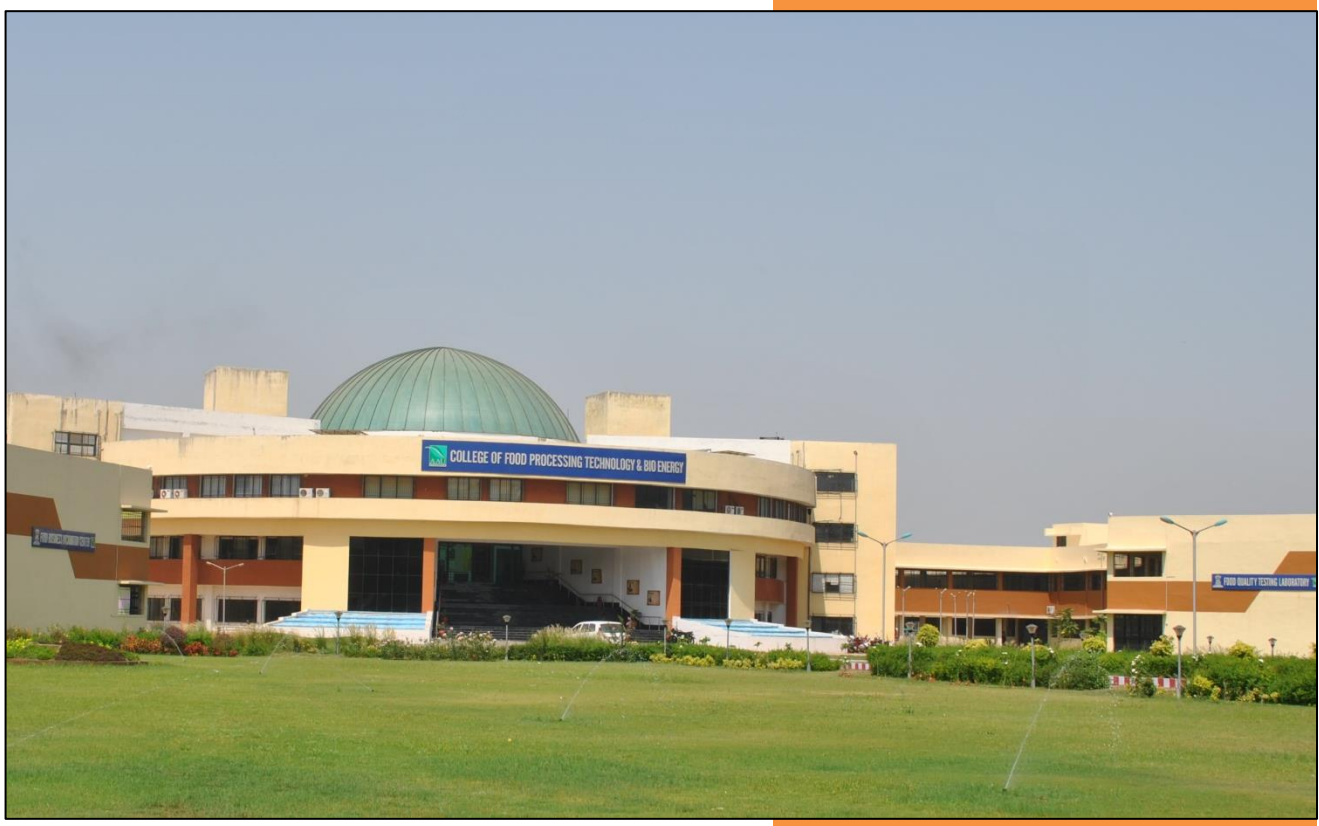
Syllabus & Course Structure

for

B. Tech (Food Technology)



As per ICAR 5th Deans' Committee Recommendations

COLLEGE OF FOOD PROCESSING TECHNOLOGY & BIO ENERGY
ANAND AGRICULTURAL UNIVERSITY
ANAND – 388 110

May, 2017

College of Food Processing Technology & Bio-Energy

Anand Agricultural University, Anand – 388 110

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Syllabus and course structure for B. Tech (Food Technology) as per ICAR 5th Deans' Committee Recommendations in Faculty of Food Processing Technology and Bio-Energy, Anand Agricultural University, Anand.

Read: Resolution of 45th Meeting of the Academic Council of Anand Agricultural University held on 29/04/2017

NOTIFICATION

It is hereby notified to all concerned that vide item no 45.27 of the 45th meeting held on 29/04/2017, the Academic Council of the Anand Agricultural University has resolved as under;

"The Academic Council resolved to approve the revised course structure and syllabus for B. Tech (Food Technology) based on ICAR 5th Deans' Committee Recommendations and as per **Annexure –I** and **II**. The same is to be implemented for the students admitted from academic year 2017-18 and onwards"

(D.C.Joshi)
Dean

NO.: AAU/FPT&BE/PG Acad/477/2017
Date: 18/05/2017
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Encl: As Above
Copy F.W.Cs to:

1. All members of the Academic Council of University
2. All officers of Anand Agricultural University, Anand
3. Registrar AAU, Anand

Copy to:

1. All the HODs of this college
2. P.S to Hon. Vice Chancellor, AAU, Anand
3. Academic Branch of this college
4. Notification File

Annexure-I

Course Structure for B.Tech (Food Technology)

	Semester-I		
1	FQA 111	General Microbiology	3 (2+1)
2	FQA 112	Food Chemistry of Macronutrients	3 (2+1)
3	ENG 111	English Language	2 (1+1)
4	MATH 111	Engineering Mathematics-I	2 (2+0)
5	ESD 111	Environmental Sciences & Disaster Management	2 (1+1)
6	FPE 111	Basic Electrical Engineering	3 (2+1)
7	FPE 112	Workshop Technology	3 (1+2)
8	FPE 113	Engineering Drawing and Graphics	3 (1+2)
9	FBM 111	Computer Programming and Data Structures	2 (1+1)
	PED111	NCC/NSS/Physical Education	1 (0+1)*****
	Total		**23(13+10)**
	* Non-Credit Course		
	Semester-II		
1	FQA 121	Food Microbiology	3 (2+1)
2	FQA 122	Food Chemistry of Micronutrients	3 (2+1)
3	FPE 121	Food Thermodynamics	3 (2+1)
4	FPE 122	Fluid Mechanics	3 (2+1)
5	FPE 123	Post-Harvest Engineering	3 (2+1)
6	FPE 124	Basic Electronics Engineering	3 (2+1)
7	FPT 121	Fundamentals of Food Processing	3 (2+1)
8	MATH 121	Engineering Mathematics-II	2 (2+0)
	PED 121	NCC/NSS/Physical Education	1 (0+1)*
	Total		**23 (16+7)**
	* Non-Credit Course		
	Semester-III		
1	FQA 231	Food Biochemistry and Nutrition	3 (2+1)
2	FQA 232	Industrial Microbiology	3 (2+1)
3	FPE 231	Heat and Mass Transfer in Food Processing	3(2+1)
4	FPE 232	Food Refrigeration and Cold Chain	3 (2+1)
5	FPE 233	Fundamentals of Food Engineering	3 (2+1)
6	FPT 231	Processing Technology of Liquid Milk	2 (1+1)
7	FPT 232	Processing Technology of Cereals	3 (2+1)
8	STAT 231	Statistical Methods and Numerical Analysis	2 (1+1)
	PED 231	NCC/NSS/Physical Education	1 (0+1)*
	Total		**22 (14+8)**
	* Non-Credit Course		
	Semester-IV		
1	FQA 241	Food Biotechnology	3 (2+1)
2	FQA 242	Food Plant Sanitation	2 (1+1)
3	FPE 241	Food Plant Utilities & Services	3 (2+1)
4	FPT 241	Unit Operations in Food Processing	3 (2+1)
5	FPT 242	Processing Technology of Dairy Products	3 (2+1)
6	FPT 243	Processing Technology of Legumes and Oilseeds	3 (2+1)
7	FPT 244	Processing of Spices and Plantation Crops	3 (2+1)
8	FBM 241	Business Management and Economics	2 (2+0)

	PED 241	NCC/NSS/Physical Education	1 (0+1)*
		Total	**22 (15+7)**
		* Non-Credit Course	
	Semester-V		
1	FQA 351	Instrumental Techniques in Food Analysis	3 (1+2)
2	FPE 351	Food Storage Engineering	3 (2+1)
3	FPE 352	Food Process Equipment Design	3 (2+1)
4	FPT 351	Design & Formulation of Foods	3 (2+1)
5	FPT 352	Processing Technology of Fruits and Vegetables	3 (2+1)
6	FPT 353	Bakery, Confectionery and Snack Products	3 (2+1)
7	FBM 351	ICT Applications in Food Industry	3 (1+2)
8	FBM 352	Marketing Management and International Trade	2 (2+0)
	Total		**23 (14+9)**
	Semester-VI		
1	FQA 361	Food Additives and Preservatives	2 (1+1)
2	FQA 362	Food Quality, Safety Standards and Certification	2 (2+0)
3	FPE 361	Instrumentation and Process Control in Food Industry	3 (2+1)
4	FPE 362	Applications of Renewable Energy in Food Processing	2(1+1)
5	FPT 361	Processing of Meat, Fish & Poultry Products	3 (2+1)
6	FPT 362	Processing Technology of Beverages	3 (2+1)
7	FPT 363	Sensory Evaluation of Food Products	3 (2+1)
8	FPT 364	Food Packaging Technology and Equipment	3 (2+1)
9	FBM 361	Entrepreneurship Development	2 (1+1)
		Total	**23 (15+8)**
	Semester-VII		
1	FBM 471	Communication and Soft Skills Development	2 (1+1)
2	FBM 472	Project Preparation and Management	2 (1+1)
3	FPO 471	Student READY - Experiential Learning Programme – I	7 (0+7)
4	FPO 472	Student READY - Experiential Learning Programme – II	7 (0+7)
5	FPO 473	Student READY - Research Project	3 (0+3)
6	FPO 474	Student READY – Seminar	1 (0+1)
		Total	**22 (2+20)**
	Semester-VIII		
1	FPO 481	Student READY - Industrial Tour	2 (0+2)
2	FPO 482	Student READY - Internship/In-Plant Training	20 (0+20)
		Total	**22 (0+22)**
			Grand Total of Credit Hours 180 (89+91)

Course Structure (Discipline-wise) for B.Tech. (Food Technology)

Discipline of Food Processing Technology			
1	FPT 121	Fundamentals of Food Processing	3 (2+1)
2	FPT 231	Processing Technology of Liquid Milk	2 (1+1)
3	FPT 232	Processing Technology of Cereals	3 (2+1)
4	FPT 241	Unit Operations in Food Processing	3 (2+1)
5	FPT 242	Processing Technology of Dairy Products	3 (2+1)
6	FPT 243	Processing Technology of Legumes and Oilseeds	3 (2+1)
7	FPT 244	Processing of Spices and Plantation Crops	3 (2+1)
8	FPT 351	Design & Formulation of Foods	3 (2+1)
9	FPT 352	Processing Technology of Fruits and Vegetables	3 (2+1)
10	FPT 353	Bakery, Confectionery and Snack Products	3 (2+1)
11	FPT 361	Processing of Meat, Fish & Poultry Products	3 (2+1)
12	FPT 362	Processing Technology of Beverages	3 (2+1)
13	FPT 363	Sensory Evaluation of Food Products	3 (2+1)
14	FPT 364	Food Packaging Technology and Equipment	3 (2+1)
	Total		**41 (27+14)**
Discipline of Food Safety and Quality Assurance			
1	FQA 111	General Microbiology	3 (2+1)
2	FQA 112	Food Chemistry of Macronutrients	3 (2+1)
3	FQA 121	Food Microbiology	3 (2+1)
4	FQA 122	Food Chemistry of Micronutrients	3 (2+1)
5	FQA 231	Food Biochemistry and Nutrition	3 (2+1)
6	FQA 232	Industrial Microbiology	3 (2+1)
7	FQA 241	Food Biotechnology	3 (2+1)
8	FQA 242	Food Plant Sanitation	2 (1+1)
9	FQA 351	Instrumental Techniques in Food Analysis	3 (1+2)
10	FQA 361	Food Additives and Preservatives	2 (1+1)
11	FQA 362	Food Quality, Safety Standards and Certification	2 (2+0)
	Total		**30 (19+11)**
	Discipline of Food Process Engineering		
1	FPE 121	Food Thermodynamics	3 (2+1)
2	FPE 122	Fluid Mechanics	3 (2+1)
3	FPE 123	Post-Harvest Engineering	3 (2+1)
4	FPE 231	Heat and Mass Transfer in Food Processing	3 (2+1)
5	FPE 232	Food Refrigeration and Cold Chain	3 (2+1)
6	FPE 233	Fundamentals of Food Engineering	3 (2+1)
7	FPE 241	Food Plant Utilities and Services	3 (2+1)
8	FPE 351	Food Storage Engineering	3 (2+1)
9	FPE 352	Food Process Equipment Design	3 (2+1)
10	FPE 361	Instrumentation and Process Control in Food Industry	3 (2+1)
11	FPE 362	Applications of Renewable Energy in Food Processing	2 (1+1)
	Total		**32 (21+11)**
Discipline of Food Business Management			
1	FBM 241	Business Management and Economics	2 (2+0)
2	FBM 351	ICT Applications in Food Industry	3 (1+2)
3	FBM 352	Marketing Management and International Trade	2 (2+0)
4	FBM 361	Entrepreneurship Development	2 (1+1)
5	FBM 471	Communication and Soft Skills Development	2 (1+1)
6	FBM 472	Project Preparation and Management	2 (1+1)

