And Operators &Expressions; Assignment, Input / Output statements; Flow Control; Conditionals and Branching: Iteration:

**Module III:** Functions, Function Types, Scope Rule; Recursion: Arrays, Pointers, Structures. (A programming Language C shall be used as a basis language. The same language is to be used for the laboratory).

**Module IV :** Computer Applications: Use of computers for preparing and presenting documents, spreadsheets. Appropriate statistical and other relevant packages, Internet. Use of Library documentation and scientific literature searching, Use of internet in Food Industry++,

**Module V :** MATLAB Programming Introduction to MATLAB, MATLAB Basics, Branching Statement and Program Design, Loops, User-Defined Functions, Complex Data, Character Data, and Additional Plot Types, Spares Arrays and Structures , Input / Output Functions ,Handle Graphics, Graphical User Interfaces, Use of word processing software for creating report, Familiarization with software related to food industry,

**Module VI :** Role of Computer in Optimization: Introduction to operation Research; A Computer Oriented Algorithmic approach; Queuing systems and waiting models; PERT, CPS and CPM.

**Module VII:** Food Process Modeling and Simulation; CAD and CAM in Food Industry: instrumentation, process Control, inventory Control, Automation, Robotics,Expert system and artificial intelligence.

### **Books:**

- 1.Principles and Calculations in Chemical Engineering by Himmelblau, D.M. 6th ed., Prentice- Hall of India.
2. Computer Application in Food Technology by SinghR. P., Academic Press.
3. Solving Problems in Food Engineering by StavrosYanniotis, Springer.
4. Amos Gilat, "Matlab- An Introduction withApplications"
5. Rajaraman, "Fundamentals of Computers", PrenticeHall of India, 3rd Edition..
6. Gillette BE. *Introduction to Operation Research* (A Computer OrientedAlgorithmic Approach).
- 7.Groover MP& Zimmers EW. *CAD/CAM: Computer Aided Design andManufacturing*.PrenticeHall.

## **SAF 3021-FOOD SUPPLY CHAIN MANAGEMENT**

Module I : Building blocks of supply chain network, performance measures, decisions in supply world and models. Supply chain inventory management, economic order quantity models, recorder point models, multi echelon inventory systems.

**Module II:** Use of stochastic models and combinatorial optimization in SC planning, layout, capacity planning, inventory optimization, dynamic routing and scheduling.

**Module III:** Internet technologies and electronic commerce in SCM related to ERP, Procurement, e-logistics, internet auctions, e-market, electronic, business process optimization.

**Module IV: Cold chain -**Introduction, scope and importance of cold chain in food processing industry and retail chain, components of cold chain and integration.

**Module V:** Products going in cold chain, their temperature and humidity requirements ,packaging needs and their compatibility in cold chain.

**Module VI:** Stages and points of control in cold storages and structures, functions in cold storages, pallet layout and stacking options, flexibility storage systems cold chain transportation in land and export, retail & supermarket cold chain and display systems.

**Module VI:** Temperature recording devices used during transport, documentation and traceability, Risk management problem diagnosis, cost benefit studies for type of transport, loading and unloading, storage duration.

### **Books:**

1. *I. Systems*. Prentice Hall. Chopra S & Meindel P. 2002. *Supply Chain Management: a. Strategy, Planning and Operation*. Prentice Hall.
2. Handfield RB & Nichols EL. 1999. *Introduction to Supply Chain Management*. Prentice Hall.
3. Hopp WJ & Spearman ML. 1996. *Factory Physics: Foundations of Manufacturing Management*. McGraw Hill.
4. Levi DS, Kaminsky P & Levi ES. 2000. *Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies*. Mc Graw Hill.
5. Shapiro JF. 2001. *Modeling the Supply Chain*. Duxbury Thomson Learning.
6. Tayur S, Ganeshan R & Magazine M. 1999. *Quantitative Models for Supply Chain Management*. Kluwer Academic Publ.
7. Viswanadham N. 2000. *Analysis of Manufacturing Enterprises*. Kluwer.
8. 9. Viswanadham N & Narahari Y. 1998. *Performance Modeling of Automated Manufacturing*

## **SAF 3023-FOOD PLANT AND EQUIPMENT DESIGN**

**Module I :** Physical properties of food materials and energy balance calculations for preliminary estimation of plant capacity and equipment sizes. Preparation of flow sheets for material movement and utility consumption in food plant.

**Module II :** Materials of construction : welding and machining of stainless steel. Fabrication of equipment.

**Module III:** Design of storage vessels for liquid food and grains. Pressure vessels design and design of vessel for drum drying.

**Module IV:** Performance characteristics and selection of fans, blowers, ejector compressors and vacuum pumps.  
Design of fluid conveyance system; pipe, sanitary pipe fitting and valves. Performance characteristics and selection of centrifugal and positive displacement sanitary pumps.  
Design of CIP system.

**Module V:** Design of heat exchange equipment-plate, scraped surface and extended surface for heating and cooling of gas and liquid.

**Module VI:** Design of evaporator calandria, vapour separator and condenser,

**Module VII:** Design considerations for location of food plant. Equipment layout and ventilation in food process plants.

