

CENTRAL INSTITUTE OF TECHNOLOGY
(Centrally Funded Institute under Ministry of HRD, Govt. of India)
Bodoland Territorial Council, Kokrajhar, Assam-783370
(B.Tech Syllabus in Food Processing Technology)

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STUDY PLANS

Total Credit Requirements : 219

Total Number of Semesters : 8

1st YEAR: 1st SEMESTER (JULY-DEC)

A. Theory							
	Code	Subjects	Contacts (periods per week)				Credit points
			L	T	P	Total	
1.	MA101	Engineering Mathematics -I	3	1	0	4	4
2.	PH101	Engineering Physics	3	1	0	4	4
3.	CS101	Introduction to Computer Programming	3	1	0	4	4
4.	HU101	Communication Skills	3	0	0	3	3
5.	ES101	Environmental Engineering	3	1	0	4	4
Total of theory							19

B. Practicals							
	Code	Subjects	Contacts (periods per week)				Credit points
			L	T	P	Total	
1.	PH171	Physics Lab	0	0	3	2	2
2.	CE101	Engineering Graphics	0	1	0	1	1
3.	CE171	Engineering Graphics Lab	0	0	3	2	2
4.	WS171	Workshop Practice -I	0	1	3	3	3
5.	CS171	Computing Lab	0	0	3	2	2
Total of practicals							10

Total of 1st Semester: 29

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1st YEAR: 2nd SEMESTER (JAN-JUNE)

A. Theory							
	Code	Subjects	Contacts (periods per week)				Credit points
			L	T	P	Total	
1.	MA201	Engineering Mathematics -II	3	1	0	4	4
2.	CY201	Engineering Chemistry	3	1	0	4	4
3.	ES201	Basic Electrical Engineering	3	1	0	4	4
4.	ME201	Engineering Mechanics	3	1	0	4	4
5.	EC201	Basic Electronics	3	1	0	4	4
6.	HU201	Professional Ethics and Human value	2	0	0	2	2
Total of Theory							22

B. Practicals							
	Code	Subjects	Contacts (periods per week)				Credit points
			L	T	P	Total	
1.	CY271	Engineering Chemistry Lab	0	0	3	2	2
2.	WS271	Workshop Practice -II	0	1	3	3	3
3.	EE271	Basic Electrical and Electronics Lab	0	0	3	2	2
Total of Practicals							7

Total of 2nd Semester: 29

***** Approved by GU**

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2ND YEAR: 3RD SEMESTER (JULY-DEC)

A. Theory							
	Code	Subjects	Contacts (per week)				Credit Points
			L	T	P	Total	
1.	FPT301	Basic Microbiology	3	0	0	3	3
2.	FPT302	Principles of Food Processing and Preservation	3	0	0	3	3
3.	ME301	Basic Thermodynamics	3	1	0	4	4
4.	FPT303	Fluid Mechanics	3	1	0	4	4
5.	FPT304	Food Chemistry and Nutrition	3	0	0	3	3
6.	MA301	Mathematics-III	3	1	0	4	4
Total of Theory							21

B. Practical							
	Code	Subjects	Contacts (periods per week)				Credit points
			L	T	P	Total	
1.	FPT371	Microbiology Lab	0	0	3	3	2
2.	FPT372	Food Processing Lab	0	0	3	3	2
3.	FPT374	Food Chemistry Lab	0	0	3	3	2
4.	HU371	Language Lab	0	0	3	3	2
Total of practical							8

Total of 3rd Semester: 29

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2ND YEAR: 4TH SEMESTER (JAN-JUNE)

A. Theory							
	Code	Subjects	Contacts (per week)				Credit Points
			L	T	P	Total	
1.	HU401	Engineering Economics	3	0	0	3	3
2.	FPT401	Food Process Technology-I (Fruits & Vegetables)	3	0	0	3	3
3.	FPT402	Food Process Technology-II (Cereals & Legume Processing Technology)	3	0	0	3	3
4.	FPT403	Transfer Process Engineering	3	1	0	4	4
5.	FPT404	Food Microbiology	3	0	0	3	3
6.	MA401	Numerical Methods and Computer Programming	3	0	0	3	3
Total of Theory							19

B. Practical							
	Code	Subjects	Contacts (periods per week)				Credit points
			L	T	P	Total	
1.	FPT471	Product Technology- I /II Lab	0	0	3	3	2
2.	FPT472	Transfer Process Engineering Lab	0	0	2	2	1
3.	FPT473	Food Microbiology Lab	0	0	3	3	2
4.	MA471	Numerical Methods & Computer Programming Lab	0	0	2	2	1
Total of practical							6

Total of 4th Semester: 25

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3RD YEAR: 5TH SEMESTER (JULY-DEC)

A. Theory							
	Code	Subjects	Contacts (per week)				Credit Points
			L	T	P	Total	
1.	FPT501	Food Industry Waste Management	4	0	0	4	4
2.	FPT502	Food Product Technology-III (Milk and Milk Products)	3	0	0	3	3
3.	FPT503	Food Process Engineering	3	1	0	4	4
4.	FPT504	Mechanical Design of Process Equipment	3	0	0	3	3
5.	HU501	Industrial Management and Entrepreneurship	3	0	0	3	3
Total of Theory							17

B. Practical							
	Code	Subjects	Contacts (periods per week)				Credit points
			L	T	P	Total	
1.	FPT571	Product Technology-III Lab	0	0	3	3	2
2.	FPT572	Food Engineering Lab	0	0	3	3	2
3.	FPT573	Process Equipment Drawing	0	1	4	5	3
Total of practical							7

Total of 5th Semester: 24

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3RD YEAR: 6TH SEMESTER (JAN-JUNE)

A. Theory							
	Code	Subjects	Contacts (per week)				Credit Points
			L	T	P	Total	
1.	HU601	Professional Communication	2	0	0	2	2
2.	FPT601	Food Packaging Technology	3	0	0	3	3
3.	FPT602	Food Analysis, Quality Control and Management	3	0	0	3	3
4.	FPT603	Biochemistry and Biotechnology	4	0	0	4	4
5.	FPT61*	Elective	3	0	0	3	3
6.	IE604	Process Instrumentation and Control	3	1	0	4	4
Total of Theory							19

B. Practical							
	Code	Subjects	Contacts (periods per week)				Credit points
			L	T	P	Total	
1.	FPT671	Product Technology- IV/V Lab	0	0	3	3	2
2.	FPT672	Food Packaging Technology Lab	0	0	2	2	1
3.	FPT673	Food Analysis and Quality Control Lab	0	0	3	3	2
4.	FPT674	Biochemistry and Biotechnology Lab	0	0	2	2	1
5.	IE671	Instrumentation Lab	0	0	2	2	1
Total of practical							7

Total of 6th Semester: 26

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4TH YEAR: 7TH SEMESTER (JULY-DEC)

A. Theory							
	Code	Subjects	Contacts (per week)				Credit Points
			L	T	P	Total	
1.	FPT701	Food Hygiene and Plant Sanitation	3	0	0	3	3
2.	FPT702	Food Process Equipment Design	3	0	0	3	3
3.	FPT703	Food Additives and Legislation	3	0	0	3	3
4.	FPT71*	Elective	3	0	0	3	3
Total of Theory							12

B. Practical							
	Code	Subjects	Contacts (periods per week)				Credit points
			L	T	P	Total	
1.	FPT791	Major Project-I	0	0	14	14	10
2.	FPT792	Report and Presentation on Practical Training-II	-	-	-	-	3
3.	FPT770	Seminar	0	0	3	3	2
Total of practical							15

Total of 7th Semester: 27

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4TH YEAR: 8TH SEMESTER (JAN-JUNE)

A. Theory							
	Code	Subjects	Contacts (per week)				Credit Points
			L	T	P	Total	
1.	FPT801	Plant Design and Project Engineering	3	0	0	3	3
2.	FPT81*	Elective-I	3	0	0	3	3
3.	FPT81*	Elective-II	3	0	0	3	3
Total of Theory							9

B. Practical							
	Code	Subjects	Contacts (periods per week)				Credit points
			L	T	P	Total	
1.	FPT891	Major Project-II	0	0	18	18	09
2.	FPT892	Project Defense	-	-	-	-	4
3.	FPT893	Comprehensive Viva Voce	-	-	-	-	8
Total of practical							21

Total of 8th Semester: 30

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List of Elective Courses in Food Processing Technology

1. FPT611: Food product Technology-IV (Bakery, Confectionary and Extruded Products)
2. FPT612: Food Product Technology-V (Oils & Fats Processing)
3. FPT711: Industrial Microbiology and Enzyme Technology
4. FPT712: Fermentation Technology
5. HU711: Marketing and Sales Management
6. EC718: Applied Electronics
7. FPT713: Refrigeration and Air conditioning
8. FPT811: Modeling and Simulation of Food Processes
9. FPT812: Concentration and Dehydration of Foods
10. FPT813: Food Product Technology – VI (Fish, Meat & Poultry Technology)
11. FPT814: Optimization Techniques in Food Engineering
12. FPT815: Material Science and Technology
13. FPT816: Specialty Foods: Nutraceuticals & Functional Foods
14. FPT817: Renewable Energy Technology

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DETAIL SYLLABUS

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BASIC SCIENCE COURSES

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MA301: ENGINEERING MATHEMATICS –III

Code: MA301
Credits: 04
L-T-P: 3-1-0

Partial Differential Equations

Basic concepts, formation of partial differential equations, equation solvable by direct integration, linear and non-linear equations of first order. Homogenous linear equations with constant coefficients, solutions of heat equations, wave equations, transmission line equations and Laplace equations.