		Total	**13 (8+5)**
Discipline of Basic Engineering			
1	FPE 111	Basic Electrical Engineering	3 (2+1)
2	FPE 112	Workshop Technology	3 (1+2)
3	FPE 113	Engineering Drawing and Graphics	3 (1+2)
4	FBM 111	Computer Programming and Data Structures	2 (1+1)
5	FPE 124	Basic Electronics Engineering	3 (2+1)
	Total		**14 (7+7)**
Discipline of Basic Science & Humanities			
1	ENG 111	English Language	2 (1+1)
2	MATH 111	Engineering Mathematics-I	2 (2+0)
3	ESD 111	Environmental Sciences & Disaster Management	2 (1+1)
4	MATH 121	Engineering Mathematics-II	2 (2+0)
5	STAT 231	Statistical Methods and Numerical Analysis	2 (1+1)
		Total	**10 (7+3)**
Discipline of Food Plant Operations (Student READY Courses)			
1	FPO 471	Student READY - Experiential Learning Programme - I	7 (0+7)
2	FPO 472	Student READY - Experiential Learning Programme - II	7 (0+7)
3	FPO 473	Student READY - Research Project	3 (0+3)
4	FPO 474	Student READY – Seminar	1 (0+1)
5	FPO 481	Student READY - Industrial Tour	2 (0+2)
6	FPO 482	Student READY - Internship/In-Plant Training	20 (0+20)
		Total	**40 (0+40)**
		Grand Total of Credit Hours	**180 (89+91)**

Annexure-II
Syllabus for B.Tech (Food Technology)

SEMESTER I

1. General Microbiology (FQA 111) 3 (2+1)

(32 Lectures + 16 Practicals)

Units	Topics	Lectures
Unit 1	**Scope and history of microbiology** (notable contributions of Leeuwenhoek, Pasteur, Koch, etc.),	2
	Place of Microorganisms in living world	1
	Groups of microorganisms	1
	Applied area of microbiology	1
	Classification and identification of micro organism	
	Major Characteristics of Microorganisms	1
	Methods of classification of bacteria	2
Unit 2	**Microscopy**	
	Introduction to microscope	1
	Component of microscope	1
	Types of microscope & Microscopic techniques	2
Unit 3	**Microbial Ultra Structure and Functions**	
	Morphological features	1
	Structures external to cell wall	1
	Cell wall	1
	Structures internal to cell wall	2
Unit 4	**Cultivation and preservation of micro-organisms**	
	Nutritional requirements	1
	Types of media	1
	Physical condition required for the growth	1
	Enumeration methods for micro-organisms,	1
Unit 5	**Bacterial Metabolism and Growth**	
	Reproduction of bacteria	1
	Growth of bacteria: growth curve, continuous culture, synchronous culture	2
	Methods of isolation of pure cultures; Maintenance and preservation of pure	1
	cultures; Culture collections	1
Unit 6	**Control of microorganisms**	
	Physical and Chemical agents,	2
Unit 7	**Bacterial genetics**	
	Structure & functions of DNA and RNA	2
	Overview of replication and regulation	2

List of Practicals

S. No.	Title of Experiment
1	Guidelines for safety in food microbiology laboratory work
2	Introduction to equipments commonly used in microbiology laboratory
3	Sterilization of glasswares used in microbiology laboratory.
4	Observation of permanent slides
5	Simple Staining: Monochrome Staining
6	Simple Staining: Negative Staining
7	Differential staining: Gram's Staining
8	Differential staining: Spore Staining
9	Measuring size of microorganisms by micrometry
10	Preparation of culture media

11	Isolation of microorganisms using Streak plate method
12	Isolation and enumeration of microorganisms using Spread plate method
13	Isolation and enumeration of microorganisms using Pour plate method
14	Microbial examination of air
15	Effect of environmental factors on microbial growth
16	Microbiological examination of water for coli forms by MPN technique

Suggested Reading

Gerard J. Tortora, Berdell R. Funke, Christine L. Case. 2014. Microbiology: An Introduction, 12th Ed. Prentice-Hall, NY, USA.

Johanne M. Willey, Linda M. Sherwood and Christopher J. Woolverton. 2013. Prescott's Microbiology, 9th Ed. McGraw-Hill Higher Education, NY, USA.

Michael J. Pelczar Jr., E.C.S. Chan and Noel R. Krieg. 1998. Microbiology, 5th Ed. Tata McGraw-Hill Education, New Delhi.

2. Food Chemistry of Macronutrients (FQA 112) 3 (2+1)

(32 Lectures + 16 Practicals)

Units	Topics	Lectures
Unit 1	**Water** Moisture in foods, role and type of water in foods, functional properties of water, water activity and sorption isotherm, molecular mobility and foods stability; Dispersed systems of foods: Physicochemical aspects of food dispersion system (Sol, gel, foam, emulations); Rheology of diphase systems;	 2 1 2 1 1
Unit 2	**Carbohydrates** Monosaccharaides, disaccharides and polysaccharides modification of carbohydrates, dietary fibres and carbohydrates digestibility; Enzymatic and chemical reactions of carbohydrates;	 3 1 1 1
Unit 3	**Proteins** Proteins in foods: Proteins and nutrition Functional properties of proteins Processing induced, physical, chemical and nutritional changes in protein, chemical and enzymatic modification of protein;	 2 2 2 1 1
Unit 4	**Lipids** Lipids in foods: Role and use of lipids/fat, crystallization and consistency, chemical aspects of lipids, lipolysis, auto-oxidation, thermal decomposition, chemistry of frying technology of fat and oil; Oil processing: Refining, hydrogenations, inter esterification, use of oils and fats in food formulation; Enzymatic and chemical reactions of fats; Rancidity and its types, detection techniques, chemical aspects of lipids, antioxidants;	 1 1 2 1 1 2 1 1 1

List of Practicals

S. No.	Title of Experiment
1	Determination of moisture content of foods
2	Studies of sorption isotherms of different foods
3	Swelling characteristics of starch
4	Solubility characteristics of starch
5	Determination of reducing sugars

6	Determination of non-reducing sugars
7	Determination of fiber content in food
8	Determination of viscosity of food samples
9	Texture profile analysis of food samples
10	Determination of crude proteins by micro-Kjeldhal method
11	Determination of protein by spectrophometer method
12	Isolation of egg and milk protein
13	Determination of fat content in food by Soxhelet method
14	Determination of acid value of fat/oil
15	Determination of saponification value fat/oil
16	Determination of and iodine number fat/oil

Suggested Reading

John W. Brady. 2013. Introductory Food Chemistry. Comstock Publishing Associates, Cornell University Press, Ithaca, USA.

H.-D. Belitz, W. Grosch and P. Schieberle. 2009. Food Chemisry, 4th Ed. Springer-Verlag Berlin Heidelberg.

Owen R, Fennema. 1996. Food Chemistry, 3rd Ed. Marcel Dekker, Inc., New York, USA.

Lillian Hoagland Meyer. 1974. Food Chemistry. The AVI Publishing Co Inc., Connecticut, MA, USA.

3. English Language (ENG 111) 2 (1+1)

(16 Lectures + 16 Practical)

Units	Topics	Lectures
Unit 1	Importance of language and communication skills in the engineering profession	1
	Development of vocabulary, Vocabulary building tasks	1
	Reference skills: Dictionary, thesaurus, indexing, contents, glossary	2
	Concept of register	1
Unit 2	Proper use of nouns and pronouns,	1
	Proper use of adjectives and adverbs	1
	Proper use of phrases and clauses	1
	Basic sentence patterns in English: Agreement between subject and verb; Some basic rules of composition	2
Unit 3	Spoken and conversational English: Main features, agreement, disagreement, likes, dislikes and enquiries	2
	Debate and discussion	2
Unit 4	Note-taking and note-making	1
	Development of paragraphs; Cohesion, coherence and style	1

List of Practicals

S. No.	Title of Experiment
1-2	Tenses
3	Voice-change
4	Direct/indirect narration
5	Prepositions and determiners
6-7	Word-formation with parts of speech
8-9	Types of sentences and Composition
10-11	Elementary knowledge of English sound with word-stress, intonation pattern
12	Comprehension
13-14	Letter and application writing
15-16	Précis and Report writing

Suggested Reading

Alice Oshima and Ann Hogue. 1998. Writing Academic English. Addison Wesley Longman, White Plains, NY, USA.

N. Krishnaswamy and T. Sriraman. 1995. Current English for Colleges. Macmillan India Ltd., Chennai

4. Engineering Mathematics-I (MATH 111) 2(2+0)

(32 Lectures + 00 Practical)

Units	Topics	Lectures
Unit 1	Taylor's and Maclaurin's expansions, indeterminate form	3
	Curvature, asymptotes, tracing of curves	2
	function of two or more independent variables, partial differentiation, homogeneous functions and Euler's theorem, composite functions, total derivatives, derivative of an implicit function, change of variables, Jacobians, error evaluation, maxima and minima	4
Unit 2	Reduction formulae, Gamma and Beta functions	3
	Rectification of standard curves, volumes and surfaces of revolution of curves	2
	Double and triple integrals, change of order of integration, application of double and triple integrals to find area and volume	2
Unit 3	Exact and Bernoulli's differential equations, equations reducible to exact form by integrating factors, equations of first order and higher degree, Clairaut's equation,	3
	Differential equations of higher orders, methods of finding complementary functions and particular integrals, Method of variation of parameters	3
	simultaneous linear differential equations with constant coefficients	1
	Cauchy's and Legendre's linear equations	1
	Bessel's and Legendre's differential equations	1
	series solution techniques	2
Unit 4	Differentiation of vectors, scalar and vector point functions, vector differential operator Del	1
	Gradient of a scalar point function, Divergence and Curl of a vector point function and their physical interpretations,	2
	Identities involving Del, second order differential operator	1
	Line, Surface and volume integrals, Stoke's, divergence and Green's theorems.	1
Total		**32**

Suggested Reading

B.S. Grewal. 2004. Higher Engineering Mathematics. Khanna Publishers Delhi.

Shanti Narayan. 2004. Differential Calculus. S. Chand and Co. Ltd., New Delhi.

Shanti Narayan. 2004. Integral Calculus. S. Chand and Co. Ltd. New Delhi.

Shanti Narayan. 2004. A Textbook of Vector Calculus. S. Chand and Co. Ltd. New Delhi

5. Environmental Sciences and Disaster Management (ESD 111) 2 (1+1)
(16 Lectures + 16 Practical)

Units	Topics	Lectures
Unit 1	Environment, components of environment, man-environment relationship, impact of technology on the environment, environmental degradation.	2
Unit 2	Ecology and ecosystems: introduction; ecology: objectives and classification, concepts of an ecosystem, structure and function of ecosystem, components of ecosystem, energy flow in ecosystem, food chains, ecological pyramids.	3
Unit 3	Population and natural resources, population and pollution, Renewable and non-renewable energy resources, Water resources, Forest resources.	2
Unit 4	Environmental pollution - Water pollution: Introduction, water quality standards, sources of water pollution, Air pollution: Composition of air, structure of atmosphere, ambient air quality standards, Land and noise pollution: Introduction, lithosphere, land uses, causes of land degradation, sources of noise pollution.	4
Unit 5	Food processing industry waste and its management; Management of urban waste water; Recycling of organic waste; Recycling of factory effluent; Control of environmental pollution through law; Composting of biological waste; Sewage, uses of water disposal effluent treatment; Current environmental global issues: Global warming and greenhouses effects.	3
Unit 6	Disaster management: natural and manmade disasters, disaster management, natural disaster management framework, financial management.	2
Total		16

List of Practicals

S. No.	Title of Experiment
1	Study of the earth's atmosphere & hydrosphere
2	Study of lithosphere and bio-sphere
3	Study of the ecosystem of a pond
4	Study of hydrological and carbon cycle
5	Study of nitrogen and sulphur cycle
6	Study of major ecosystem of the earth.
7	Study of population growth and method of population forecasting
8	Study of water resources, its overuse and related problems
9	Study of forest resources
10	Study of energy resources
11	Estimation of BOD
12	Estimation of COD
13	Study of water pollution, classification and their effects
14	Study of common air pollutants and their effects.
15 &16	Visit to ETP unit & case studies

Suggested Reading

Gilbert M. Masters and Wendell P. Ela. 2013. Introduction to Environmental Engineering and Science. Pearson Education Limited, NY, USA.

Suresh K. Dhameja. 2009. Environmental Engineering and Management. S. K. Kataria & Sons, New Delhi.

Bernard J. Nebel and Richard T. Wright. 1993. Environmental Science: The Way the World Works. Prentice-Hall Professional, New Delhi.

Bharucha Erach. 2005. Text book of environment studies for undergraduate couses. University Grants Commission, University Press, Hyderabad.