References:

1. D. Q. Kern, Process Heat Transfer,McgrawHill
2. J. H. Perry, Chemical Engineers Handbook, McgrawHill
- 3.. Howerd F. Rase Piping design for process plant, JohnWilley.
4. Stanley M. Walas Chemical Process Equipments , Butterworth, Heinemann.
5. Coulson and Richardson Chemical Engineering Design Vol-6, Butterworth, Heinemann.



## **SAF 3025-PLANTATION CROPS, SPICES & CONDIMENT TECHNOLOGY**

**Module -I :** Plantation Crops - Description of various types of Plantation crops, viz., coconut, areca nut, coffee, tea, cocoa etc. Processing and preservation methods. Value-added products shelf-stable products viz., coconut water bottling, desiccated coconut powder, coffee concentrate, instant coffee powder, instant tea powder, cocoa processing.

**Module -II :** Leafy vegetables - Description of various types of leafy vegetables, viz., hibiscus, curry leaves, coriander leaves, etc. Their composition, nutritive value, health benefits. Preservation methods and packaging techniques.

**Module -III :** Spices & Condiments - Description of various types of spices and condiments, their composition, functional properties, flavouring agents. Nutritive value of spices and their health benefits. Intermediate Moisture Products – Intermediate Moisture Products viz., ginger paste, ginger – garlic paste, tamarind paste, tamarind concentrate. Their importance in culinary preparations. Flavour retention and packaging methods.

**Module -IV :** Spice Powders & Curry Powders : Their importance in culinary preparations, their preparation methods, grinding and packaging methods for spice powders like chilli powder, turmeric powder, ginger powder, garlic powder; and Masala Powders for chicken masala, meat masala, biryani masala, chat masala etc. Importance of Cryogenic grinding of spices.

**Module V :** Spice Oils – Concept and importance of spice oils from spices like and condiments like clove, cardamom, cinnamon etc. Their application in food processing, and extraction methods of spice oils by various techniques, viz., solvent extraction, steam distillation etc.

**Module VI:** Extraction of Oleoresins – Concept and importance of oleoresins in food processing, processing of spices like chili, turmeric, pepper, ginger etc. for solvent extraction of oleoresins. Oleoresins technology, desolventization methods, regulatory and statutory requirements for oleoresin processing. Extraction of Natural Food Colors - Extraction of Natural Food colors from paprika, turmeric, blue grapes, beet root etc. Their importance in food processing.

**Module -VII :** Herbs – Description of various types of herbs, viz., Basil, Chives, Cilantro, Dill, Coriander, Mint, Oregano, Parsley, Chives, Borage and Avocado leaves, Rose marry, Saga, Tarragon, Thyme, Winter savory and bolbo leaves, Papalo, Pipicha and Safflower. Their nutritive value & health benefits, their processing and Post harvest handling. Packaging methods for processed products.

### **TEXTBOOKS :**

1. Spices & Condiments, J S Pruthi, National Book Trust, New Delhi (2001).
2. Spices : Morphology, History , Chemistry., J W Parry, Chemical Publishing Co., New York (1969).
3. Leafy Spices, V Prakash, CRC Press, Florida (1990).

## **SAF 3027 -BAKERY & CONFECTIONARY**

**Module - I:** Introduction to baking; Bakery ingredients and their functions; Machines & equipment for batch and continuous processing of bakery products.

**Module- II :** Bakery and confectionary industry ; raw materials and quality parameters; dough development; methods of dough mixing; dough chemistry; rheological testing of dough-Farinograph, Mixograph, Extensograph, Amylograph/ Rapid Visco Analyzer, Falling number, Hosney's dough stickiness tester and interpretation of the data.

**Module- III:** Technology for the manufacture of bakery products – bread, biscuits, cakes and the effect of variations in formulation and process parameters on the quality of the finished product; quality consideration and parameters; Staling and losses in baking.

**Module - IV:** Chocolate Processing Technology, Compound coatings & Candy Bars, Tempering technology, Chocolate hollow figures, Chocolate shells, Enrobing technology, Manufacture of candy bars, Presentation and application of vegetable fats. Production of chocolate mass.

**Module- V:** Sugar confectionery manufacture, General technical aspects of industrial sugar confectionary manufacture, Manufacture of high boiled sweets- Ingredients, Methods of manufacture- Types- Center- filled, lollipops, coextruded products. Manufacture of gums and jellies- Quality aspects.

**Module- VI :**Quality characteristics of confectionery ingredients; technology for manufacture of flour , fruit, milk, sugar, chocolate and special confectionery products; colour, flavor and texture of confectionery; standards and regulations ; machineries used in confectionery industry.

**Module -VII :** Manufacture of Miscellaneous Products, caramel, Toffee and fudge- Liquorices paste and aerated confectionery, Lozenges, sugar panning and Chewing gum, Count lines Quality aspects, fruit confections.

### **Text Books:**

1. Extrusion of Food, Vol 2; Harper JM; 1981, CRC Press.
2. Bakery Technology & Engineering; Matz SA; 1960; AVI Pub.

### **References:**

1. Up to-date Bread Making; Fance WJ & Wrogg BH; 1968, Maclasen & Sons Ltd.
2. Modern Cereal Chemistry; Kent-Jones DW & Amos AJ; 1967, Food Trade Press Ltd.