Tensor Analysis

Curvilinear coordinates, unit vectors in curvilinear system, representation of a vector in terms of unit base vectors, contravariant and covariant components of F, arc length and volume element in orthogonal curvilinear coordinates. Transformations of coordinates. Definition of tensors, fundamental operations with tensors, Symmetric and skew-Symmetric tensors, Riemannian space and metric tensor, Conjugate tensor, Christoffel symbols.

Calculus of Complex Variables

Analytic functions, C-R equations, conjugate functions, Harmonic functions, orthogonal systems. Formation of analytic functions, conformal mapping, integration of a complex functions, Cauchy's Integral Theorem, power series representation of complex functions, Laurent's Series, singularities, Residue Theorem.

Transformations

Laplace transformation of elementary functions, inverse Laplace transform, Linearity, Laplace transform of derivatives and integrals, shifting Theorems, Laplace transform of unit step function, Dirac-delta function, Differentiation and integration of transforms, convolution, Application to differential equations.

Definition, properties, Z-transform of some basic sequences, Z-transforms of some basic discrete functions, Shifting theorems.

Texts / References:

1. *B.S. Grewal: Higher Engg. Mathematics, Khanna Publishers*
2. *Gilbert Strang: Linear Algebra and applications, Thomson Books*
3. *P.L. Meyer: Introduction to Probability & Statistics*
4. *Shanti Narayan: Functions of Complex Variables, S. Chand & Co.*
5. *Murray R. Spiegel: Laplace Transforms, Thomson Books*
6. *I.M. Snedon: Elements of Partial Differential Equations, S. Chand & Co.*

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MA401: NUMERICAL METHODS & COMPUTER PROGRAMMING

Code: MA401
Credits: 04
L-T-P: 3-1-0

Computer Arithmetic

Floating point Arithmetic, Normalization, Approximations and errors, types of errors in computations

Transcendental and Polynomial Equations

Methods of iteration for finding solution of transcendental and equations: Newton Raphson Method, Regula-Falsi Method, Bisection Method, Secant Method.

Solution of linear simultaneous equations by Gauss Elimination Method & Gauss Siedal Method.

Curve Fitting and Interpolation

Linear and non-linear Regression Analysis. Difference table, Newton's Forward and Backward interpolation formulae, Lagrange's Interpolation Formula, Divided differences and Newton's general formula.

Numerical Differentiation & Integration

Numerical differentiation, Numerical Integration: Trapezoidal and Simpson's Rules. Gaussian Quadrature Formula.

Numerical Solution of Ordinary Differential Equations

Euler method, Modified Euler Method, Taylor Series Method, Runge - Kutta Method and Predictor – Corrector Method.

Lab: Developing C programs for the following methods:

1. Numerical integration by Trapezoidal & Simpson's Rules
2. Various iteration methods for solving transcendental and algebraic equations: viz. Newton Raphson Method, Bisection Method, Regula – Falsi Method, Secant Method
3. Gauss – Siedal Iteration Method
4. Various matrix operations and their uses as sub – routines

Texts / References:

1. *E. Balaguruswamy: Numerical Methods, Tata McGraw Hill*
2. *Jain, Iyengar and Jain: Numerical Methods for Scientific and Engineering Computations, New Age International, New Delhi*
3. *Sastry, S.S.: Introductory Methods of Numerical Analysis, PHI*
4. *B.S. Grewal: Numerical Methods for Engineering and Science, Khanna Publishers*
5. *Schaum's Outlines: Numerical Analysis, Tata McGraw Hill*

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HUMANITIES & SOCIAL SCIENCE COURSES

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HU401: ENGINEERING ECONOMICS

Code: HU401

Credits: 03

L-T-P: 3-0-0

Definition of Economics, Consumer behaviour, Utility analysis and demand analysis, Kinds of Demand, Law of Demand and Law of Supply, Elasticity of Demand: Types and Measurement, Scope of Economics including economics of environment and e-commerce.

Market forms-Perfect and Imperfect markets, Features of Perfect competition, Monopoly and Monopolistic competition. Price and output determination under Perfect Competition, Monopoly, Monopolistic and Oligopoly etc., Concept of Production function, Cost Analysis, Estimation of cost function-Profit and Break Even Analysis.

National Income, GNP and NNP, Per-Capita Income, Source of Public Revenue-Tax Revenue and Non-Tax Revenue, Direct and Indirect Tax. Inflation and Deflation. Banking-Definition - Types of Banks. Concept of Investment Analysis

Features of Indian Economy, Planning in India, Objectives. Economic Reforms in India-Concept of Economic Liberalization, Privatization and Globalization. Unemployment Problem in India-Types, Causes and remedial measures.

International Trade, Gains from International Trade, The World Trading Environment and Multinational Corporations, BPO etc., Function and Role of IMF, World Bank and WTO. Concept of Stock Exchange Market and Market for Securities.

Reference Book:

1. *M.L. Jhingan—Micro Economic Theory*
2. *Sumitra Paul-Managerial Economics*
3. *Joel Dean—Managerial Economics*

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HU501: INDUSTRIAL MANAGEMENT AND ENTREPRENEURSHIP

Code: HU501

Credits: 03

L-T-P: 3-0-0

Meaning and Concept of Management, Principles and function of Management, Concept of Organizational Behaviour, Function of a Manager—Planning, Organizing, Coordinating and Controlling. Motivation—implication of Managers and application. Leadership and Decision Making : Qualities and Styles of Leadership, Decision making process.

Individual Process in Organizations-Perception, attitude and personality, Factors that affect them, How they influence people. Group Process in Organizations, Group formation, Group effectiveness, Group Conflict.

Evolution, Role and Status of Human Resource Management in India. Recruitment and Selection Process in Organization, Job Analysis, Job Specification, Selection Process-Test and Interview. Trade Union and Collective Bargaining

Entrepreneurship-Meaning, Types of entrepreneur, Qualities of an entrepreneur, Role of Entrepreneur, Factors affecting entrepreneurial growth. Entrepreneurship Development Programme-Concept, Objective and Importance, Engineer Entrepreneurship Training Programme Scheme

Small Scale Industry-Definition, Types of Small Scale Industry, How to Set up Small Scale Industry, Role and Problem of Small Scale Industry. Concept of Joint Stock Company, Private and Public Limited Company. Source of Finance for Entrepreneur-Bank, Government and Financial Institutions etc.

Reference Books:

1. *S.S. Khanka-Organisational Behaviour.*
2. *S.S. Sarkar, R.K.Sharma and S.K.Gupta – Business Organisation and Entrepreneurship Development.*
3. *Cynthia L. Greene – Entrepreneurship.*

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HU601: PROFESSIONAL COMMUNICATION

Code: HU601

Credits: 02

L-T-P: 2-0-0

Oral Communication: Aims at improving the oral communication skills. Public speaking skills, features of effective speech – verbal – non-verbal, Presentation skills, Group discussion. Mock Interviews.

Written Communication: Focuses on improving the writing skills. A review of grammar, transformation of sentences; reading comprehension; Precis-writing, skills to express ideas through various kinds of essays; business administrative and E-correspondence, business reports, technical documentation & project proposal writing and CVs/ resumes; Application letters, Notices, Agenda, Minutes & Memos. Case Analysis.

Organization Communication: Attempts to acquaint students with the process and requirements of communication in organizations. It includes the objectives of communication, Channels of communication, Barriers in Communication, Non-verbal & Cross-cultural communication, Meetings, Conferences, Press Conference and Press release. Business Communication Technology: Audio-Visual aids, Internet, e-mail. Creative Communication: Slogan-writing, Advertisement.

Texts / References:

1. *Wren & Martin., English Grammar*
2. *John Metchell., How to write Reports*
3. *Mark McCormack., Communication*
4. *Rajendra Pal & J.S. Korlahalli, Essentials of Business Communication*

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PROGRAM CORE COURSES

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FPT301: BASIC MICROBIOLOGY

Code: FPT301

Credits: 03

L-T-P: 3-0-0

History and Scope of Microbiology; Classification of Microorganisms-Bacteria, Fungi, Virus, Alga, Protozoa ; sterilization techniques, disinfectant and antiseptic agents. Microscopy - types of microscopes and their applications-simple and compound, bright field, dark field, fluorescence, phase-contrast and electron microscopes.

Major groups of bacteria- Archaeobacteria, Actinomycetes, Chemoautotrophs, Eubacteria, Pseudomonads, cyanobacteria, Rickettsias, chlamydias and spirochetes; Bacterial cell- structure and functions of cellular components-cell wall composition of Gram positive and Gram negative bacteria, sub-cellular organizations, flagella, capsule and spores; Bacterial Staining; antimicrobial agents-antibiotics, chemotherapeutic drugs-antibacterial agents-mode of action; antibiotic .

Classification, morphology and characteristics of Virus, Fungi & Protozoa- structure of DNA - and RNA viruses, Viral replication, Bacteriophages- Lysogeny and Lytic cycle; Virus like agents-satellites, viroids and prions, antiviral and antifungal drugs; Classification of Helminthic parasites; Life cycle of malarial and filarial parasites.