Sharma J.P. 2003. Introduction to environment science, Lakshmi Publications, Delhi

Gupta P.K. 2004. Methods in environmental analysis, water, soil and air. Agro Bios, Jodhpur.

Sharma R.K. & Sharma G. 2005. Natural disaster. APH publishing corporation, New Delhi

Husain Majid.2013. Environment and Ecology: Biodiversity, Climate Change and Disaster Management, online book.

6. Basic Electrical Engineering (FPE 111) 3 (2+1)

(32 Lectures + 16 Practicals)

Units	Topics	Lectures
Unit 1	**AC Fundamentals:** Definitions of cycle, frequency, time period, amplitude, Peak value, RMS value, Average value, Electro motive force, Magnetic circuits, composite magnetic circuits, magnetic leakage, hysteresis and eddy currents, phase relations and vector representation, AC through resistance, inductance and capacitance, AC series and parallel circuits, Simple R-L, R-C and R-L-C circuits	5
Unit 2	**3 Phase Systems:** Star and Delta connections, Relationship between line and phase voltages and currents in Star and Delta connections, various methods of single and three phase power measurement	3
Unit 3	**Transformer:** Principle of working, construction of single phase transformer, core type, shell type transformer, emf equation, Phasor diagrams, Ideal transformer, transformer on no load, Transformer under load, Equivalent circuits, Transformer losses, efficiency, Regulation, Open and short circuit test	4
Unit 4	**Single phase induction motor:** double field revolving theory, characteristics, phase split, shaded pole motors	2
Unit 5	**Poly phase induction motor:** Construction, operation, equivalent circuit, production of rotating field, effect of rotor resistance, torque equation, starting and speed control methods.	4
Unit 6	**Alternators:** principle of operation, types of rotors, emf equation	2
Unit 7	**D.C. Machine (generator and motor):** Types, Construction and Operation, EMF equation, armature reaction, commutation of D.C. generator and their characteristics. D.C. Motors, their starting, speed controls and characteristics	4
Unit 8	**Electric Power Economics:** Maximum demand charge, Load factor, Power factor and power factor improvement	2
Unit 9	**Measuring Equipment's:** Classification, Characteristics of different electrical measuring systems and equipment's	2
Unit 10	**Electrical Wiring:** system of wiring, domestic wiring installation, industrial electrification	2
Unit 11	**Protection devices:** Earthing, Circuit protection devices, fuses, ELCB & relays	2

List of Practicals

S. No.	Title of Experiment
1	Voltage and current relationship in 3 phase Star connection
2	Voltage and current relationship in 3 phase Delta connection
3	Measurement of Power in 3 phase circuit by wattmeter and energy meter for balanced load system
4	No-load test for single-phase transformer
5	Measuring no load power and power factor of single phase induction motor
6	Study of cross sectional view of squirrel cage induction motor
7	Starting of induction motors by D.O.L. starter
8	Starting of induction motors by Auto-transformer and star delta starter
9	Test on 3 phase induction motor- determination of line current, speed and power factor at various outputs
10	Study of D.C. motor
11	Study of electrical measuring instruments
12	Study of magger
13	Study of LT distribution components and use
14	Study of looping system of wiring
15	Study of stair case wiring system
16	Study of various circuit protection devices

Suggested Reading

B.L. Theraja and A.K. Theraja. 2005. A Textbook of Electrical Technology, Vol. II. S. Chand & Company Ltd., New Delhi.
Vincent Del Toro. 2000. Electrical Engineering Fundamentals. Prentice-Hall India Private Ltd., New Delhi.

7. Workshop Technology (FPE 112) 3 (1+2)

(16 Lectures + 32 Practicals)

Units	Topics	Lectures
Unit 1	Introduction to basic materials: Ferrous and non-ferrous materials and important engineering materials such as timber, abrasive materials, silica, ceramics, glasses, graphite, diamond, plastic polymers and composite materials, their properties and applications	2
Unit 2	Safety measures in workshop; Indian Factory Acts on safety;Measuring and Gauging: Basic measuring instruments and gauges	1
Unit 3	Heat treatment processes: Introduction to hardening, tempering, annealing, normalizing, etc.	2
Unit 4	Welding: Introduction, types of welding, types of electrodes, types of flames, types of welding joints, edge preparation, welding techniques and equipment; Gas welding and cutting, arc welding; Introduction to soldering and brazing and their uses; Estimation of welding and soldering cost	3
Unit 5	Smithy and forging: Introduction to different tools and their uses, different forging operations	2
Unit 6	Carpentry: Introduction to various carpentry tools and materials; Type of woods and their characteristics, brief ideas about band saw, wooden lathe circular saw, wood planner, etc.	2
Unit 7	Machinery: Introduction to various workshop machines (1) Lathe, (2) power hacksaw, (3) Shaper and planner, (4) Drilling, (5) Grinder and (6) CNC machines; Length of cut, feed, depth of cut, RPM, cutting speed, time, time allowances; Estimation of machining time for different lathe operations; Estimation of machining time for shaping, slotting and planning operations, work holding and tool holding devices	3
Unit 8	Sheet-metal: Introduction, different operations, sheet metal joints; Allowances for sheet metal, operations and joints, estimate of cost.	1

List of Practicals

S. No.	Title of Experiment
1	Identification of different engineering materials
2	Demonstration of different measuring instruments and measurement technique
3	Study of different types of gauges
4	Identification of various hand tools
5	Identification of various carpentry tools
6	Demonstration of various power tools
7	Demonstration of various machine tools
8	Simple exercises in filing
9	Simple exercises in fitting
10	Simple exercises in chipping
11	Simple exercises in hack sawing
12	Simple exercises in chiseling
13	Simple exercises in tapping
14	Introduction to arc welding machine, processes, tools, their use and precautions
15	Simple exercises on arc welding
16	Introduction to gas welding machine, processes, tools, their use and precautions
17	Simple exercises in gas welding
18	Demonstration of various casting processes and equipment, tools and their use
19	Introduction of Lathe machine
20	Simple exercises on turning

21	Simple exercises on step turning
22	Simple exercises on taper turning
23	Simple exercises on facing
24	Simple exercises on knurling
25	Introduction to drilling machines
26	Simple exercises on drilling
27	Simple exercises on threading
28	Introduction to shaper and planner machine
29	Simple exercises on shaper machine
30	Simple exercises on planner machine
31	Introduction of CNC machine
32	Simple exercises on CNC machine

Suggested Reading

B.S. Raghuwamsi. 1996. A Course in Workshop Technology, Vols. I and II. Dhanpet Rai & Sons, New Delhi.

W.A.J. Chapman. 1989. Workshop Technology, Parts I and II. Arnold Publishers (India) Pvt. Ltd., New Delhi.

S.K. Hazra Choudari and S.K. Bose. 1982. Elements of Workshop Technology, Vols. I and II. Media Promoters and Publishers Pvt. Ltd., Mumbai.

8. Engineering Drawing and Graphics (FPE 113) 3 (1+2)

(16 Lectures + 32 Practicals)

Units	Topics	Lectures
Unit 1	Definition of projection, Principle of projection, Methods of projections, Orthographic projection, plane of projection, First and third angle of projection	2
Unit 2	Different methods of dimensioning	1
Unit 3	Isometric scale, Isometric axes, Isometric projection, Preparation of working drawing from models and isometric views	2
Unit 4	Concept of sectioning; Revolved and oblique section	1
Unit 5	Sectional drawing of simple machine parts;	2
Unit 6	Types of rivet heads and riveted joints, Symbols for different types of welded joints; Processes for producing leak proof joints	2
Unit 7	Nomenclature, thread profiles, multi-start threads, left and right hand thread; Square headed and hexagonal nuts and bolts; Conventional representation of threads; Different types of lock nuts, studs, machine screws, cap screws and wood screws; Foundation bolts;	2
Unit 8	Drawing of missing views	1
Unit 9	Application of computers for design, definition of CAD, benefits of CAD, CAD system components; Computer hardware for CAD.	3
	Total	16

List of Practicals

S. No.	Title of Experiment
1	Study of drawing scales
2	Study of plane and diagonal scale
3	Study of vernier, comparative and scale of chord
4	Study of principle of orthographic projects, reference plane and different quadrant
5	Drawing of orthographic projection by first angle project method
6	Drawing of orthographic projection by third angle project method
7	Drawing of projection of point
8	Drawing of projection of line
9	Drawing of projection of plane
10	Drawing of projection of solid
11	Drawing of projection of section of solid

12	Study of interpretation of solid
13	Study and drawing of development of surfaces of geometrical solids
14	Study and drawing of isometric projection
15	Preparation of manual drawing with dimension from different model
16	Preparation of manual drawing with dimension from isometric object
17	Preparation of manual drawing with dimension from machine component
18	Drawing of section of machine parts
19	Study and drawing of riveted joints
20	Study and drawing of welded joints
21	Drawing of thread and thread fasteners
22	Study of computer graphics
23	Study of computer aided drafting
24	Study and application of computer graphics in food engineering
25	Interpretation of sectional view of food equipment and components
26	Study and use of AutoCAD
27	Study of two dimensional drawing command in AutoCAD
28	Study of three dimensional drawing command in AutoCAD
29	Two dimensional drawing in AutoCAD
30	Three dimensional drawing in AutoCAD
31	Isometric drawing in AutoCAD
32	Small project using cad / cam

Suggested Reading

Ibrahim Zeid. 2004. Mastering CAD/CAM. McGraw-Hill Book Co., NY, USA.

Kunwoo Lee. 1999. Principles of CAD/CAM/CAE Systems. Prentice-Hall, USA.

N.D. Bhat and V.M. Panchal. 1995. Machine Drawing. Charotar Publishing House, Anand.

N.D. Bhat. 1995. Elementary Engineering Drawing. Charotar Publishing House, Anand.

9. Computer Programming and Data Structures (FBM 111) 2 (1+1)

(16 Lectures + 16 Practicals)

Units	Topics	Lectures
Unit 1	Introduction and historical background: Review of computer technology; processor, memory, secondary storage, display devices and other peripheral devices	1
	Basic computer organisation; future trends. Brief review of present-day applications	1
Unit 2	Programming. Introduction to systems software, applications software and programming language	1
	Algorithms and flow-charts: Input-processing-output model of a computer program. Role of the compiler and the integrated development environment	2
Unit 3	Introduction to C: Structure of a C program. Simple data types	1
	Declarations; operators and expressions. The assignment statement. Library functions	1
Unit 4	Control Structures : Conditional and iterative execution of statements	2
	Importance of documentation. Nesting of control structures and the use of indentation to indicate nesting levels. Labels and the “go to” statement	1
Unit 5	Arrays; single and multi-dimensional arrays	2
	Character strings and string functions	1
Unit 6	Functions : Scope rules. Argument passing by reference and by value. Storage classes	2
	Use of function prototypes.	1

List of Practicals

No	Title of Experiment
1-2	Familiarizing with Turbo C IDE; Building an executable version of C program; Debugging a C program
3-4	Developing and executing simple programs
5-6	Creating programs using decision making statements such as if, go to & switch; Developing program using loop statements while, do & for
7-8	Using nested control structures
9-10	Familiarizing with one and two dimensional arrays;
11-12	Using string functions
13-14	Creating user defined functions;
15-16	Using local, global & external variables with the user defined function; Libarary Functions

Suggested Reading

Yashavant Kanetkar. 2012. let us C, 13th Ed. BPB Publications, New Delhi.

E. Balagurusamy. 2012. Programming in ANSI C 6th Ed. Tata McGraw-Hill Publishing Company Limited, New Delhi.

Svetlin Nakov & Co. 2013. Fundamentals of Computer Programming with c#. Sofia, Bulgaria.

PED111	NCC/NSS/Physical Education	1 (0+1)*****

***** Non-Credit Course

SEMESTER II

1. Food Microbiology (FQA-121) 3 (2+1)

(32 Lectures + 16 Practicals)

Units	Topics	Lectures
Unit 1	**Importance and significance of microbes** in food science	2
Unit 2	**Sources of microorganism**s in foods and their effective control	2 2
Unit 3	**Factors affecting growth and survival of microorganisms in foods:** Intrinsic factors i.e., pH, water activity, nutrients, redox potential, oxygen etc., Extrinsic factors: Relative humidity, temperature, gaseous atmosphere etc.	 2 2
Unit 4	**Normal Microbiological quality of Foods and its significance:** milk and milk products, fruits and vegetables, cereals and cereal products, meat and meat products, fish and other sea foods, poultry and eggs; sugar and sugar products, slats and spices and canned foods	 2 1 1
Unit 5	**Chemical changes caused by microorganisms**: Changes in nitrogenous organic compounds, non-nitrogenous organic compounds, organic acids, other compounds, lipids, pectic substances	 2 1 1
Unit 6	**Shelf life:** Calculation of shelf lif, Shelf life requirements, deteriorative reactions, accelerated testing; Simulations of product: Package environment interaction, shelf life simulation for moisture, oxygen, and light sensitive products;	 1 1 2
Unit 7	**Microbial toxins:** Bacterial toxins, fungal toxins, algal toxins and mushroom toxins	 2 1 1
Unit 8	**Food borne intoxications and infections:** types of food involved, toxicity and symptoms,	 2

	chemical properties, environmental conditions	2
Unit 9	**Food borne viruses:** types of food involved, noroviruses, rota viruses, prion diseases, toxicity and symptoms	2

List of Practicals

S. No.	Title of Experiment
1	Isolation of bacteria and molds from foods; vegetable and fruits/meat and meat products/fish and other sea foods/ eggs and poultry/ milk and milk products/ sugar, salts and spices/Fermented foods
2	Isolation of bacteria and molds from foods; vegetable and fruits/meat and meat products/fish and other sea foods/ eggs and poultry/ milk and milk products/ sugar, salts and spices/Fermented foods
3	Microbial examination of cereal and cereal products
4	Microbial examination of vegetable and fruits
5	Microbial examination of canned products for Anaerobic spores
6	Microbial examination of canned products for yeasts and molds
7	Microbial examination of milk
8	Microbial examination of milk products
9	Microbial examination of sugar, salts and spices
10	Determination and enumeration of pathogenic and indicator organisms in foods (Coliform/Enterococcus)
11	Thermal death time determination
12	Detection of Salmonella from food sample
13	Detection of coliforms from milk by MPN method
14	Detection of *Staphylococcus aureus* from food sample
15	Enumeration of important groups of microorganisms in foods ie., Proteolytic, lipolytic, acid producers
16	Enumeration of important groups of microorganisms in foods i.e., Psychrotrophic, thermoduric, thermophilic bacteria

Suggested Reading

Bibek Ray and Arun Bhunia. 2008. Fundamental Food Microbiology, 4th Ed., CRC press, Taylor and Francis Group, USA.

Martin R. Adams and Maurice O. Moss. 2008. Food Microbiology, 3rd Ed., The Royal Society of Chemistry, Cambridge, UK.

James M. Jay. 2000. Modern Food Microbiology, 6th Ed. Aspen Publishers, Inc., Gaithersburg, Maryland, USA.

George J. Banwart. 1989. Basic Food Microbiology, 2nd Ed. Chapman & Hall, New York, USA.

William C. Frazier and & Dennis C. Westfoff. 1987. Food Microbiology, 4th Ed. Tata McGraw-Hill Education, New Delhi.

2. Food Chemistry of Micronutrients (FQA 122) 3 (2+1)

(32 Lectures + 16 Practicals)

Units	Topics	Lectures
Unit 1	**Flavour** Philosophy and definitions of flavour, Chemistry of food flavour; flavourmatics/flavouring compounds, sensory assessment of flavour, technology for flavour retention;	 1 1
Unit 2	**Pigments** Pigments in animal and plants kingdoms: Heme pigments, chlorophyll, carotenoids, phenolic and flavonoids, betalins, effect of processing on pigment behaviour; Technology for retention of natural colours of food stuffs;	2 1 1
Unit 3	**Food colorants** Popular colors used in food and their fictional properties Regulatory use of regulatory dyes; Colour losses during thermal processing;	 2 1
Unit 4	**Vitamins** Vitamin functions in body and deficiency conditions	 3

	Requirements, allowances, enrichment, restorations, fortifications, losses of vitamins, optimization and retention of vitamins;	1 2 2
Unit 5	**Minerals** Important minerals and their function in body and deficiency conditions Requirements, allowances, enrichment, restorations, fortifications, losses of minerals, optimization and retention of minerals;	 3 2 1
Unit 6	**Antinutritional Factors** Various antinutitional factors their mode of action and inactivation	 1
Unit 7	**Enzymes in Food Industry** Carbohydrases, proteasase, lipases; Modification of food using enzymes: Role of endogenous enzymes in food quality, enzymes use as processing aid and ingredients	 1 1 1 2 2 1

List of Practicals

S. No.	Title of Experiment
1	Determination of Total Ash
2	Determination of Acid Insoluble Ash
3	Preparation of mineral solution by using ash and tri-acid
4	Estimation of calcium
5	Determination of phosphorus
6	Determination of iron
7	Colour representation system and measurement of colour
8	Estimation of tannins and phytic acid from food
9	Determination of Vitamin A
10	Determination of Vitamin C
11	Determination of Vitamin E
12	Determination of Thiamine
13	Determination of Riboflavin
14	Determine activity of enzyme
15	Compititive Inhibition of Enzymes
16	Study of enzyme kinetics

Suggested Reading

H.-D. Belitz, W. Grosch and P. Schieberle. 2009. Food Chemisry, 4th Ed. Springer-Verlag Berlin Heidelberg.

Owen R, Fennema. 1996. Food Chemistry, 3rd Ed. Marcel Dekker, Inc., New York, USA.

3. Food Thermodynamics (FPE 121) 3 (2+1)

(32 Lectures + 16 Practical)

Units	Topics	Lecture
Unit 1	Basic concepts: definitions, approaches, thermodynamic systems, thermodynamic properties and equilibrium, state of a system, state diagram, path and process, different modes of work, Zeroth law of thermodynamics, concept of temperature, heat.	3
Unit 2	First law of thermodynamics: Energy, enthalpy, specific heats, applications of first law, steady and unsteady flow analysis	3
Unit 3	Second law of thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, entropy, availability and irreversibility	4

Unit 4	Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapor phases, P-V-T behaviour of simple compressible substances, phase rule	4
Unit 5	Thermodynamic cycles: Carnot vapor power cycle, ideal Rankine cycle, air standard Otto cycle, air standard Diesel cycle, vapor-compression refrigeration cycle	4
Unit 6	Psychometry: thermodynamic properties of moist air, perfect gas relationship, absolute humidity, relative humidity, percentage humidity, humid volume, total heat, enthalpy, dry bulb temperature, wet bulb temperature, dew point temperature, adiabatic processes, wet bulb depression, humid heat, specific volume, heating, cooling, dehumidifying, sorption isotherms	4
Unit 7	Three stages of water, phase diagram for water, vapour pressure-temperature curve for water, heat requirement for vaporization, measurement of humidity	4
Unit 8	Boilers and steam generation: fuels for boilers and steam generation, boiler types, boiler mountings and accessories, Introduction to Indian Boiler Regulation Act. Layout of steam pipe-line and expansion joints. Boiler Draught: Definition, importance and classification of draught, Natural and artificial draught, Calculation of Height of chimney, draught analysis; Properties of steam: Wet, dry saturated, superheated steam, use of steam tables	6
		32

List of Practicals

S. No.	Title of Experiment
1	Demonstration and application of zeroth law of thermodynamics
2	Demonstration and application of first law of thermodynamics
3	Demonstration and application of second law of thermodynamics
4	Study of different types of boilers
5	Study of boiler mounting and accessories
6	Study of various types of burners and fuels
7	Determination of calorific values of different fuels
8	Study of vapour compression refrigeration test rig
9	Study of heat pump
10	To study properties of wet, dry, saturated and superheated steam
11	Use of steam tables and Moiler charts
12	Determination of dryness fraction of steam
13	Determination of thermodynamic properties on psychrometric charts
14	Use of psychometric chart for humidification, dehumidification, heating and drying
15	Study of steam trap and steam line layouts
16	Visit to food plant with steam utilization
17	Problems on thermodynamic applications

Suggested Reading

R.K. Rajput. 2007. Engineering Thermodynamics, 3rd Ed. Laxmi Publications (P) Ltd., Bangalore.

P.K. Nag.2005. Engineering Thermodynamics, 3rd Ed. Tata-McGraw-Hill Education, New Delhi.

J.M. Smith, H.C. Van Ness and M.M. Abbott. 2005. Introduction to Chemical Engineering Thermodynamics, 7th Ed. McGraw-Hill, Inc., NY, USA.

Warren L. McCabe, Julian Smith, Peter Harriott. 2004. Unit Operations of Chemical Engineering, 7th Ed. McGraw-Hill, Inc., NY, USA.

Christie John Geankoplis. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th Ed. Prentice-Hall, NY, USA.

Donald B. Brooker, Fred W. Bakker-Arkema and Carl W. Hall. 1976. Drying Cereal Grains. The AVI Publishing Company, Inc., Connecticut, MA, USA.

4. Fluid Mechanics (FPE 122) 3 (2+1)

(32 Lectures + 16 Practical)

Units	Topics	Lecture
Unit 1	Units and dimensions; Properties of fluids; Static pressure of liquids: Hydraulic pressure, absolute and gauge pressure, pressure head of a liquid; Pressure on vertical rectangular surfaces	3
Unit 2	Flow behavior of viscous fluids; Compressible and non-compressible fluids; Surface tension, capillarity	3
Unit 3	Pressure measuring devices: Simple, differential, micro-, inclined manometer, mechanical gauges, piezometer	3
Unit 4	Floating bodies: Archimedis principle, stability of floating bodies; Equilibrium of floating bodies, metacentric height	2
Unit 5	Fluid flow: Classification, steady, uniform and non-uniform, laminar and turbulent, continuity equation; Bernoulli's theorem and its applications	4
Unit 6	Navier-Stokes equations in cylindrical co-ordinates, boundary conditions; Simple application of Navier-Stokes equation: Laminar flow between two straight parallel boundaries	4
Unit 7	Flow through pipes: Loss of head, determination of pipe diameter; Determination of discharge, friction factor, critical velocity; Flow through orifices, mouthpieces, notches and weirs; Vena contracta, hydraulic coefficients, discharge losses; Time for emptying a tank; Loss of head due to contraction, enlargement at entrance and exit of pipe; External and internal mouthpieces, types of notches, rectangular and triangular notches, rectangular weirs; Venturimeters, pitot tube, rotameter; Water level point gauge, hook gauge	4
Unit 8	Dimensional analysis: Buckingham's theorem application to fluid flow phenomena, Froude Number, Reynolds number, Weber number and hydraulic similitude	4
Unit 9	Pumps: classification, centrifugal pumps, submersible pumps, reciprocating pumps, positive displacement pump; Centrifugal pumps: Pumps in series and parallel, basic equations applied to centrifugal pump, loss of head due to changed discharge, static head, total head, manometric head, manometer efficiency, operating characteristics of centrifugal pumps, Submersible pumps; Reciprocating pumps: Working of reciprocating pump, double acting pump, instantaneous rate of discharge, acceleration of piston and water, gear pump; Pressure variation, work efficiency; Pressure requirements for viscous foods to lift them to different heights and selection of pumps	5
		32

List of Practicals

S. No.	Title of Experiment
1	Study of different types of pipes, pipe fittings, tools and materials for fittings
2	Study of different types of valves used in dairy and food processing
3	Study of manometers and other pressure measuring devices
4	Verification of Bernoulli's theorem
5	Determination of critical Reynold's number by Reynold apparatus
6	Calibration of Pitot tube
7	Determination of discharge co-efficient for venturimeter
8	Flow measurement through rectangular venturimeter
9	Determination of discharge co-efficient for orifice
10	Determination of discharge co-efficient for rectangular notch
11	Determination of discharge co-efficient for V-notch
12	Calibration of rotameter
13	Visualize and analyse the flow patterns
14	Determination of losses in pipe due to friction
15	Determination of losses due to pipe fittings such as elbow, bend, coupling

16	Study and operation of centrifugal and other pumps used in dairy and food processing plants

Suggested Reading

Frank M. White. 2010. Fluid Mechanics, 7th Ed. McGraw-Hill Book Co., Inc., Boston, USA.

Yunus A. Çengel and John M. Cimbala. 2006. Fluid Mechanics: Fundamentals and Applications. McGraw-Hill, Inc., New York, USA.

Bruce R. Munson, Donald F. Young and Theodore H. Okiishi. 2002. Fundamentals of Fluid Mechanics, 4th Ed. John Wiley & Sons, Inc., New York, USA.

E. John Finnemore and Joseph B. Franzini. 2002. Fluid Mechanics with Engineering Applications, 10th Ed. McGraw-Hill, Inc., New York, USA.

R. Byron Bird, Warren E. Stewart and Edwin N. Lightfoot.2002. Transport Phenomena, 2nd Ed. John Wiley & Sons, Inc., New York, USA.

Noel de Nevers. 1991. Fluid Mechanics for Chemical Engineers. McGraw-Hill, Inc., New York, USA.

Victor L. Streeter. 1962. Fluid Mechanics, 3rd Ed. McGraw-Hill Book Co., Inc., Boston, USA.