Microbial culture continuous culture and synchronous culture; composition of culture media - solid and liquid media, chemically defined media, complex and differential media; Effect of pH, temperature and radiation on microbial growth.

Microbial nutrition : Heterotrophs, autotrophs; uptake of nutrients, Enrichment culture technique. Transformation of elements: Carbon, Nitrogen, Phosphorous and Sulphur.

Text Books:

1. Prescott, Harley and Klein- *Microbiology-5th edition*; Publisher: McGraw Hill science 2002
2. Gerard J. Tortora, Berdell, R. Funke, Christine L. Case, , *Microbiology: An Introduction. 8th edition Hardcover: 944 pages, Publisher: Benjamin Cummings. 2004.*

Suggested Reading:

Kenneth J. Ryan, C. George Ray, John C. Sherris, Sherris Medical Microbiology : An Introduction to Infectious Diseases , Hardcover: 992 pages, Publisher: McGraw-Hill Professional, 2003.

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FPT302: PRINCIPLES OF FOOD PROCESSING AND PRESERVATION

Code: FPT302

Credits: 03

L-T-P: 3-0-0

Basic consideration : Aim and objectives of preservation and processing of foods, characteristics of tissue and non-tissue foods, degree of perishability of unmodified foods, causes of quality deterioration and spoilage of perishable foods, intermediate moisture foods, wastage of foods.

Preservation of foods by low temperatures

Chilling temperatures : Considerations relating to storage of foods at chilling temperature, applications and procedures, controlled and modified atmosphere storage of foods, post storage handling of foods.

Freezing temperature : Freezing process, slow and fast freezing of foods and its consequences, other occurrences associated with freezing of foods. Technological aspects of pre-freezing, Actual freezing, frozen storage and thawing of foods.

Preservation of foods by high temperature: Basic concepts in thermal destruction of microorganisms- D, Z, F, values Heat resistance and thermophilisms in micro-organisms. Cooking, blanching, pasteurization and sterilization of foods. Assessing adequacy of thermal processing of foods, general process of canning of foods, spoilages in canned foods.

Preservation by water removal:

Principles, technological aspects and applications of evaporative concentration processes, freeze concentration and membrane processes for food concentrations. Principles, technological aspects and applications of drying and dehydration of foods, cabinet, tunnel, belt bin, drum, spray, vacuum, foam mat, fluidized-bed and freeze drying of foods.

Principles, technological aspects and applications of sugar and salt, antimicrobial agents, biological agent, no ionizing and ionizing radiations in preservations of foods. Hurdle technology.

Books Recommended:

1. *"Principles of Food Science-Part-II":Physical Method of Food Preservation* by M.Karel, O.R. Fennema and D.B.Lund, Marcel Dekkar Inc.
2. *'Principles of Food Preservation'* by V.Kyzlink,Elsevier Press.
3. *'Modern Food Microbiology'* by James M.Jay, D.Van Nostrand.

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ME301: BASIC THERMODYNAMICS

Code: FPT303

Credits: 04

L-T-P: 3-1-0

Fundamental Concepts and Definitions: Definition of thermodynamics, system, surrounding and universe, phase, concept of continuum, macroscopic & microscopic point of view. Density, specific volume, pressure, temperature. Thermodynamic equilibrium, property, state, path, process, cyclic process, Energy and its form, work and heat, Enthalpy.

Laws of thermodynamics

Zeroth law: Concepts of Temperature, zeroth law.

First law: First law of thermodynamics. Concept of processes, flow processes and control volume, Flow work, steady flow energy equation, Mechanical work in a steady flow of process.

Second law: Essence of second law, Thermal reservoir, Heat engines. COP of heat pump and refrigerator. Statements of second law. Carnot cycle, Clausius inequality. Concept of Entropy.

Properties of steam and thermodynamics cycles: Properties of steam, use of property diagram, Steam-Tables, processes involving steam in closed and open systems. Rankine cycle. Introduction to I.C. Engines-two & four stroke S.I. and C.I. engines. Otto cycle, Diesel cycle.

Reference:

1. Van Wylen G.J. & Sonntag R.E. : *Fundamentals of classical thermodynamics*, John Wiley & Sons, Inc. NY.
2. Wark Wenneth : *Thermodynamics (2nd edition)*, Mc Graw Hill book Co. NY.
3. Holman, J.P. : *Thermodynamics*, MC Graw Hill book Co. NY.
4. Yadav R. : *Thermodynamics and Heat Engines, Vol I & II (SI Edition)* Central Publishing House Allahabad.
5. Yadav R. : *Steam & Gas Turbines*.
6. Kshitish Chandra Pal : *Heat Power*, Orient Longman Limited, 17, Chitranjan Avenue, Calcutta.
7. S. Rao, B.B. Parulekar, 'Energy Technology', Khanna Pub., New Delhi.

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FPT303: FLUID MECHANICS

Code: FPT304

Credits: 04

L-T-P: 3-1-0

Properties of fluid. Fluid Statics: Pressure and its relationship with height, hydrostatic forces on submerged surfaces, Buoyancy and floatation. **Fluid kinematics:** Types and classification of fluid flow, flow rate and continuity equation, potential function and stream function, vortex flow.

Fluid Dynamics: Euler's equation, Bernoulli's Theorem, Momentum of fluids in motion.

Laminar viscous Flow: Reynolds number, Navier-stoke's equation, Hagen-Poiseuille equation, frictional loss. Turbulent Flow: Darcy-Weisbach equation, chezy's formula, shear stress in turbulent flow.

Flow through pipes: Pipe fittings and valves, loss of head due to sudden enlargement, contraction, at entrance and exit, due to obstruction, bend and various pipe fittings, flow through pipe in series and parallel, siphon, nozzles.

Boundary layer flows: Introduction, Prandtl's boundary layer equation and Boundary layer separation. Flow around submerged bodies: Drag force, lift and drag coefficient, drag on flat plate circular cylinder and sphere.

Flow Measurements: Orifice and venturi meter, Pitot tube, Rotameter and other flow measuring instruments. Hydraulic Pumps: Positive displacement and centrifugal pumps.

Reference:

1. *Unit Operation of Chemical Engineering - Mc Cabe, Smith & Harriot*
2. *Transport Processes and Unit Operations - Geankoplis*
3. *Chemical Engineering (Vol. I & II) - Coulson, J. M. & Richardson, J. F.*
4. *Introduction to Chemical Engineering - Badger, W. L. & Bacher, J. T.*
5. *Chemical Engineering Handbook - Perry, A. S. and Wenzel, L. A.*

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FPT304: FOOD CHEMISTRY AND NUTRITION

Code: FPT305

Credits: 03

L-T-P: 3-0-0

Water: The basic molecular of life. Physical properties of water. Properties of Hydration, solvation. Bound water, free water, gels, emulsions and foams, water activity. Distribution of water in various foods and moisture determination.

Carbohydrates: Nomenclature and classification, structure and chemical properties of monosaccharide carbohydrates CH-2 disaccharides and polysaccharides (cellulose, starch, fructans, galactans, hemi-cellulose, pectic substances, carageenan); changes in carbohydrates during processing. Carbohydrates determination methods.

Proteins: Classification, structure and properties of amino acids, structure of protein, physical and chemical properties of proteins. Changes in protein during processing, protein determination methods. Proteins from plant and animal sources.

Lipids: Classification, structure, physical and chemical properties of fatty acids and fats. Lipids-simple & derived. Changes during food processing.

Vitamins and Minerals : Sources and structures of minerals & vitamins; Effect of processing and storage of vitamins; Pro vitamins A & D; Vitamins as antioxidants.

Food Pigments & Flavouring Agents : Importance, types and sources of pigments — their changes during processing & storages.

Nutrition: Introduction to human nutrition; Nutritive values of foods; Basal metabolic rate; Techniques for assessment of human nutrition, Dietary requirements and deficiency diseases of different nutrients.

Text Books / References :

1. *Food science Chemistry & Experimental Foods* Dr. M.Swaminathan
2. *Food chemistry* by Lillian Hoagland Meyer
3. *Food Chemistry* by Fennema
4. *Essentials of Food and Nutrition*, Swaminathan, Vol 1 & 2
5. *Fundamentals of Food and Nutrition* by Sumati. R. Muldambi
6. *Nutrition and dietetics* by Rose
7. *Nutrition and dietetics* by Joshi

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FPT401: FOOD PRODUCT TECHNOLOGY-I (FRUITS AND VEGETABLES)

Code: FPT401

Credits: 03

L-T-P: 3-0-0

Current status of production and processing of fruits and vegetables. Structural, compositional and nutritional aspects. Post-harvest physiology, handling, losses and conservation of fruits and vegetables.

Techniques of extension of shelf life of unmodified produce: use of adjuncts, novel packaging, controlled and modified atmosphere storages.

Technology of Products: juices & pulps, concentrates & powders, squashes & cordials, nectars, fruit drinks & beverages carbonated and its quality control. Fermented products (Cider, wine, brandy).

Jam, Jelly & Marmalades; candied fruits, dried fruits and fruit products (eg. Aam papads, bars); soup mixes; sauces & ketchups; puree & pastes; chutneys & pickles.

Spices & condiments, spice oils oleoresins, Processing of cashew nuts, coffee & cocoa beans, and tealeaves, Specialty fruit and vegetable products.

Books Recommended

1. *Food science by B.Srilakshami;New Age International.*
2. *Fundamentals of Foods and Nutrition by R. Madambi & M.V. Rajgopal.*
3. *Foods :Facts and Principles by N Shakuntala manay;New Age International (P) Ltd.*
4. *Preservation of Fruits and Vegetable by Girdhari lal and Sidappa; CBS Publications*
5. *Food Science and Processing Technology, Vol., 2 by Mridula and Sreelata*
6. *Food Preservation by Sandeep Sareen*
7. *Fruit and Vegetable Preservation by Shrivastava and Kunal.*
8. *Post-Harvest Physiology & Handling of Fruits & Vegetables by Wills, Lee, Graham, McGlasson & Hall (AVI)*
9. *Literature from Spice Board of India, etc.*

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FPT402: FOOD PRODUCT TECHNOLOGY-II (CEREALS AND LEGUMES)

Code: FPT402

Credits: 04

L-T-P: 3-1-0

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.

Structure, types, composition, quality characteristics and physicochemical properties of wheat. Cleaning, tempering and conditioning, and milling processes for different wheat's. Turbogriding & 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.

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.

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.

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.

Books Recommended

1. *Cereals Technology* by Samuel A.Matz. CBS Publications.
2. *Technology of Cereals* by N.L.Kent.
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 CFTRI.
7. *Cereals & Cereals Products-Chemistry & Technology* by DAV Dendy & B.J.Dobraszezsk, Aspen Publication.
8. *Development in Milling & Baking Technology* by AFST (I), CFTRI, Mysore, India.
9. *Food Industries of CEEDC, IIT, Madras.*
10. *Articles on Pulse Milling in India Food Industry & JFST,both Publications of AFST (I).*

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FPT403: TRANSFER PROCESS ENGINEERING

Code: FPT403

Credits: 04

L-T-P: 3-1-0

Newton's law of viscosity, pressure and temperature dependence of viscosity, theory viscosity of gases (low density), and liquids, convective momentum transport. Shell momentum balance, boundary conditions, selected applications.

The Equations of change for isothermal system – Navier stokes equation, use of equations of change to solve steady state flow problems. Comparison of laminar and turbulent flow, time smoothed equations of change for incompressible fluids. The time smoothed velocity profile near a wall, turbulent flow in duct and jets.

Fourier's law of heat conduction, temperature and pressure dependence of thermal conductivity thermal conductivity of gases, liquids, solids and composite solids.

Shell energy balances, boundary conditions heat conduction with an electrical heat source, nuclear heat, viscous heat source, chemical heat source, composite walls and fines. Forced convection and free convection.

Fick's law of diffusion, analogy with heat transfer& mass transfer, Transport by molecular motion, shell mass balances, boundary conditions, temperature and pressure dependence of diffusivities, concentration profile for stagnant gas film, a heterogeneous chemical reaction, homogeneous chemical reaction and porous catalyst.

Reference:

1. Bird, R.B., Stewart, W.E. and Lightfoot, E.N., "Transport Phenomena," John Wiley, 1960
2. Christie J. Geankophis, " Transport process and unit operation". Prentice-Hall,India,"

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FPT404: FOOD MICROBIOLOGY

Code: FPT404

Credits: 04

L-T-P: 4-0-0

Introduction – definition, historical development and significance of food microbiology; Microscope; Classification & morphology of microbes; Techniques of pure culture; Bacteriology of air & water; Anti-microbial agents – physical & chemical – mechanism & action.

Micro-organisms importance in food - Factors affecting the growth of micro organisms in food - Intrinsic and Extrinsic parameters that affect microbial growth. Role of microbes in fermented foods and genetically modified foods.

Disinfection & disinfectants; Energy metabolism of aerobic & anaerobic microbes; Thermal inactivation of microbes; Concept, determination & importance of TDT, F, Z & D values; Factors affecting heat resistance; Pasteurization and sterilization.

Microbiology of milk & milk products like cheese, butter, ice-cream, milk powder; Microbiology of meat, fish, poultry & egg and their products.

Food borne diseases: *Bacterial food borne diseases* (Staphylococcal intoxication, Botulism, Salmonellosis, Shigellosis, Enteropathogenic Escherichia Coli Diarrhoea, Clostridium Perfringens gastroenteritis, Bacillus cereus Gastroenteritics) Food Borne Viral Pathogens (Norwalk virus, Norovirus, Reovirus, Rotavirus, Astrovirus, Adenovirus, Parvovirus, Hepatitis A Virus) *Food Borne Animal Parasites* Protozoa, Giardiasis, Amebiasis, Toxoplasmosis, Sarcocystosis, Cryptosporidiosis. Cysticercosis/Taeniasis. Roundworm Trichinosis, Anisakiasis. *Mycotoxins*: Aflatoxicosis, Deoxyvalenol Mycotoxicosis, Ergotism

Text Books / References :

1. *Essentials of Microbiology*; K. S. Bilgrami; CBS Publishers, Delhi
2. *Food Microbiology*; WC Frazier; Tata McGraw Hill, Delhi
3. *Modern Food Microbiology*; James M Jay; CBS Publishers, Delhi
4. *Microbiology*; Pelczar, Chan and Krieg; Tata McGraw Hill, Delhi
5. *Basic Food Microbiology*; Bannett, Chapman and Hall
6. *Food Microbiology*; M. R. Adams
7. *Hand Book of Microbiology*; Bise
8. Pelezar, M.I and Reid, R.D. (1993) *Microbiology McGraw Hill Book Company, New York, 5th Edition.*
9. Jay, James, M(2000) *Modern Food Microbiology, 2nd Edition. CBS Publisher*
10. Frazier, W.C. (1988) *Food Microbiology, Mc Graw Hill Inc. 4th Edition.*
11. Doyle, P. Bonehat, L.R. and Mantville, T.J-(1997): *Food Microbiology, Fundamentals and Frontiers, ASM Press, Washington DC.*

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FPT501: FOOD INDUSTRY WASTE MANAGEMENT

Code: FPT501

Credits: 04

L-T-P: 4-0-0

Characterization and utilization of by-products from cereals, pulses, oilseeds, fruits, vegetables, plantation, dairy, eggs, meat, fish and poultry processing industries. Elements of importance in efficient management of wastes from aforesaid food industries.

Standards for emission or discharge of environmental pollutants from food processing industries covered under PFA Act., 1986. Characterization of food industries effluents, in terms of parameters of importance.

Unit concept of treatment of food industry effluents: Screening, sedimentation, floatation as per and primary treatments, biological oxidations:– objectives, organisms, reactions, oxygen requirements, aeration devices.

Effect on characteristic parameters of effluents in treatments using lagoons, trickling filters, activated sludge process, oxidation ditches, rotating biological contractors and their variations and advanced modifications.

Advanced wastewater treatment systems: physical, physicochemical and chemical treatments. Coagulation and flocculation, disinfection, handling and disposal of sludge and treated effluents conforming to EPA provisions.

Books Recommended:

1. *Water technology* by N.F.Gray.
2. *Environmental pollution* by K.C.Agrawal.
3. *Industrial microbiology* by L.E.Casida Jr
4. *Environmental pollution control engineering* by C.S. Rao.
5. *Food processing waste management by green and Kramer (AVI)*
6. *By- products from food industries: utilization and disposal* by AFSI(I)
7. *Environment (protection) act, 1986.*
8. *Handbook of advanced wastewater treatment* by Culp and Wisner.

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FPT502: FOOD PRODUCT TECHNOLOGY-III (MILK & MILK PRODUCTS)

Code: FPT502

Credits: 04

L-T-P: 3-1-0

Introduction: Status of Dairy Industry in India. Cooperative Dairying. Operation Floods. Chemical composition, microbiological quality, and nutritional importance of milk and milk product in PFA Act, Rules, 1955 as amended to date.

Fluid Milks: Physicochemical characteristics and factors affecting them. Production, collection, testing quality, cooling, storage, and transportation of liquid milks. Receiving and quality assessing of liquid milk in dairy industry for detection of adulteration, decision for acceptance/rejection, and determination of price of the milk.

Standardization and/or processing (pasteurization, sterilization and UHT processing), storage, packaging and distribution of liquid milks: whole, standardized, toned, double-toned, and skim milk. Recombined, reconstituted, and flavored milks. Cleaning and sanitization of dairy equipments and plant as a whole.

Milk Products: Definition, composition, methods of preparation/production, quality and/or grading parameters, packaging, storage characteristics, uses and shelf-life of cream, butter and ghee; evaporated and condensed milks, skimmed, whole and instants milk powders.

Ice-Creams, fermented milks (Curd, yogurt etc.) and milk-products (cheeses, butter milk, lassi etc.); other milk products (khoa, casein, whey proteins, lactose etc.); milk and milk product based sweetmeats (burfi, rasogolla, milk-cake, kalakand, ruberii etc.)