5. Post-Harvest Engineering (FPE 123) 3 (2+1)

(32 Lectures + 16 Practical)

Units	Topics	Lecture
Unit 1	**Overview of Post-Harvest Technology** Concept and science, Introduction to different agricultural crops, their cropping pattern, production, harvesting and post-harvest losses, reasons for losses, importance of loss reduction, Post-Harvest Handling operations	3
Unit 2	**Water Activity** Water binding and its effect on enzymatic and non-enzymatic reactions and food texture, control of water activity and moisture	2
Unit 3	**Engineering Properties of Food Materials** physical, thermal, aerodynamic, optical, mechanical, rheological and electromagnetic properties and their measurement	4
Unit 4	**Cleaning** Cleaning of grains, washing of fruits and vegetables, types of cleaners, screens, types of screens, rotary screens, vibrating screens, machinery for cleaning of fruits and vegetables (air cleaners, washers), cleaning efficiency, care and maintenance; Peeling	3
Unit 5	**Sorting and Grading** Sorting, grading, methods of grading; Grading- Size grading, colour grading, specific gravity grading; screening, equipment for grading of fruits and vegetables, grading efficiency, care and maintenance	4
Unit 6	**Separation** Magnetic separator, destoners, electrostatic separators, pneumatic separator	2
Unit 7	**Decorticating and Shelling** Principles of working, design and constructional details, operating parameters, maintenance, etc. of various decorticators/dehullers/shellers, description of groundnut decorticators, maize shellers, etc.	2
Unit 8	**Milling** Milling, polishing, grinding, milling equipment, dehuskers, polishers (abrasion, friction, water jet), flour milling machines, pulse milling machines, grinders, cutting machines, oil expellers, machine efficiency and power requirement	5
Unit 9	**Materials Handling** Introduction to different conveying equipment used for handling of grains, fruits and vegetables; Scope and importance of material handling devices	2
Unit 10	**Study of different Material Handling systems** Classification, principles of operation, conveyor system selection/design **Belt conveyor:** Principle, characteristics, design, relationship between belt speed and width, capacity, inclined belt conveyors, idler spacing, belt tension, drive tension, belt tripper	5

	Chain conveyor: Principle of operation, advantages, disadvantages, capacity and speed, conveying chain **Screw conveyor:** Principle of operation, capacity, power, troughs, loading and discharge, inclined and vertical screw conveyors **Bucket elevator:** Principle, classification, operation, advantages, disadvantages, capacity, speed, bucket pickup, bucket discharge, relationship between belt speed, pickup and bucket discharge, buckets types, power requirement **Pneumatic conveying system:** types, air/product separators; Gravity conveyor design considerations, capacity and power requirement.	
		32

List of Practicals

S. No.	Title of Experiment
1	Determination of shape and size of food materials
2	Determination of densities, porosity and specific gravity of solid/powder materials
3	Determination of terminal velocity and angle of repose of grain sample
4	Determine co-efficient of external and internal friction of different crops
5	Study of Thermal and rheological properties of food materials
6	Study of Optical properties measurement equipment/instruments
7	Study of cleaners and washers for agricultural produces
8	Study of graders for agricultural produces
9	Study of decorticators
10	Study of Maize shellers
11	Study of crop dryers
12	Study of rice milling machines
13	Study of pulse milling machines
14	Study of different components of flour mill
15	Study of oil expeller
16	Study of different materials handling equipment

Suggested Reading

A. Chakraverty. 2008. Post Harvest Technology of Cereals, Pulses and Oilseeds, 3rd Ed. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

Amalendu Chakraverty and R. Paul Singh. 2014. Post Harvest Technology and Food Process Engineering. CRC Press, Boca Raton, FL, USA.

Carl W. Hall and Denny C. Davis. 1979. Processing Equipment for Agricultural Products. The AVI Publishing Company, Inc., Connecticut, MA, USA.

Don W. Green and Robert H. Perry. 2008. Perry's Chemical Engineers' Handbook. McGraw-Hill Co., Inc., NY, USA.

G. Boumans. 1985. Grain Handling and Storage. Elsevier Science Publishers, Amsterdam, The Netherlands.

James G. Brennan. 2006. Food Processing Handbook. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany.

K.M. Sahay and K.K. singh. 2001. Unit Operations of Agricultural Processing. Vikas Publishing House Pvt. Ltd., Noida, UP.

Mohsenin, Nuri N. 1980. Thermal Properties of Foods and Agricultural Materials. Gordon and Breach Science Publishers, New York.

Mohsenin, Nuri N. 1984. Electromagnetic Radiation Properties of Foods and Agricultural Products. Gordon and Breach Science Publishers, New York.

Mohsenin, Nuri N. 1986. Physical Properties of Plant and Animal Materials : Structure, Physical Characteristics and Mechanical properties, 2nd Ed. Gordon and Breach Science Publishers, NY.

R.L. Earle. 1983. Unit operations in Food Processing. Pergamon Press, New York, USA.

S.M. Henderson and R.L. Perry. 1966. Agricultural Process Engineering, 2nd Ed. The AVI Publishing Company, Inc., Connecticut, MA, USA.

6. Basic Electronics Engineering (FPE 124) 3 (2+1)

(32 Lectures + 16 Practicals)

Units	Topics	Lectures
Unit 1	Semiconductors, P-n junction, V-I characteristics of P-n junction, diode as a circuit element, rectifier; Diode circuits for OR and AND (both positive and negative logic); voltage multiplier, filter circuits	6
	Bipolar junction transistor: Operating point, classification (A, B and C) of amplifier, various biasing methods (fixed, self, potential divider)	6
Unit 2	Ideal OP-AMP characteristics, linear and non-linear applications of OP-AMP integrator, active rectifier, comparator, differentiator, differential, instrumentation amplifier and oscillator), Zener diode voltage regulator, transistor series regulator, current limiters, OP-AMP voltage regulators	6
Unit 3	Basic theorem of Boolean algebra; Combinational logic circuits (basic gates, SOP rule and K-map) and sequential logic circuits binary ladder D/A converter and A/D converter	6
Unit 4	Transducers: Classification, selection criteria, characteristics, sensors and actuators construction, working principles, applications of following transducers- Potentiometers RTD, thermocouples, thermistors, LVDT, strain gauges, capacitive and inductive transducers, piezoelectric transducers, photoelectric transducers, self-generating transducers, variable parameter type, digital, actuating and controlling devices	4
Unit 5	Measurement of displacement, temperature, velocity, force and pressure using potentiometer, resistance thermometer, thermocouples	4

List of Practicals

S. No.	Title of Experiment
1	Study of PN Junction diode characteristics;
2	Study of Zener diode Characteristics
3	Study of Diode as Clipper and Clamper.
4	Study of Half Wave Rectifier with and without filters
5	Study of Full wave Center tap Rectifier with and without filters
6	Study of Full Wave Bridge rectifiers with and without filters
7	Study and verification of Basic and universal logic gates (AND, OR, NOT, NAND & NOR)
8	Study of Implementation of Basic Logic Gates using Universal Logic Gates.
9	Study of Flip -Flop and Counters.
10	Study of Transistor Characteristics in Common Emitter Configuration;
11	Study of Transistor Characteristics in Common Base Configuration;
12	To design study fixed and self-bias transistor.
13	To design study potential divider bias transistor.
14	Study of OP-Amp IC 741 as differential amplifier;
15	Study of OP-Amp IC 741 as active rectifier
16	To familiarize with various types of transducers.

Suggested Reading

A. Anand Kumar. 2014. Fundamentals of Digital Circuits. PHI Pvt. Ltd., New Delhi.

A.K. Sawhney. 2010. Course in Electrical and Electronics Measurements and Instrumentation. Dhanpat Rai Publications (P) Limited, New Delhi.

V.K. Mehta and Rohit Mehta. 2008. Principles of Electronics. S. Chand and Co., New Delhi.

D. Choudhury Roy. 2003. Linear Integrated Circuits. John Wiley International, NY.

Sanjeev Gupta. 2002. Electronic Devices and Circuits. Dhanpat Rai Publications (P) Limited, New Delhi.

7. Fundamentals of Food Processing (FPT 121) 3 (2+1)

(32 Lectures + 16 Practicals)

Units	Topics	Lectures
Unit 1	Sources, types and perishability of foods; Causes and types of food spoilage; Scope and benefit of food preservation	**03**
Unit 2	Methods of food preservation; Preservation by salt and sugar: Principle, method and effect on food quality	**02**
Unit 3	Preservation by heat treatment: Principle and equipment for blanching, canning, pasteurization, sterilization	**04**
Unit 4	Preservation by use of low temperature: Principle, methods, equipment	**03**
Unit 5	Preservation by drying, dehydration and concentration: Principle, methods, equipment	**03**
Unit 6	Preservation by irradiation: Principle, methods, equipment	**02**
Unit 7	Preservation by chemicals- antioxidants, mould inhibitors, antibodies, acidulants, Hurdle technology etc	**02**
Unit 8	Preservation by fermentation: Principles, methods, equipment;	**03**
Unit 9	Non-thermal preservation processes: Principles, equipment – Pulsed electric field and pulsed intense light, ultrasound, dielectric heating, ohmic and infrared heating, high pressure processing, microwave processing, etc.;	**06**
Unit 10	Quality tests and shelf-life of preserved foods.	**03**

List of Practicals

S. No.	Title of Experiment
1	Demonstration of various perishable food items and degree of spoilage
2	Preservation of food by high concentration of sugar
3	Preservation of food by using salt
4	Blanching of selected food items
5	Preservation of food by heat treatment- pasteurization
6	Demonstration of preserving foods under cold vs. freezing process
7	To study IQF processing of fruits/ vegetable
8	Drying of fruit slices pineapple slices, apple slices in cabinet drier
9	Effect of irradiation on sprouting of potatoes and onions
10	Preservation of food by using acidulants i.e. pickling by acid, vinegar or acetic acid
11	Preservation of food by using chemical preservatives
12	Preservation of bread, cake using mold inhibitors
13	Processing of foods using fermentation technique, i.e. preparation of sauerkraut
14	Study on ohmic heating system
15	Study on effect of high pressure on microbe
16	Visit to food processing industry

Suggested Reading

Stavros Yanniotis. 2008. Solving Problems in Food Engineering. Springer Science + Business Media, NY, USA.

Gaurav Tewari and Vijay K. Juneja. 2007. Advances in Thermal and Non-Thermal Food Preservation. Blackwell Publishing, Ames, Iowa, USA.

M. Shafiur Rahman. 2007. Handbook of Food Preservation, 2nd Ed. CRC Press, Boca Raton, FL, USA.

James G. Brennan. 2006. Food Processing Handbook. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany.

Marcus Karel and Darvl B. Lund. 2003. Physical Principles of Food Preservation, 2nd Ed. Marcel Dekker, Inc., NY, USA.

Peter Zeuthen and Leif Bùgh-Sùrensen. 2003. Food Preservation Techniques. CRC Press LLC, Boca Raton, FL, USA.

P. Fellows. 2000. Food Processing Technology: Principles and Practice, 2nd Ed. CRC Press, Boca Raton, FL, USA.

Norman N. Potter and Joseph H. Hotchkiss. 1995. Food Science, 5th Ed. Chapman & Hall, NY, USA.

Norman W. Desrosier and James N. Desrosier. 1977. The Technology of Food Preservation, 4th Ed. AVI Publishing Co., Connecticut, USA.
Girdhari Lal, G.S. Siddappa and G.L. Tandon. 1959. Preservation of Fruits and Vegetables. ICAR, New Delhi.

8. Engineering Mathematics-II (MATH 121) 2(2+0)

(32 Lectures + 00 Practical)

Units	Topics	Lectures
Unit 1	Elementary transformation and rank of a matrix, reduction to normal form, Gauss-Jordan method to find inverse of a matrix	3
	Consistency and solution of linear equations	2
	Eigen value and vectors, Cayley-Hamilton theorem	2
	Linear and orthogonal transformations	1
	Diagonalization of matrices, Bilinear ,Quadratic forms	2
Unit 2	Limit, continuity, derivative of function of complex variable	2
	Analytical function, C-R equations, conjugate function, harmonic functions	2
Unit 3	Fourier series: Infinite series and its convergence, periodic function, Euler's formulae for calculating Fourier coefficients, Dirichlet's conditions	2
	Fourier series of functions with arbitrary period	2
	Fourier series of odd and even functions	2
	Half range sine and cosine series, Harmonic analysis	2
Unit 4	Formation of partial differential equations	1
	Lagrange's linear equation	2
	Higher order linear partial differential equation with constant coefficients	3
	Solution of non-linear partial differential equation (Charpit's method)	2
	Application of partial differential equations: One dimensional wave e.q, one dimensional heat equation, two dimensional steady state heat equation i.e. Laplace equation	2
Total		32

Suggested Reading

B.V. Ramana. 2008. Engineering Mathematics. Tata McGraw-Hill Book Co., New Delhi.
B.S. Grewal. 2004. Higher Engineering Mathematics. Khanna Publishers, Delhi.
Shanti Narayan 2004. A Textbook of Matrices. S. Chand and Co. Ltd., New Delhi.