Books Recommended:

1. *Outlines of Dairy Technology* by Sukumar De, Oxford University Press.
2. *Principles of Dairy Processing* by James N. Warner, Wiley Eastern Ltd.
3. *Milk and Milk Products* by Eckles, Combs; and Macy, Tata McGraw Hill.
4. *Technology of Indian Milk Products* by Aneja et al. A Dairy India Publication.
5. *PFA Act 1954 & Rules 1955 as amended to date.*
6. *Robinson RK; 1996; Modern Dairy Technology, Vol 1 & 2; Elsevier Applied Science Pub.*
7. *Milk & Milk Processing; Herrington BL; 1948, McGraw-Hill Book Company.*
8. *Modern Dairy Products, Lampert LH; 1970, Chemical Publishing Company.*
9. *Developments in Dairy Chemistry – Vol 1 & 2; Fox PF; Applied Science Pub Ltd.*

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FPT503: FOOD PROCESS ENGINEERING

Code: FPT503

Credits: 04

L-T-P: 3-1-0

Geometrical, physical, functional and growth property of foods. Cleaning, sorting and grading of foods. Size Reduction: Principles and types of size reduction equipment, disintegration of fibrous materials, screening, types of screen and mechanical separations. Mixing: Mixing of liquids and solids (powder), mixing equipments. Agitation, types of agitators.

Filtration: Principle of filtration, types of filtration equipments, settling classifiers, flotation and centrifugation, types of centrifuge.

Drying: Principle of drying and dehydration, rate of drying and drying equipments. Crystallization: equipments, crystal growth, crystallization process.

Humidification: General theory, psychometric chart, fundamental concept of humidification and dehumidification, cooling tower.

New separation Techniques: Introduction to membrane based separation techniques, reverse osmosis, ultra filtration, micro filtration, evaporation, dialysis. Foam separation, micellar separation and supercritical fluid extraction.

Reference:

1. *Food Engineering Operation - Brennan, Butters, Cowell and Lilly.*
2. *Food Process Engineering - Heldman, D. R. and Singh, R. P.*
3. *Fundamental of Food Process Engineering - Romeo T. Toledo*
4. *Unit Operation of Chemical Engineering - Mc Cabe, Smith & Harriot*
5. *Mass Transfer Operation - Treybal, R. E.*
6. *Chemical Engineering (Vol. I & II) - Coulson, J. M. & Richardson, J. F.*

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FPT504: MECHANICAL DESIGN OF PROCESS EQUIPMENT

Code: FPT504

Credits: 03

L-T-P: 3-0-0

Material of construction: Introduction to material selection; Material properties; Environmental effects on material selection; Mechanical properties & strength of materials. Design basis: Design code; Design pressure; Design temperature; Design stress & factor of safety; Design & actual thickness; Corrosion allowance; Weld joint efficiency factor; Design loadings; Criteria of failure.

Design of thin walled process vessels: Cylindrical & spherical vessels under internal and external pressure; Design of attachments and closures; Compensation for openings; Design of flange connections & threaded fasteners; Design of supports.

Design of thick walled high pressure vessels; Design of piping; Methods of fabrication of ferrous & non-ferrous metals; concrete, wood and other non-metallic construction.

Design of belt and chain drives; toothed gearing; shafting & bearing; specification of handling equipment.

Reference:

1. *Introduction to Chemical Equipment Design — Mechanical Aspects*; B. C. Bhattacharya; CBS Publishers, Delhi
2. *Process Equipment Design*; H. C. Hesse and J. H. Rushton; Van Nostrand, East West Press
3. *Selection of Material and Fabrication for Chemical Process Equipment*; B. C. Bhattacharya; Chem. Engg. Education Dev. Centre; I.I.T Madras
4. *Process Equipment Design*; L. E. Brownell and E. H. Young; John Wiley and Sons, Inc. N.Y.
5. *Computer Aided Design of Chemical Process Equipment*; B. C. Bhattacharya; and C. M. Narayanan; New Central Book Agency, Kolkata
6. *Mechanical Design and Fabrication of Process Equipment*; B. C. Bhattacharya; Khanna Publishers, Delhi

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IE604: PROCESS INSTRUMENTATION AND CONTROL

Code: IE604

Credits: 04

L-T-P: 3-1-0

Introduction of process variables, static and dynamic characteristic of instruments and their general classification. Elements of measuring system and their function, principles, construction and operation of instruments for the measurements, transmission, control/ indication / recording of process variables like pressure, flow, level, humidity and composition. Principles of transducers: electropneumatic, pneumatic, electrical and multipressure.

Construction and characteristics of final control elements such as proportional, integral, PD, PID controllers, pneumatic control valve, principles and construction of pneumatic and electronic controllers.

Process instrumentation diagrams and symbols, process instrumentation for process equipments such as distillation column, heat exchangers, fluid storage vessel.

Laplace Transform, Linear open loop system, first and second order system and their transient response. Interacting and non interacting system. Transportation lag, linear closed loop system, block diagram of closed loop transfer function, controllers, transient response of closed loop systems.

Stability concept, Routh stability criterion, relative stability, huwitz Stability criterion, Nyquist's criterion. Root locus technique, introduction to frequency response, Bode diagrams, Bode stability criterion, gain and phase margins, Ziegler Nicholas controller setting.

Reference:

1. Coughanowr, D. R. *Process Systems Analysis and Control 2nd edition McGraw Hill 1991.*
2. Stephanopoulos, G , *Chemical process control PHI,1984 ,NEW DELHI.*
3. Luyben, W. L, *Process Modeling, Simulation and Control for Chemical Engineers, McGraw hill, 1973.*
4. Patranabis D., *Principles of Industial Instrumentation .*
5. Eckman D.P., *Principles of Industrial instrumentation Willey Eastern,1978.*

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FPT601: FOOD PACKAGING TECHNOLOGY

Code: FPT602

Credits: 03

L-T-P: 3-0-0

Functions of packaging; Type of packaging materials; Selection of packaging material for different foods; Selective properties of packaging film; Methods of packaging and packaging equipment.

Mechanical strength of different packaging materials; Printing of packages .Barcodes & other marking; Interactions between packaging material and foods; Environmental and cost consideration in selecting packaging materials.

Manufacture of packaging materials; Potential of bio-composite materials for food packaging; Packaging regulations; Packaging and food preservation; Disposal of packaging materials.

Testing of packaging; Rigid and semi rigid containers; Flexible containers; Sealing equipment; Labelling; Aseptic and shrink packaging; Secondary and transport packaging.

References:

1. *Food and Packaging Interactions* by Joseph H. Hotchkiss, (ACS symposium series -365, April 5-10, 1987, American chemical society, Washington DC, 1988.)
2. *Packaging foods with plastics* by winter A. Jenkins & James P Harrington – Technomic publishing co. Inc, Lancaster. Basel.
3. *Flexible food packaging (Question & Answers)* by Arthur Hirsch VNB – Van Nostrand Reinhold, New York (An AVI Book), ISBN 0-442-00609-8.
4. *Food Packaging and Preservation (theory & practice)* by M.Mathlouthi- Elsevier Applied science publisher, London and New york.
5. *Food Packaging Materials (Aspect of Analysis & Migration of contaminants)* by N.T.crosby applied science publishers LTD. London.
6. *Plastics in Packaging* by A.S Athlye, TMGH, New Delhi.
7. *Packaging (specifications, purchasing & Quality Control)* 3rd edition by Edmond A Leonard-Marcel Dekker, INC- Newyork & Basel.
8. *Plastics in packaging* by forwarded by H.B Ajmera & M.R Subramanium – Indian institute of packaging. Published by A.P.Vaidya, Secretary IIP, E2, MIDC, Industrial Area (Andheri (East), Bombay-400093.
9. *Food Packaging-* Stanley Sacharois & Roger C. Griffin- The AVI Publishing company Inc. 1970.
10. *Principles of packaging development-* Griffin & Sacharow. (The AVI Publishing company, Inc. 1972).

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FPT602: FOOD ANALYSIS, QUALITY CONTROL AND MANAGEMENT

Code: FPT603

Credits: 03

L-T-P: 3-0-0

Ways of describing food quality: Composition, appearance, kinesthetic and flavor attributes. Nutritional quality of foods and its assessment (content and quality of nutrients). Microbiological quality of foods.

Sensory quality and its evaluation, instrumental measurement of sensory attributes such as color, viscosity, texture etc.

Quality control, quality assurance and total quality management in food industry-ISO9000, 14000 series.

Defects in food quality, its sources, classification, prevention and control. Statistical quality control. Quality costs.

Antinutritional factors in food. Undesirable constituents developing in Process and storage of food. Microbial contamination, pesticide residues, concept of HACCP, physical, chemical and microbiological safety of food.

Books Recommended:

1. *Quality control in the food industry* -S. M. Herschfoerfer
2. *Quality control for the food industry* -A. Kramer and B.A.Twigg
3. *Principles of sensory evaluation of Foods* -M. A. Amerine
4. *Rheology and Texture in Food Quality* -J. M. deMan, P. W. Vowsy
5. *Food Chemistry* - Fenemma
6. *Analysis of Fruits and vegetables* -Ranganna

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FPT603: BIOCHEMISTRY AND BIOTECHNOLOGY

Code: FPT604

Credits: 04

L-T-P: 4-0-0

Introduction to Biochemistry. Proteins and protein structures; Essential amino acids. Metabolism of proteins (digestion and absorption); Nitrogen balance & nitrogen pool; Evaluation of quality of proteins,

Enzymes; Definition, function, classification, nomenclature & structure; Co-enzymes and its function; Mechanism of enzyme action, enzyme kinetics & environmental effects; Enzyme inhibition.

Carbohydrates; Definition & classification; General chemistry of carbohydrates; Metabolic pathways for breakdown of carbohydrates: glycolytic pathway, pentose phosphate pathway, citric acid cycle, electron transport chain, ATP balance, gluconeogenesis; General chemistry of lipids; Essential fatty acids; Digestion & absorption of lipids.

Biotechnology-General definition; Application of Biotechnology in relation to food processing technology, Principles of genetic engineering and its applications; Concept of tissue culture, DNA technology.

Text Books / References :

1. *Lehninger, Nelson & Cox, Principle of Biochemistry, CBS Publication*
2. *Modern Experimental Biochemistry, Boyer, Pearson Education*
3. *Lubert stryer, Biochemistry, Freeman & Co, N.Y.*
4. *Voet & Voet, Fundamentals of Biochemistry, Jonh Willey & Sons*
5. *Hames, B. D. (Ed), Biochemistry, Viva Books*

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FPT701: FOOD HYGIENE AND PLANT SANITATION

Code: FPT701

Credits: 0

L-T-P: 3-0-0

General principle of food hygiene, Hygiene in rural and urban areas in relation to food preparation, personal hygiene and food handling habits. Place of sanitation in food plants. Sanitary aspects of building and equipment: Plant layout and design, Comparative studies on sanitary fabrication of different types of processing equipments.

Safe and effective insect and pest control: Extraneous materials in foods, Principles of Insects and pets control. Physical and chemical control. Effective control of micro-organisms: microorganisms important in food sanitation, micro-organisms as indicator of sanitary quality. Physical and chemical methods.

Sanitary aspects of water supply: Source of water, quality of water, water supply and its uses in food industries. Purification and disinfection of water preventing contamination of potable water supply.

Effective detergency and cleaning practices: Importance of cleaning technology, physical and chemical factors in cleaning, classification and formulation of detergents and sanitizers, cleaning practices.

Sanitary aspects of waste disposal. Establishing and maintaining sanitary practices in food plants, role of sanitation, general sanitary consideration and sanitary evaluation of food plants.

Books Recommended:

1. *Guide to Improve Food Hygiene - Gaston and Tiffney*
2. *Practical Food Microbiology & Technology - Harry H. Weiser, Mounthey, J. and Gord, W.W.*
3. *Food Poisoning and Food Hygiene - Betty C. Hobbs*
4. *Principles of Food Sanitation - Marriott and Norman, G.*
5. *Hygiene and Sanitation in Food Industry - S. Roday*
6. *Basic Concepts of Industrial Hygiene, Ronald M Scott, CRC Press.*
7. *Safety design criteria for industrial plants. Maurizio Cumo & Antonio Naviglia. CRC Press.*
8. *Industrial Hygiene & Toxicology by Josef Brozek-1948.*
9. *Food Hygiene, Microbiology & HACCP. S J Forsythe, P R Hayes. Springer.*

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FPT 702 FOOD PROCESS EQUIPMENT DESIGN

Code: FPT702

Credits: 0

L-T-P: 3-0-0

Introduction to design of post harvest equipments. Design considerations and their interaction with material selection, equipment size and structural design. Code and material selection.

Design of material handling equipment: Belt conveyor, bucket elevator, screw conveyor, cyclone conveyor, chain conveyor, pneumatic conveyor.

Design of heat exchangers: Shell and tube, plate and scraped surface heat exchanger (Design will include functional & structural design).

Design of seed processing equipments: Air screen cleaner, rotary cleaner, graders based on size shape and surface produce handled, seed treater.

Storage and pressure vessels: Design of shell conveyor and other components including nozzles, flanges, reinforcement.

Books Recommended:

1. *Process Plant Design - Beckhurst, J. K. and Harber, J. H.*
2. *Process Equipment Design - Brownell, L. E. and Young, E. H.*
3. *Process Equipment Design - Joshi, M. V.*
4. *Chemical Engineering Handbook - Perry, R. H. and Chilton, C. H.*
5. *Fundamentals of Food Process Engineering, 2nd ed; Toledo Romeo T; CBS Publishers.*
6. *Preservation of Fruits & Vegetables; Lal G, Sidhapa GS & Tandon GL; ICAR.*
7. *Introduction to Chemical Equipment Design – Mechanical Aspects; Bhattacharyya BC; CBS Publis*

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FPT 703 FOOD ADDITIVES AND LEGISLATION

Code: FPT703

Credits: 03

L-T-P: 3-0-0

Definitions, uses and functions of Acid, Base, Buffer systems, Salts and chelating/sequestering agents, Masticatory substances. Low calorie and non nutritive sweeteners, Polyols.

Antioxidants, Emulsifying and stabilizing agents, Anti-caking agents, thickeners, Firming agents. Flour bleaching agents and Bread improvers.

Anti microbial agents / Class I and Class II preservatives as per PFA Act.

Colorants, Flavoring agents and related substances, Clarifying agents. Gases and Propellants. Tracers and other additives.

Food standards and Specifications: Compulsory and voluntary trade and Company standards. Consumer Protection Act (1986) and relevant Food Legislation (Act, orders, standards): PFA(1954), FPI(1955), SWMA, MPO(1977), VCO(1978), AgMark, BIS, US, Canadian, EU, ISO and Codex Food Standards, Export Quality Control and Inspection act (1963), Environment Protection Act (1986), WTO & GATT.

Books Recommended:

1. *Food Chemistry O.R.Fennema*
2. *Food Chemistry Belitz, Grosch*
3. *Various acts, orders, standards & specification*

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FPT801: PLANT DESIGN AND PROJECT ENGINEERING

Code: FPT801

Credits: 03

L-T-P: 3-0-0

Process Design and Development: General designs considerations; The hierarchy of chemical process Designs, The Nature of process synthesis and Analysis; Developing a conceptual design and finding the best Flowsheet: input information and batch versus continuous, input/output structure of the flowsheet.

Recycle structure of the flowsheet; separation system; heat exchangers system networks. Plant Designs: process designs development and general designs considerations.

Process Economics: Economics feasibility of project using order of magnitude cost estimates plant and equipments cost estimations, product cost estimations.

Cash flows: Time value of money, investment, costs, sales, profits, taxes, depreciation.

Profitability Analysis: Rate of return, payback period, discount rate of return, net present worth, internal rate of return, comparing investment alternatives.

References:

1. Douglas ,J.M. , “*Conceptual Designs of Chemical Processes*”,. McGraw Hill, 1989.
2. Peters ,M.s and Timmerhaus ,K.D, “*Plant Designs and Economics for Chemical Engineers*” 4th Edition McGraw Hill,1 991
3. Biegler L.,grossmann I.E.and Westeberg A.W. “*Systematic Methods of Chemical Engineering and Process Designs* ,” prentice Hall ,1997.

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ELECTIVE COURSES

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FPT611: FOOD PRODUCT TECHNOLOGY-IV (BAKERY, CONFECTIONARY AND EXTRUDED PRODUCTS)

Code: FPT611

Credits: 03

L-T-P: 3-0-0

Current status, growth rate, and economic importance of Bakery and Confectionary Industry in India. Product types, nutritional and safety of products, pertinent standards & regulations.

Bakery Products: Ingredients & processes for breads, biscuits, cookies & crackers, cakes & pastries; doughnuts; rusks; other baked products.

Equipments used, product quality characteristics, faults and corrective measures for above bakery products. Defining and assessing quality of ingredients & products.

Confectionary Products: Hard-boiled candies, toffees fruit drops, chocolates and other confections:- ingredients, equipments & processes, product quality parameters, faults and corrective measures.

Production & quality of chewing and bubble gums, cocoa products, breakfast cereals, macaroni products, sprouted grains.

Extruded Products: 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.

Books Recommended

1. *Bakery Technology and Engineering* by Samuel a. Matz, CBS Publications.
2. *Cereals as Food and Feed* by Samuel A.Matz, CBS Publications
3. *Industrial Chocolate Manufacture* by Beckette.
4. *Dough rheology and baked product texture* by Faridi Faubion, CBS Publications.
5. *Chocolate, Cocoa and Confectionary* by Minifie B.W.
6. *Cookies & Cracker Technology* by S.A. Matz.
7. *Baking Science and Technology* by Pylar
8. *Basic Baking* by S.C. Dubey.
9. *Extrusion of Food, Vol 2; Harper JM; 1981, CRC Press.*
10. *Up to-date Bread Making; Fance WJ & Wrogg BH; 1968, Maclasen & Sons Ltd.*
11. *Modern Cereal Chemistry; Kent-Jones DW & Amos AJ; 1967, Food Trade Press Ltd.*

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FPT612: FOOD PRODUCT TECHNOLOGY-V (OILS AND FATS)

Code: FPT612

Credits: 03

L-T-P: 3-0-0

Sources; chemical composition; physical and chemical characteristics; functional and nutritional importance of dietary oils and fats. Post-harvest handling storage and processing of oilseeds 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.

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.

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.

Books Recommended

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).
5. *The Chemistry & Technology of Edible Oils and Fats;* Devine J & Williams PN; 1961, Pergamon Press.
6. *Food Oils and their Uses;* Weiss TJ; 1983, AVI.
7. *Edible Oils & Fats: Developments since 1978 (Food Technology Review # 57);* Torrey S; 1983, NDC.