PED 121	NCC/NSS/Physical Education	1 (0+1)*

***** Non-Credit Course

SEMESTER III

1. Food Biochemistry and Nutrition (FQA 231) 3 (2+1)

(32 Lectures + 16 Practicals)

Units	Topics	Lectures
Unit 1	**Concepts of Food and Nutrition** Functions of food; Basic food groups; nutrients supplied by food; Water and energy balance, water intake and losses, basal metabolism Formulation of diets, classification of balanced diet, preparation of balanced diet for various groups; Recommended dietary allowances for various age groups; Malnutrition; Assessment of nutritional status; Food fad and faddism; Potentially toxic substance in human food	2 2
Unit 2	**Mechanism of Enzyme action** Introduction to enzyme and characteristics, coenzymes, kinetics and mechanism of enzyme action	2

	Derivation of Michaelis-Menten Equation, Enzyme inhibition by pH, allosteric enzymes	2
Unit 3	**Nucleic acids** Nucleic acids, structures of various components of DNA and RNA	 2
Unit 4	**Nutrients** Functions, sources, digestion, absorption, assimilation, transport of carbohydrates Functions, sources, digestion, absorption, assimilation, transport of proteins Functions, sources, digestion, absorption, assimilation, transport of fats	 1 1 1
Unit 5	**Metabolism of Carbohydrates** Introduction to carbohydrates metabolism, glycolysis, TCA cycle Electron transport chain, oxidative and substrate level phosphorylation	 2 1
Unit 6	**Metabolism of Lipids** Introduction to lipid metabolism, β-oxidation of long chain fatty acids, Ketosis, breakdown of phospholipids Biosynthesis of fatty acids, triglycerides and phospholipids	 2 2
Unit 7	**Metabolism of Proteins** Introduction to protein metabolism, transamination Deamination and decarboxylation Fixation of Nitrogen, Urea Cycle	 1 1 1
Unit 8	**Minerals** Functions, sources, absorption, deficiency of macrominerals Functions, sources, absorption, deficiency of microminerals Functions, sources, absorption, deficiency of trace minerals	 1 1 1
Unit 9	**Vitamins and Hormones** Functions, sources, absorption, deficiency of Vitamins A &D Functions, sources, absorption, deficiency of Vitamins E & K Functions, sources, absorption, deficiency of water soluble vitamins Information about hormones & relation between vitamins and hormones	 1 1 3 1

List of Practicals

S. No.	Title of Experiment
1	Preparation of various solutions and buffers
2	Measurement of calorific value using bomb calorimeter
3	Determination of pka of acids
4	Determination of pI for casein
5	Estimation of sugars in fruits by Anthrone method
6	Estimation of protein by Lowry method
7	Estimation of amino acid using Biuret reaction
8	Separation of amino acids using paper chromatography
9	Separation of amino acids using thin layer chromatography
10	Separation of nucleic acids using electrophoresis
11	Estimation of phosphorus in malted foods
12	Estimation of iron content in malted foods
13	Determination of calcium in malted foods
14	Estimation of β-carotene using column chromatography
15	Estimation of ascorbic acid in fruit juices using dye method
16	Effects of acids and alkali on pigments

Suggested Reading

Gaile Moe, Danita Kelley, Jacqueline Berning and Carol Byrd-Bredbenner. 2013. Wardlaw's Perspectives in Nutrition: A Functional Approach. McGraw-Hill, Inc., NY, USA.

David L. Nelson and Michael M. Cox. 2012. Lehninger Principles of Biochemisry, 6th Ed. Macmillan Learning, NY, USA.

Donald Voet and Judith G. Voet. 2011. Biochemisry, 4th Ed. John Wiley and Sons, Inc., NY, USA.

Carolyn D. Berdanier, Elaine B. Feldman and Johanna Dwyer. 2008. Handbook of Nutrition and Food, 2nd Ed. CRC Press, Boca Raton, FL, USA.

Bob B. Buchanan, Wilhelm Gruissem and Russell L. Jones. 2002. Biochemistry & Molecular Biology of Plants. John Wiley and Sons, Inc., NY, USA.

Jeremy M. Berg, John L. Tymoczko, Lubert Stryer and Gregory J. Gatto, Jr. 2002. Biochemisry, 7th Ed. W.H. Freeman and Company, NY, USA.

2. Industrial Microbiology (FQA 232) 3 (2+1)

(32 Lectures + 16 Practicals)

Units	Topics	Lecture
Unit 1	**Overview of Industrial Microbiology** Introduction to industrial fermentations, Range of fermentation processes, Chronological development Compartmental part of fermentation processes	 **02** **01** **02** **01**
Unit 2	**Industrially Important Microorganisms** Criteria for Selection of Industrially Important Microorganisms Overview of strain improvement of Industrially Important Microorganisms Preservation of industrially important microorganisms	 **01** **03** **01**
Unit 3	**Fermentation Media** Media selection Medium Formulation Medium for industrial fermentation	 **01** **02** **02**
Unit 4	**Microbial Growth-** Typical Growth Curve, Synchronous growth, Batch Fermentations Continuous Fermentation Fed Batch Fermentation	 **01** **01** **01**
Unit 5	**Bioreactor Design:** Basic functions, Parts of stirred tank fermenter: Aeration and agitation; agitator, Impeller, sparger systems, baffles and other accessories Types of reactor; Problems related to scale up of Process	 **01** **02** **02** **01** **01**
Unit 6	**Upstream and Down Stream Processes:** Upstream processes Overview of Downstream Processing Methods of cell destruction Methods of purification of enzyme/product Concentration and Packaging	 **01** **01** **01** **02** **01**

List of Practicals

S. No.	Title of Experiment
1.	To study the bacterial growth curve in batch culture
2.	To study the thermal death characteristics of known bacterial culture
3.	To study the thermal death characteristics of known bacterial culture
4.	Isolation and screening of amylolytic microorganisms
5.	Isolation and screening of protease producing microorganisms
6.	Isolation and screening of antibiotic producing microorganisms
7.	To carry out quantitative estimation of protease
8.	To carry out quantitative estimation of amylase
9.	To measurement C.O.D. of effluent
10.	To demonstrate the fermenter operations
11	To carry out the ethanol fermentation by *S. cerevisiae*
12	To carry out the ethanol fermentation by *S. cerevisiae*
13	To carry out the ethanol fermentation by *S. cerevisiae*
14	To produce citric acid by *A. niger*
15	To produce citric acid by *A. niger*

16	To produce citric acid by *A. niger*

Suggested Reading

Nduka Okafor. 2007. Modern Industrial Microbiology and Biotechnology. Science Publishers, Enfield, New Hampshire, USA.

Dennis E. Briggs, Chris A. Boulton, Peter A, Brookes and Roger Stevens. 2004. Brewing Science and Practice. Woodhead Publishing Ltd. Cambridge, England.

G. Reed. 2004. Prescott & Dunn's Industrial Microbiology, 4th Ed. AVI Publishers, Connecticut, USA.

Peter F. Stanbury, Allan Whitakar and Stephen J. Hall. 1995. Principles of Fermentation Technology, 2nd Ed. Elsevier Science Ltd., Burlington, MA, USA.

L.E. Casida Jr. 1968. Industrial Microbiology. New Age International Publishers, New Delhi.

3. Heat and Mass Transfer in Food Processing (FPE 231) 3 (2+1)

(32 Lectures + 16 Practical)

Units	Topics	Lecture
Units 1	Basic heat transfer processes, heat transfer coefficients, properties related to heat transfer, food properties measurements and errors	3
Units 2	**One-dimensional steady state conduction**: Theory of heat conduction, Fourier's law and its derivation, Concept of electrical analogy and its application for thermal circuits, heat transfer through composite walls and insulated pipelines	3
Units 3	**One-dimensional steady state heat conduction with heat generation**: Heat flow through slab, hollow sphere and cylinder with linear heat transfer, uniform/non-uniform heat generation, development of equations of temperature distribution with different boundary conditions	3
Units 4	**Steady-state heat conduction with heat dissipation to environment**: Introduction to extended surfaces (fins) of uniform area of cross-section and with Equation of temperature distribution with different boundary conditions; Effectiveness and efficiency of the fins	3
Units 5	**Introduction to unsteady state heat conduction**: System with negligible internal resistance and in various geometries; Convection: Forced and free convection, use of dimensional analysis for correlating variables affecting convection heat transfer	4
Units 6	**Dimensionless numbers**: Concept of Nusselt number, Prandtl number, Reynolds number, Grashoff number, some important empirical relations used for determination of heat transfer coefficient; Heisler charts and calculations	4
Units 7	**Heat transfer to flowing fluids**; Radiation: Heat radiation, emissivity, absorptivity, transmissivity, radiation through black and grey surfaces, determination of shape factors	3
Units 8	**Heat Exchangers**: General discussion, fouling factors, jacketed kettles, LMTD, parallel and counter flow heat exchangers, shell and tube and plate heat exchangers, heat exchanger design; Efficiency and NTU analysis; Application of different types of heat exchangers in dairy and food industry	4
Units 9	**Mass transfer**: Fick's law of diffusion, steady state diffusion of gases and liquids through solids, equimolal diffusion, isothermal evaporation of water into air, mass transfer coefficient, application in dairy and food industry.	5
		32

List of Practicals

S. No.	Title of Experiment
1	Heat transfer analysis during conduction and convection
2	Determination of thermal conductivity of food products and insulators
3	Determination of thermal properties (specific heat, thermal conductivity) of frozen foods
4	Determination of thermal properties (specific heat, thermal conductivity) of unfrozen foods
5	Determination of thermal diffusivity of food
6	Determination of overall heat transfer coefficient for parallel flow heat exchanger
7	Determination of overall heat transfer coefficient for counter flow heat exchanger

8	Determination of overall heat transfer coefficient for plate heat exchanger
9	Determination of overall heat transfer coefficient for shell & tube heat exchanger
10	Determination of overall heat transfer coefficient for finned tube heat exchanger
11	Determination of effectiveness of heat exchangers
12	Determination of overall heat transfer coefficient of falling film and forced circulation evaporator
13	Heat transfer during agitation and mixing
14	Study of water distillation plant
15	Demonstration of continuous distillation apparatus in operation
16	Study on temperature distribution & heat transfer in HTST pasteurizer
17	Determination of mass transfer coefficient in foods
18	Determination of glass transition temperature of food sample
19	To study mass transfer during leaching process

Suggested Reading

Eduardo Cao. 2010. Heat Transfer in Process Engineering. The McGraw-Hill Companies, Inc., New York, USA.

J.P. Holman. 2010. Heat Transfer, 10th Ed. McGraw-Hill Book Co., Boston, USA.

Don W. Green and Robert H. Perry. 2008. Perry's Chemical Engineers' Handbook. McGraw-Hill Co., Inc., NY, USA.

R. K. Rajput. 2008. Heat and Mass Transfer. S. Chand and Co., New Delhi

John H. Lienhard IV and John H. Lienhard V. 2008. A Heat Transfer Textbook. Phlogiston Press, Cambrige, MA, USA.

Warren L. McCabe, Julian Smith, Peter Harriott. 2004. Unit Operations of Chemical Engineering, 7th Ed. McGraw-Hill, Inc., NY, USA.

Christie John Geankoplis. 2003. Transport Processes and Separation Process Principles, 4th Ed. Prentice-Hall, NY, USA.

J, M. Coulson, J. F. Richardson, J. R. Backhurst and J. H. Harker. 1999. Coulson & Richardson's Chemical Engineering, Vol. 1, Fluid Flow, Heat Transfer and Mass Transfer, 6th Ed. Butterworth–Heinemann, Oxford, UK.

M. Necati Özişik. 1993. Heat Conduction, 2nd Ed. John Wiley & Sons, NY, USA.

Robert E. Treybal. 1980. Mass Transfer Operations, 3rd Ed. McGraw-Hill Book Company, Auckland, USA.

4. Food Refrigeration and Cold Chain (FPE 232) 3 (2+1)

(32 Lectures + 16 Practical)

Units	Topics	Lecture
Units 1	Principles of refrigeration: Definition, background with second law of thermodynamics,, unit of refrigerating capacity, coefficient of performance	1
Units 2	Production of low temperatures: Expansion of a liquid with flashing, reversible/ irreversible adiabatic expansion of a gas/ real gas, thermoelectric cooling, adiabatic demagnetization.	2
Units 3	Air refrigerators working on reverse Carnot cycle: Carnot cycle, reversed Carnot cycle, selection of operating temperatures; Air refrigerators working on Bell Coleman cycle: Reversed Brayton or Joule or Bell Coleman cycle, analysis of gas cycle, polytropic and multistage compression.	2
Units 4	Vapour refrigeration: Vapor as a refrigerant in reversed Carnot cycle with p-V and T-s diagrams, limitations of reversed Carnot cycle; Vapour compression system: Modifications in reverse Carnot cycle with vapour as a refrigerant (dry Vs wet compression, throttling Vs isentropic expansion), representation of vapor compression cycle on pressure-enthalpy diagram, super heating, sub cooling; effect of suction vapour, super heat and liquid sub cooling on actual vapour compression cycle;	4

	Vapour-absorption refrigeration system: Process, calculations, maximum coefficient of performance of a heat operated refrigerating machine; water/lithium bromide & ammonia/water absorption cooling.	
Units 5	Common refrigerants and their properties: classification, nomenclature, desirable properties of refrigerants- physical, chemical, safety, thermodynamic and economical; azeotrope refrigerants.	3
Units 6	Components of vapour compression refrigeration system, evaporator, compressor, condenser and expansion valve;	3
Units 7	Ice manufacture: principles and systems of ice production, basic types of ice, ice makers, Treatment of water for making ice, brines, freezing tanks, ice cans, air agitation, quality of ice;	3
Units 8	Cold storage: Cold store, design of cold storage for different categories of food resources, size and shape, construction and material, insulation, vapour barriers, floors, frost-heave, interior finish and fitting, evaporators, automated cold stores, security of operations.	2
Units 9	Refrigerated transport: Handling and distribution, cold chain, refrigerated product handling, order picking, refrigerated vans, refrigerated display.	3
Units 10	Low temperature Refrigeration: cryogenic fluid and fluid properties; liquefaction; application in food	2
Units 11	Air-conditioning: Meaning, factors affecting comfort air-conditioning, classification, sensible heat factor, industrial air-conditioning, problems on sensible heat factor; Winter/summer/year round air-conditioning, unitary air-conditioning systems, central air-conditioning, physiological principles in air-conditioning, air distribution and duct design methods; design of complete air-conditioning systems; humidifiers and dehumidifiers;	4
Units 12	Cooling/Refrigeration load calculations: Load sources, product cooling, conducted heat, convected heat, internal heat sources, heat of respiration, peak load, miscellaneous loads; etc.	3
		32

List of Practicals

S. No.	Title of Experiment
1	Study of basic refrigeration and air conditioning system and calculation of COP
2	Study of heat pump based on VCR system and calculation of COP
3	Use of psychrometric charts in refrigeration and cold chain management
4	Study of various types of compressors, condensers, expansion valves and evaporative coils used in refrigeration systems
5	Study of refrigerants and charging in compressor
6	Study of direct and indirect contact freezing equipment for foods
7	Study of spray freezing process for foods
8	Study of refrigeration system and estimation of refrigeration load for a cold storage
9	Study of refrigeration system and estimation of refrigeration load for a chocolate and ice-cream plant
10	Study of refrigeration system and estimation of refrigeration load for a dairy plant
11	Study of Ice Bank Tank system for plant
12	Study of IQF plant
13	Study of refrigerated van
14	Study of deep freezing and thawing of foods
15	Study of refrigerated display of foods and estimation of cooling load
16	Study of refrigeration system and estimation of refrigeration load for meat and poultry products
17	Study of refrigeration system of a dairy plant operation
18	Study of absorption type solar refrigeration system
19	Study on repair and maintenance of refrigeration and air-conditioning systems

Suggested Reading

William C. Whitman, William M. Johnson, John A. Tomczyk and Eugene Silberstein. 2009. Refrigeration & Air Conditioning Technology, 6th Ed. Delmar, Cengage Learning, NY, USA.

C.P. Arora. 2000. Refrigeration and Air Conditioning, 2nd Ed. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
W.F. Stoecker and J.W. Jones.1982.Refrigeration and Air Conditioning, 2nd Ed. McGraw-Hill Book Co., New York, USA.
Ashrae Handbook, 2006: Refrigeration.

5. Fundamentals of Food Engineering (FPE 233) 3 (2+1)

(32 Lectures + 16 Practical)

Units	Topics	Lecture
Units 1	**Engineering properties of food materials**: physical, thermal, aerodynamic, mechanical, optical and electromagnetic properties	3
Units 2	**Drying and dehydration:** Basic drying theory, heat and mass transfer in drying, drying rate curves, calculation of drying times, dryer efficiencies; classification and selection of dryers; tray, vacuum, osmotic, fluidized bed, pneumatic, rotary, tunnel, trough, bin, belt, microwave, IR, heat pump and freeze dryers; dryers for liquid: Drum or roller dryer, spray dryer and foam-mat dryers	8
Units 3	**Size reduction**: Benefits, classification, determination and designation of the fineness of ground material, sieve/screen analysis, principle and mechanisms of comminution of food, Rittinger's, Kick's and Bond's equations, work index, energy utilization; Size reduction equipment: Principal types, crushers (jaw crushers, gyratory, smooth roll), hammer mills and impactors, attrition mills, buhr mill, tumbling mills, tumbling mills, ultra fine grinders, fluid jet pulverizer, colloid mill, cutting machines (slicing, dicing, shredding, pulping)	5
Unit 4	**Mixing**: theory of solids mixing, criteria of mixer effectiveness and mixing indices, rate of mixing, theory of liquid mixing, power requirement for liquids mixing; Mixing equipment: Mixers for low- or medium-viscosity liquids (paddle agitators, impeller agitators, powder-liquid contacting devices, other mixers), mixers for high viscosity liquids and pastes, mixers for dry powders and particulate solids	4
Units 5	**Mechanical Separations**: Theory, centrifugation, liquid-liquid centrifugation, liquid-solid centrifugation, clarifiers, desludging and decanting machine	4
Units 6	**Filtration**: Theory of filtration, rate of filtration, pressure drop during filtration, applications, constant-rate filtration and constant-pressure filtration, derivation of equation; Filtration equipment; plate and frame filter press, rotary filters, centrifugal filters and air filters, filter aids	4
Units 7	**Membrane separation**: General considerations, materials for membrane construction, ultra-filtration, microfiltration, concentration, polarization, processing variables, membrane fouling, applications of ultra-filtration in food processing, reverse osmosis, mode of operation, and applications; Membrane separation methods, demineralization by electro-dialysis, gel filtration, ion exchange, per-evaporation and osmotic dehydration	4
		32

List of Practicals

S. No.	Title of Experiment
1	Determination of the shape and size of food materials
2	Determination of the particle density/true density and porosity of solid grains and powdery material
3	Determination of terminal velocity of grain sample
4	Determination of fineness modulus and uniformity index
5	Operation of tray dryer and drying process calculations
6	Operation of vacuum dryer and drying process calculations
7	Study of spray dryer and drying process calculations
8	Study of microwave dryer operation
9	Study of osmosis in fruit

10	Determination of solid gain and moisture loss during osmosis
11	Power requirement in size reduction of grain using Rittinger's law, Kick's law and Bond's law
12	Performance evaluation of hammer mill
13	Performance evaluation of attrition mill
14	Determination of mixing index of a feed mixer
15	Determination of cleaning effectiveness / efficiency
16	Study of centrifugal separator
17	Study of reverse osmosis process
18	Study of ultra-filtration/membrane separation process

Suggested Reading

R.L. Earle. 2004. Unit Operations in Food Processing. The New Zealand Institute of Food Science & Technology, Nz.

Warren L. McCabe, Julian Smith, Peter Harriott. 2004. Unit Operations of Chemical Engineering, 7th Ed. McGraw-Hill, Inc., NY, USA.

Christie John Geankoplis. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th Ed. Prentice-Hall, NY, USA.

George D. Saravacos and Athanasios E. Kostaropoulos. 2002. Handbook of Food Processing Equipment. Springer Science+Business Media, New York, USA.

J. F. Richardson, J. H. Harker and J. R. Backhurst. 2002. Coulson & Richardson's Chemical Engineering, Vol. 2, Particle Technology and Separation Processes, 5th Ed. Butterworth–Heinemann, Oxford, UK.

Mohsenin, Nuri N. 1986. Physical Properties of Plant and Animal Materials : Structure, Physical Characteristics and Mechanical properties, 2nd Ed. Gordon and Breach Science Publishers, New York.

Mohsenin, Nuri N. 1984. Electromagnetic Radiation Properties of Foods and Agricultural Products. Gordon and Breach Science Publishers, New York.

Mohsenin, Nuri N. 1980. Thermal Properties of Foods and Agricultural Materials. Gordon and Breach Science Publishers, New York.

6. Processing Technology of Liquid Milk (FPT 231) 2 (1+1)

(16 Lectures + 16 Practicals)

Units	Topics	Lectures
Unit 1	Historical development of dairy in India; Production and utilization of milk; Composition and properties of milk;	**01**
Unit 2	Liquid milk collection, preservation, processing, packaging and storage - standardized milk, skim milk, sterilized milk, reconstituted/rehydrated milk, recombined milk, flavored milk.	**04**
Unit 3	Effect of thermal treatment on milk constituents	**01**
Unit 4	Fermented milk, acidophilous milk, etc.; Effect of thermal treatment on milk constituents; Fermented milk products: Processing, manufacture, storage and packaging of acidophilus milk, cultured buttermilk and other fermented milk; Bio-chemical changes occurring during manufacture of fermented milks; Factors affecting these changes and effects of these changes on the quality of finished products	**03**
Unit 5	Cream: definition, classification, manufacture of different types of cream, processing of cream;	**01**
Unit 6	Adulterations in milk and its detection; Quality defects in milk - causes and prevention	**01**
Unit 7	Liquid milk collection, processing, packaging and storage systems and equipment - bulk milk coolers, milk chilling units, milk reception equipment, milk tanks/silos, pasteurizers, sterilizers, centrifuges, clarifiers, filtration units, homogenizers, packaging and filling machines, CIP units, etc.;	**03**
Unit 8	Hygienic design concepts, sanitary pipes and fittings, corrosion process and their control.	**02**

List of Practicals

S. No.	Title of Experiment
1	Sampling of milk and milk products
2	Platform tests of raw milk (clot on boiling (COB) test, alcohol test
3	Determination of physical properties of milk
4	Determination of proximate composition and biochemical properties of milk
5	Determination of microbiological properties of milk
6	Detection of adulterants in milk
7	Identification and demonstration of liquid milk processing equipment, pipes and fittings
8	Preparing standardized milk as per requirement
9	Separation of fat from milk
10	Pasteurization and homogenization of milk
11	Packaging of liquid milk
12	Preparation of sterilized flavored milk
13	Preparation of reconstituted milk/rehydrated milk
14	Preparation of cream
15	Preparation of buttermilk
16	Preparation of curd and yogurt
17	Preparation of *Lassi*
18	Visit to chilling center and dairy plant

Suggested Reading

A. Kanekanian. 2014. Milk and Dairy Products as Functional Foods. John Wiley & Sons, Ltd., UK.

Adnan Y. Tamime. 2009. Milk Processing and Quality Management. Blackwell Publishing Ltd., UK.

Pieter Walstra, Jan T.M. Wouters, Tom J. Geurts. 2006. Dairy Science and Technology, 2nd Ed. CRC Press, Boca Raton, FL, USA.

Sukumar De. 2005. Outlines of Dairy Technology. Oxford University Press, New Delhi.

H.G. Kessler. 1981. Food Engineering and Dairy Technology. Verlag A. Kessler, Fraising (F.R. Germany).

Y.H. Hui. 1993. Dairy Science and Technology Handbook, Vol. I, II and III. Wiley-VCH, USA.

7. Processing Technology of Cereal (FPT 232) 3 (2+1)

(32 Lectures + 16 Practicals)

Units	Topics	Lectures
Unit 1	Present status and future prospects of cereals and millets Morphology, physico-chemical properties of cereals, major and minor millets Chemical composition and nutritive value	**01** **02** **01**
Unit 2	Paddy processing and rice milling: Conventional milling, modern milling Milling operations, milling machines, milling efficiency; Quality characteristics influencing final milled product	**01** **02**
Unit 3	Parboiling; Rice bran stabilization and its methods Ageing of rice; Enrichment of rice – methods of enrichment; Rice fortification	**02** **02**
Unit 4	Wheat milling: Break system, purification system and reduction system; extraction rate and its effect on flour composition; Quality characteristics of flour and their suitability for baking	**02** **01**
Unit 5	Corn milling: Dry and wet milling of corn, starch and gluten separation, milling fractions and modified starches	**02**
Unit 6	Barley: Malting and milling Oat/Rye: Processing, milling Sorghum: Milling, malting, pearling Millets (Pearl millets, finger millets): Processing of millets for food uses	**02** **02** **02** **02**
Unit 7	Secondary and tertiary products processing of cereals and millets By-products processing of cereals and millets	**02** **02**
Unit 8	Processing of infant foods from cereals and millets	**02**
Unit 9	Breakfast cereal foods: Flaked, puffed, expanded, extruded and shredded	**02**

List of Practicals

S. No.	Title of Experiment
1	Morphological characteristics of cereals
2	Physical properties of cereals
3	Chemical properties of cereals
4	Parboiling of paddy
5	Effect of various factor on parboiling of paddy
6	Determination of cooking quality of rice
7	Milling of rice and quantitative analysis of various fractions
8	Conditioning and milling of wheat
9	Quantitative analysis of various fractions of milled wheat
10	Production of sorghum flakes
11	Production of popcorns
12	Production of flaked rice, puffed rice, noodles
13	Preparation of sorghum malt
14	Determination of gelatinization temperature using DSC and other methods
15	Processing of value added products from millets
16	Visit to Cereal processing unit

Suggested Reading

Chakraverty, A. and Singh, R. P. 2014. Post Harvest Technology and Food Process Engineering. CRC Press, Boca Raton, FL, USA.

Khan, K. and Shewry, P. R. 2009. Wheat: Chemistry and Technology, 4th Ed., AACC International, Inc., St. Paul, MN, USA.

Wrigley, C. 2004. Encyclopedia of Grain Science. Academic Press, London, UK.

Champagne, E. T. 2004. Rice: Chemistry and Technology, 3rd Ed., AACC International, Inc., St. Paul, MN, USA.

Chakraverty, A., Mujumdar, A.S., Vijaya Raghavan G.S. and Ramaswamy, H. S. 2003. Handbook of Post Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA.

White, P. J. and Johnson. L. Lawrence A. 2003. Corn: Chemistry and Technology, 2nd Ed., AACC International, Inc., St. Paul, MN, USA.

David A.V. Dendy and Bogdan J. Dobraszczyk. 2001. Cereal and Cereal Products: Technology and Chemistry. Springer-Verlag, US.

Kent, N.L. and Evers, A.D. 1994. Kent's Technology of Cereals: An Introduction for Students of Food Science and Agriculture, 4th Ed. Elsevier Science Ltd., Oxford, UK.

Matz, Samuel A. 1991. The Chemistry and Technology of Cereals as Food and Feed, 2nd Ed. Springer Science + Business Media, NY, USA.

Araullo, E.V., D.B. De Padna and Graham. 1976. Rice Post Harvest Technology. IDRC, Canada.