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FPT711: INDUSTRIAL MICROBIOLOGY & ENZYME TECHNOLOGY

Code: FPT711

Credits: 03

L-T-P: 3-0-0

Introduction: Classification of Microbial products. Microbial Processes for Production of organic acids, solvents, antibiotics, enzymes, polysaccharides, lipids, pigments and aroma.

Equipments and Accessories for industrial processes.

Stability of Enzymes. Enzymes stabilization by selection and genetic Engineering, protein engineering.

Reaction Environment rebuilding, Chemical modification, intra-molecular cross linking, immobilization.

Application of enzymes in industry, analytical purpose and medical therapy

Books Recommended:

- 1. Industrial microbiology:-Casida Newage Publication 2001*
- 2. Industrial microbiology:-Prescott and Dunn CBS Publications 4th Ed. 1999*
- 3. Enzymes:-Trevor. Horwood 2001*
- 4. Journals and Reviews*

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EC718: APPLIED ELECTRONICS

Code: EC718

Credits: 03

L-T-P: 3-0-0

Transistor-Transistor as an amplifier: low frequency, single stage and multistage amplifier
Regulated Power Supply: Capacitors filters for single phase rectifiers. Application of 3-pin voltage regulators ICs 78**/79**317/337

OPAMP :Introduction to operational amplifiers. Applications of OPAMP:1) Summing scaling, Averaging, integrator and differentiator:2) OPAMP as comparator 3) Instrumentation Amplifier and its application.

Digital Electronics :(1) combinational circuits :multiplexers, demultiplexers, decoders, encoders, (2) flipflops:S-R F/F, clocked S-R, F/F, DF/F, J-KF/F, TF/F (3) Counters :Asynchronous (Ripple) counter, Asynchronous UP/DOWN counter, Synchronous counter, Synchronous UP/DOWN counter (4) Registers:Serial-in, Serial-out; Parallel-in, serial-out; Serial-in, parallel out; Serial/parallel in, Serial/Parallel out.

D/A converters: R/2R register ladder. D/A converter. A/D converters :successive approx. A/D converter.

Microprocessor :Concept of microprocessor, software architecture of 8086, Addressing modes, Data transfer arithmetic logical, Jump/Call, String instructions, Writing simple assembly language programmes, Technical details of serial and parallel ports of IBM compatible PC.

Books Recommended:

1. Millman, Halkias, "Basic Electronics", Tata McGraw-Hill.
2. Coughlin and Driscoll, "Operational Amplifiers and Linear integrated Circuits", Prentice Hall of India.
3. Bray B.B, "8086-486 Intel Microprocessor", Prentice Hall of India.
4. Hall, D., "8086 Microprocessor", Tata McGraw Hill.

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HU 711 MARKETING AND SALES MANAGEMENT

Code: HU711

Credits: 03

L-T-P: 3-0-0

Marketing Concept-Defining Marketing,Core Marketing Concept: Production Concept, Product Concept,Selling concept and Marketing Mix Concept.

Analysing Consumer Markets & Buyer Behaviour, Major factors influencing buyer behavior: Cultural factors,personal factors,Social factors and psychological factors.Concept of Family Life Cycle.

Product policy-product and service differentiation,Product concept,product levels,product classification,New product Development process,product life cycle,Product Mix Decesion,Branding.Concept of price wars.

Promotion policy-Need for promotion, promotion techniques.

Channel and Distribution policy-Channel Structure,Channel decision,Wholesaling,Retailing,Physical Distribution decisions.Tranport modes available in India with its merits and demerits.

Sales Management,Selling function-personnel selling-Locating prospects,building prospect list,Pre-call planning, Sales approach-customer Needs Analysis-Sales Presentation-Handling Customer objections.

Territory Management.Sales ethics.Sales forecasting.Recruitment Training Sales people,Compensation for sales people,Evaluating Sales force performance.

Reference Books:

1. *Philip Kotler—Marketing Management*
2. *Vaswas Das Gupta—Sales Management*
3. *Fredrick Russel—Selling:Principles & Practices*

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FPT712: FERMENTATION TECHNOLOGY

Code: FPT712

Credits: 03

L-T-P: 3-0-0

Fermentation Pathways for Industrial Products: Biochemical pathways of metabolic reactions for utilization of carbon sources and formation of different metabolites by micro organisms; Possibility of control of the reactions for the increased formation of useful metabolites. Strain 24 Development - Various techniques of modifying the strains for increased production of industrial products. Use of chemicals, UV rays, genetic engineering to produce newer strains.

Media for Fermentation: Importance of media components for production of industrial products by fermentation; use of different sources of carbon, nitrogen, minerals and activators for commercial fermentation; importance of pH, temperature and aeration in fermentation; optimization of fermentation media.

Different Types of Fermenters: Laboratory and plant fermenters; shake flasks and advantages; laboratory fermentation systems with various controls and sampling and data collection provisions; aeration and agitation; production fermenters; sterilization of media; cooling systems; inoculation, temperature and pH control systems; scale-up of fermentation process.

Downstream Processing: Various equipment for product recovery; micro-filters and Ultrafiltration systems for separation of cells and fermentation medium and for concentration of medium containing product; chromatographic systems of separation; extraction of product with solvent; evaporation and crystallization; centrifugation, different types of centrifuges; drying techniques; instrumentation and controls.

Fermentative Production: a) Foods: Processes for preparing fermented products including Yogurt (curd) and other Traditional Indian Products like idli, dosa, dhokla, shrikhand, etc., Soya based products like soya sauce, natto, etc., Cocoa, Cheese etc.; control of quality in such products. Alcoholic Beverages based on fruit juices (wines), cereals (whisky, beer, vodka etc.), sugar cane (rum) etc. Process description, quality of raw materials, fermentation process controls etc.

b) Industrial chemicals: Fermentative Production of Organic acids like (Citric Acid, Lactic Acid), Amino Acids (Glutamic acid, Lysine), Antibiotics (Erythromycin, Penicillin), Polysaccharides (Dextran, Xanthan) etc.; steroids transformation and industrial enzyme production by micro-organisms; process descriptions and key controls for optimal production.

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References:

1. Vogel, H.C. and C.L. Todaro, 2005 *Fermentation and Biochemical Engineering Handbook : Principles, Process Design and Equipment* , 2nd Edition, Standard Publishers.
2. El-Mansi, E.M.T, 2007, *Fermentation Microbiology and Biotechnology* 2nd Edition, CRC / Taylor & Francis.
3. Joshi, V.K. and Ashok Pandey, 1999, *Biotechnology: Food Fermentation, Microbiology, Biochemistry and Technology* , Vol. I & vol. II Educational Publisher.

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FPT713: REFRIGERATION AND AIRCONDITIONING

Code: FPT713

Credits: 03

L-T-P: 3-0-0

Introduction : Review of basic laws of thermodynamics; Method for production of cold; Reversed Carnot cycle; Carnot; Refrigeration and heat pumps.

Mechanical Vapour Compression Refrigeration: Simple vapour compression cycle; Comparison with reversed cannot cycle; Standard rating cycle and effect of operating conditions; Evaporator pressure; Condenser pressure; Suction vapour superheat and liquid subcooling on cycle performance; Actual cycle.

Properties of Refrigerants: Designation of refrigerants; characteristics; Thermodynamic physical and chemical requirements. Multistage and Multi-evaporator Systems Cascade systems; Ice manufacture.

Compressors: Type of compression processes: Volumetric efficiency; Principle dimensions; Performance characteristics and performance of reciprocating compressors.

Expansion Valves: Construction and working of automatic and thermostatic expansion valves.

Evaporators: Flooded and dry evaporators; Mechanism of cool boiling in evaporators; Flow boiling in evaporators.

Condensers: Air cooled and water cooled condensers; Evaporative condensers.

Vapour Absorption System of Refrigeration: Simple vapour absorption system; Physical, chemical and thermodynamic requirements of refrigerant absorbent mixtures; Modifications in simple vapour absorption system.

Air Conditioning: Psychrometry; Psychrometric properties of moist air; Adiabatic psychrometer chart.

Psychrometric Processes : Psychrometry of air conditioning processes; Air washers; Winter air conditioning; Simple air conditioning system; State and mass rate of supply air.

Design Conditions: Inside and outside design conditions; Comfort chart and effective temperature and respiration heat.

Cooling Load Calculations: Internal and system heat gains; Ventilation load; Cooling load estimate; Design of cold storages.

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Transmission and Distribution of Air: Room air distribution; Total static and velocity pressure; Friction and dynamic losses in ducts.

References:

1. Arora, C.P. *"Refrigeration and Air Conditioning"*. Tata Me Graw Hills, 1981.
2. Prasad, Manohar. *"Refrigeration and Air Conditioning"*. Wiley Eastern, 1983.
3. Dossat, R.J. *"Principles of Refrigeration"*. Wiley Eastern, 1981.
4. Stoecker, W.F. *"Refrigeration and Air Conditioning"*. Me Graw Hill.

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FPT811: MODELING AND SIMULATION OF FOOD PROCESSES

Code: FPT811

Credits: 03

L-T-P: 3-0-0

Introduction to mathematical modeling; Process analysis and simulation; Model building; Classification and uses of mathematical models; Formulation of mathematical model and fundamental laws.

Batch processes in food industry; Equilibration in batch processes; Steady state flow processes of non reacting systems; Mixing in flow processes.

Simultaneous heat and mass transfer in packed tower and immobilized enzyme system.

Modelling, simulation and optimization of fermentation processes.

References:

- 1. Process modeling, simulation and control: William L Luyben, TMH*
- 2. Process analysis & simulation : Himmelblau, Kenneth & Birchoff, John Wills.*

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FPT812: CONCENTRATION AND DEHYDRATION OF FOODS

Code: FPT812

Credits: 03

L-T-P: 3-0-0

Introduction: Importance of concentration and dehydration; Various methods; Concept of water activity and sorption isotherms; Fundamentals of air-water vapour mixtures; Physico-chemical Changes caused by concentration and dehydration.

Evaporation: Properties of liquid for selection; Heat and mass balance on single and multiple effect evaporators; Types of evaporators.

Freeze Concentration: Applications, Advantages and disadvantages; Principles involved; Types of freeze concentrators.

Membrane Concentration Process: Fundamentals of membrane processing; Application of UF and RO Membranes; Properties of membranes; Types of UF and RO modules; Permeate flow calculations.

Drying of Liquid Foods: Methods of drying; Spray Drying: Stages involved, types of atomizers, types of spray dryers; powder removal methods, drying time calculation, two stage drying, factors affecting powder properties, instantiation; Drum Drying: Types of drum dryers, methods of feeding liquid, design of drum dryer.

Drying of solid foods: Drying process - constant rate period, falling rate period; mechanisms of moisture transfer; drying time calculations; factors affecting drying time; types of dryers.

Freeze Drying: Fundamentals of freeze drying; Freezing; Primary and secondary drying; Freeze-drying calculations; Types of freeze dryers.

Reference:

1. Billet, Reinhard, "Evaporation Technology: Principles, Applications and Economics" VCH Publishers, 1989.
2. Hansen, Robert, "Evaporation, Membrane Filtration and Spray Drying". North European Dairy Journal Denmark, 1985.
3. Mact.arthy, D. "Concentration and Drying of Foods", Elsevier Applied Science, 1986.
4. Kessler, H.G. "Food Engineering and Dairy Technology". V.A. Kessler, Germany, 1990.
5. Barbosa - Canovas, V. and Vega - Mercado, H. "Dehydration of Foods", Chapman and Hall, New York 1996.

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FPT813: FOOD PRODUCT TECHNOLOGY-VI (FISH, MEAT AND POULTRY TECHNOLOGY)

Code: FPT813

Credits: 03

L-T-P: 3-0-0

Classification of fresh water fish and marine fish; Commercial handling, storage and transport of raw fish; Average composition of fish; Freshness criteria and quality assessment of fish; Spoilage of Fish; Methods of Preservation of fish: Canning, Freezing, Drying, Salting, Smoking and Curing.

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.

Slaughtering technique of animal; Meat cuts and portions of meat, muscle; Color of meat; Post mortem changes of meat; Meat processing - curing and smoking; Fermented meat products (meat sausages & sauces); Frozen meat & meat storage;

By-products from meat industries and their utilization; Meat industries in India.

Classification of poultry meat; Composition and nutritional value of poultry meat & eggs ; Processing of poultry meat and eggs; Spoilage and control; Byproduct utilization and future prospects; Poultry farms in India.

Text books/ References:

1. *Processed Meats*; Pearson AM & Gillett TA; 1996, CBS Publishers.
2. *Meat*; Cole DJA & Lawrie RA; 1975, AVI Pub.
3. *Egg and poultry meat processing*; Stadelman WJ, Olson VM, Shemwell GA & Pasch S; 1988, Elliswood Ltd.
4. *Developments in Meat Science – I & II*, Lawrie R; Applied Science Pub. Ltd.
5. *Egg Science & Technology*; Stadelman WJ & Cotterill OJ; 1973, AVI Pub.
6. *Fish as Food*; Vol 1 & 2; Bremner HA; 2002, CRC Press.
7. *Fish & Fisheries of India*; Jhingram VG; 1983, Hindustan Pub Corp.

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FPT814: OPTIMIZATION TECHNIQUES IN FOOD ENGINEERING

Code: FPT814

Credits: 03

L-T-P: 3-0-0

Introduction: Engineering application of optimization, Formulation of design problems as a mathematical programming problems, Classification of optimization problems.

Linear Programming: Simplex methods, Revised simplex method, Duality in linear programming, post optimality analysis, Transportation and assignment problems.

Non Linear Programming: Unconstrained optimization techniques, Direct search methods, Descent methods, constrained optimization, Direct and Indirect methods.

Dynamic Programming: Introduction, multi decision process, computational procedure.

Reference:

1. Haddley, G. "*Linear Programming*".
2. Fox, R.L. "*Optimization Methods for Engineering Design*". Addison Wesley USA., 1971,
3. Kambo, N.S. "*Mathematical Programming Technique*" .. Affiliated East West Press, New Delhi,
4. Rao, S.S. "*Optimization Theory and Application*", Wiley Eastern, New Delhi., 1978.

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FPT815: MATERIAL SCIENCE AND TECHNOLOGY

Code: FPT815

Credits: 03

L-T-P: 3-0-0

Introduction to Materials: Engineering materials, their classification, characteristics and basic principles for their selection. Structure of atom, and types of bonds. Crystal structure. Defects in crystal structure and their influence on properties of a materials.

Metals and their alloys: Phase equilibrium diagram for iron-carbon and copper-zinc system. Ferrous and non ferrous alloys. Mild steels, special steels, stainless steels, brasses, bronzes, aluminum alloys and titanium alloys. Methods for fabrications-Rolling, forging, extrusion and joining.

Polymers: Types of plastics, structure-Properties, correlation of important plastics, polymerization processes and additives. Fiber reinforced plastics, rubbers and elastomers and applications.

Ceramics and Glass: Structure-properties, correlations oxide and non oxide ceramics of important plastics, vitreous and borosilicate glasses, glass-ceramics and enamels. Major electrical, optical and mechanical properties of ceramics and glasses. Enamelling and glass lining.

Corrosion and its control: Types of corrosion, chemical and electrochemical reactions, methods of corrosion prevention. Corrosion resistant materials.

Books Recommended:

1. James, F. Shackford, "Introduction to Materials Science", Macmillan pub. Co., NY, 1990
2. Jestrzebaski, D.Z., "Properties of Engineering Materials," 3rd ed., Toppen Co. Ltd.
3. Smith, W.F., "Foundations of Materials Science and Engineering," 2nd Ed., McGraw-Hill, 1993.
4. Raghavan, V., "Materials Science and Engineering," PHI, New Delhi.
5. Van Vlack, L.H., "Materials Science and Engineering," Addison Wesley.

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**FPT816: SPECIALTY FOODS: NUTRACEUTICALS AND
FUNCTIONAL FOODS**

Code: FPT816

Credits: 03

L-T-P: 3-0-0

Scope, importance and renewed emphasis on speciality foods, health foods, functional foods. Nutraceuticals, infant and baby foods, adolescent/ teen age foods, foods for pregnant ladies and nursing mothers, geriatric foods.

Food recommended and restricted in metabolic disorders and disturbances, gastrointestinal disorders; fever and infection; liver, gall, bladder and pancreatic disturbances; blood, circulatory and cardiac diseases; urinary and musculoskeletal diseases; allergies.

Nutritional deficiencies and its correction through fortification and supplementation of foods. Beneficial effect of spices, honey, spirulina etc.

Health benefits/ mode of action of PUFA/ gamma linolenic acids, antioxidants, dietary fiber, oligosaccharides, sugar alcohols, peptides and proteins, glycosides, alcohols, iso-prenoids and vitamins, choline, LAB, phenolics, flavonols, minerals and other minor food constituents as reported in literature.

Transgenic plant foods with health claims. Prebiotics and Probiotics.

Books Recommended:

1. *'Human Nutrition'* by Benjamin T. Burton, Mc Graw Hill.
2. *'Nutrition and Dietetics'* by Shubhangini A. Joshi, Tata Mc Graw Hill Co. Ltd.
3. *'Dietetics'* by B. Shrilakshmi, New Age International (P) Ltd. New Delhi.
4. *'Nutrition and Dietetic Foods'* by Arnold E. Bender, Chem. Pub. Co. New York.
5. *'Basic Nutrition in Health & Disease'* by P. S. Howe, W. B. Saunders Company, London.

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FPT817: RENEWABLE ENERGY TECHNOLOGY

Code: FPT817

Credits: 03

L-T-P: 3-0-0

Biological fuel generation; Biomass as a renewable energy source; Types of biomass: forest, agricultural and animal residues; Industrial and domestic organic wastes; Conversion of biomass to clean fuels and petrochemical substitutes by physicochemical and/or fermentation processes.

Biogas from anaerobic digestion; Thermal energy from biomass combustion; Ethanol from biomass.

Hydrogen production by photosynthetic bacteria, biophotolysis of water and by fermentation; Microbial recovery of petroleum by biopolymers (Xanthum gum), biosurfactants.

Solar energy; Solar collectors, solar pond, photovoltaic cells, chemical storage; Geothermal energy and wind energy; Use of geothermal energy; Operating principles of different types of wind energy mills; Nuclear energy; Nuclear reactions and power generation; Tidal wave energy.

Reference:

1. *J.E.Smith – Biotechnology, 3rd edn. Cambridge Univ Press.*
2. *S.Sarkar – Fuels and combustion, 2nd edn., University Press.*