8. Statistical Methods and Numerical Analysis (STAT 231) 2 (1+1)

(16 Lectures + 16 Practical)

Units	Topics	Lectures
Unit 1	Statistical inference and testing of hypothesis – Z test, t test and F test	4
Unit 2	Chi-square test and its uses – testing the goodness of fit and test of independence (contingency table)	2
Unit 3	Correlation and regression analysis	3
Unit 4	Basic principles of experimental design Analysis of variance (ANOVA) – one way and two way classification. Basic designs- Layout and analysis of completely randomized design (CRD) with equal and unequal number of observations, randomized block design (RBD), Latin square design (LSD)	5
Unit 5	Response surface methodology	2

List of Practicals

S. No.	Title of Experiment
1-2	Problems on Z test – One and two sample test
3-4	Problems on t test - One and two sample (dependent and independent) test
5	Problems on F test

6-7	Problems on chi square test
8	Problems on correlation and regression
9-10	Problems on CRD
11-12	Problems on RBD
13-14	Problems on LSD
15-16	Problems on response surface methodology

Suggested Reading

Erwin Kreyszig, 2006. Advanced Engineering Mathematics, 9th Ed. John Wiley & Sons, New York, USA.

B.S. Grewal. 2004. Higher Engineering Mathematics. Khanna Publishers, Delhi.

P.P. Gupta and C.C. Malik. 1993. Calculus of Finite Differences and Numerical Analysis. Krishna Prakash Mandor, Meerut.

PED 231	NCC/NSS/Physical Education	1 (0+1)*

***** Non-Credit Course

SEMESTER IV

1. Food Biotechnology (FQA 241) 3 (2+1)

(32 Lectures + 16 Practicals)

Units	Topics	Lecture
Unit 1	**Introduction to genetic material:** Chemical nature, properties, and functions of the genetic material.	01
	Overview of bacterial DNA replication: Origin of replication, Enzymes and proteins required for DNA replication and overview of replication	02
	Bacterial transcription: Types of RNA and overview of bacterial transcription.	02
	Bacterial translation: Genetic code and overview of bacterial translation.	02
	Mutation and DNA repair: Types of mutation, mechanisms of repair of damaged DNA (photo reactivation, excision repair, recombination repair, SOS repair and mismatch repair).	02
Unit 2	**Overview of genetic recombination in bacteria**	
	Bacterial transformation: Griffith experiment, Avery, MacLeod & McCarty experiment and Mechanism of bacterial transformation.	02
	Bacterial Conjugation: Lederberg & Tatum experiment, Bernard & Devis ('U' tube experiment), F factor and mechanism of bacterial conjugation.	02
	Bacterial Transduction: Structure of bacteriophage, replication cycle of bacteriophage and Mechanism of bacterial transduction.	02
Unit 3	**Regulation of gene expression in prokaryotes:** Fine structure of gene (Operator, Promoter, Structural and regulatory gene sequence) and Mechanism of bacterial gene expression regulation - Lac operon.	03
Unit 4	**Introduction to recombinant DNA technology**	
	DNA modifying enzymes: Restriction enzymes and other modifying enzymes	01
	Cloning vectors: Introduction, plasmid and other vectors	01
	Steps of gene cloning: Isolation and purification of insert DNA, selection and isolation of vector DNA, construction of recombined DNA, introduction of recombined DNA into host cell, identification and selection of cells containing cloned genes	02 04
Unit 5	**Immobilization:** Introduction, types and application	02
	Biosensors: Introduction, classification and application in food industries	02
Unit 6	**GMO food:** Introduction, Ethical issues and guidelines	02

List of Practicals

S. No.	Title of Experiment
1	Isolation and analysis of chromosomal/genomic DNA from bacteria

2	Isolation and analysis of chromosomal/genomic DNA from bacteria
3	Isolation and analysis of chromosomal/genomic DNA from plant
4	Isolation and analysis of chromosomal/genomic DNA from plant
5	Detection of food borne pathogen by conventional microbiological method
6	Introduction to ELISA
7	Introduction to Southern blot
8	To carry out fermentation of amylase
9	To carry out fermentation of amylase
10	Demonstration of Enzyme immobilization
11	Demonstration of PCR
12	Demonstration of PCR
13	Pathogen detection by using real time PCR
14	Demonstration for detection of GMO foods
15	Demonstration for gene cloning
16	Demonstration for gene cloning

Suggested Reading

B.D. Singh. 2014. Biotechnology - Expanding Horizons. Kalyani Publishers, New Delhi.

Meenakshi Paul. 2007. Biotechnology and Food Processing Mechanics. Gene-Tech Books, New Delhi.

James D. Watson. 2013. Molecular Biology of the Gene, 7th Ed. Benjamin Cummings, San Francisco, USA.

Oliver Brandenberg, Zephaniah Dhlamini, Alessandra Sensi, Kakoli Ghosh and Andrea Sonnino 2011. Introduction to Molecular Biology and Genetic Engineering. FAO, Rome, Italy.

S.B. Primrose and R.M. Twyman. 2006. Principles of Gene Manipulation and Genomics, 7th Ed. Blackwell Publishing, Victoria, Australia.

Ashok Agarwal and Pradeep Parihar. 2005. Industrial Microbiology: Fundamentals and Applications. Agrobios India, Jodhpur.

2. Food Plant Sanitation (FQA 242) 2 (1+1)

(16 Lectures + 16 Practicals)

Units	Topics	Lecture
Unit 1	**Sanitation and food industry:** Sanitation, sanitation laws, regulations, and guidelines, establishment of sanitary Practices.	1
	Foodborne bioterrorism: Potential risks and protection measures for bioterrorism	1
	The Relationship of microorganisms to sanitation: Microbial growth in relation to spoilage and food borne out breaks and its control measures	1
Unit 2	**The Relationship of allergens to sanitation:** Food allergens and its control measures	1
	Food contamination sources: Sources of contamination, contamination of foods, protection against contamination	1
	Personal hygiene and sanitary food handling: Personal hygiene, employee hygiene, sanitary food handling, role of employee supervision, employee responsibility	1
Unit 3	**Cleaning compounds and sanitizers:** Classification, selection of cleaning compounds and sanitizers, handling and storage, precautions	3
	Pest and Rodent Control: Insect infestation, cockroaches, insect destruction, rodents, birds, use of pesticides, integrated pest management	1
Unit 4	**Sanitary design and construction for food processing:** Site selection, site preparation, building construction considerations, processing and design considerations, pest control design **Waste product handling**: solid waste and liquid waste management	2 2
	Role of HACCP in sanitation: Good manufacturing practices, current good manufacturing practices; Standard operating procedures, good laboratory practices	2

List of Practicals

S. No.	Title of Experiment
01	Estimation of BOD (Biological Oxygen Demand)
02	Estimation of COD (Chemical Oxygen Demand);
03	Determination of hardness of water
04	Good Manufacturing Practices (GMPs) and personal hygiene
05	Sewage treatment: Primary, secondary, tertiary and quaternary;
06	Lab demonstration on state of water
07	Study of CIP plant
08	Aerobic and anaerobic sludge treatment
09	Isolation and identification of Actinomycetes;
10	Enrichment and isolation of cellulose degrading bacteria
11	Biodegradation of phenol compounds;
12	Bacteriological examination of water: Coliform MPN test;
13	Sampling of airborne microorganisms
14	Sampling of surfaces - equipment and physical plant
15	Aerosol sampling and measurement guidelines
16	Visit to Food Processing Plant/ Restaurants/ Food Mall etc.

Suggested Reading

Michael M. Cramer. 2013. Food Plant Sanitation: Design, Maintenance, and Good Manufacturing Practices. CRC Press, Boca Raton, FL, USA.

Ralph Mitchell and Ji-Dong Gu. 2010. Environmental Microbiology, 2nd Ed. John Wiley & Sons, Inc., Hoboken, New Jersey, USA.

Norman G. Marriott and Robert B. Gravani. 2006. Principles of Food Sanitation, 5th Ed. Springer Science & Business Media, Inc., NY, USA.

I.L. Pepper and C.P. Gerba. 2005. Environmental Microbiology: Laboratory Manual, 2nd Ed. Elsevier Academic Press, Amsterdam.

Y. H. Hui, Bernard L. Bruinsma, J. Richard Gorham, Wai-Kit Nip, Phillip S. Tong and Phil Ventresca. 2003. Food Plant Sanitation. Marcel Dekker, Inc., NY, USA.

3. Food Plant Utilities & Services (FPE 241) 3 (2+1)

(32 Lectures + 16 Practical)

Units	Topics	Lecture
Unit 1	**Introduction**	
	Classification of Various Utilities and Services in food Plant/ industry. Commercial energy Pricing	**2**
Unit 2	**Electrical System**	
	Introduction to electric power supply systems, electrical billing, electrical load management & maximum demand control, power factor improvement & benefits, transformers, system distribution losses, harmonics, trouble shooting of electrical power system	**2**
Unit 3	**Electrical motors**	
	Types, losses in Introduction motor, motor efficiency, factors affecting motor performers, performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors	**1**
Unit 4	**Compressed air system**	
	Requirement, types, compressor efficiency, efficient compressor operation, compressed air system components, capacity assessment, leakage test, factors affecting the performance & efficiency	**3**
Unit 5	**HV AC & Refrigeration system**	
	Requirement, vapor compression refrigeration cycle, refrigerants, coefficient of performance, capacity, factors affecting refrigeration & air conditioning system performance & saving opportunities. Vapor absorption refrigeration system: Working principle, types & comparison with VCR system, saving potential	**2**
Unit 6	**Fans and blowers**	
	Requirement, types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities	**2**

Unit 7	**Pumps and pumping systems**	
	Requirement, types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities	**2**
Unit 8	**DG set system**	
	Requirement, introduction, factors affecting selection	**1**
Unit 9	**Fuels and combustion**	
	Introduction to fuels; properties offuel oil, coal & gas; storage; handling & preparation of fuels; principles of combustion, combustion of oil, coal & gas; draft system	**2**
Unit 10	**Boilers**	
	Boiler specification, Indian boiler regulation, system components, types, combustion in boilers, performance terms, analysis of losses, feed water treatment, blow down, energy conservation opportunities	**2**
Unit 11	**Steam system**	
	Properties of steam, assessment of steam distribution losses, steam leakage, steam trapping, condensate and flash steam recovery system, opportunities for energy savings	**2**
Unit 12	**Waste heat recovery**	
	Classification, advantages and application, commercially viable waste heat recovery devices, saving potential	**3**
Unit 13	**Other utilities & services**	
	Lighting, CIP system, waste water/drainage, water treatment, dust removal, fire protection and maintenance system	**4**

List of Practicals

S. No.	Title of Experiment
1	Study on energy basic, types, forms, terms and measuring instruments used in food plant utilities.
2	Study on plant's electrical power supply system, billing and load estimation.
3	Motors and variable speed drives specification, selection, performance terms & definitions.
4	Study on compressed air system components and performance terms & definitions.
5	Study of refrigeration & HVAC system components, performance terms & definitions and load estimation of a plant.
6	Study of fans and blowers, types, specification, performance terms & definitions.
7	Pumps types, specification, selection, performance terms & definitions.
8	Study on plant lighting system and their components.
9	Study on DG system their specification and selection.
10	Study on combustion of oil, gas & coal.
11	Study on fuel substitution.
12	Study on boiler performance terms and assessment.
13	Study on cost of steam
14	Study on waste heat recovery devices [Recuperates, Regenerators, Heat wheel, Heat pipes, Economizers, Heat exchanger (Shell and tube, PHE, run around coil exchanger, direct contact HX), Waste heat recovery boilers, Heat pumps and Thermo compressor].
15	Study on ClP' system components.
16	Study on fire control operations and use of fire extinguisher.
17	Study of water treatment plant.
18	Study of effluent treatment plant.

Text books

Energy Efficiency and Management in Food Processing Facilities, by Lijun Wang. Published by CRC Press, 2008

Energy-saving Techniques for the Food Industry by M. E. Casper. Published by Noyes Data Corp., 1977

Chilton's Food Engineering. Published by Chilton Co., 1979

Reference book

A Survey of Water Use in the Food Industry by W. E. Whitman, S. D. Holdsworth. Published by British Food Manufacturing Industries Research Association.

4. Unit Operations in Food Processing (FPT 241) 3 (2+1)

(32 Lectures + 16 Practicals)

Units	Topics	Lectures
Unit 1	Evaporation: Principles of evaporation, mass and energy balance, factors affecting rate of evaporation, thermodynamics of evaporation (phase change, boiling point elevation, Dühring plot; Heat and mass transfer in evaporator, factors influencing the overall heat transfer coefficient, influence of feed liquor properties on evaporation	02
	Evaporation equipment: Natural circulation evaporators, horizontal/vertical short tube, natural circulation with external calandria, long tube, forced circulation; Evaporator ancillary plant, design of evaporation systems, single effect, multiple effect evaporators, feeding methods of multiple effect evaporation systems, feed preheating, vapour recompression systems	02
	Fouling of evaporators and heat exchangers; Recompression heat and mass recovery and vacuum creating devices	02
Unit 2	Food freezing: Introduction, freezing point curve for food and water, freezing points of common food materials, Principles of food freezing,	02
	Freezing time calculation by using Plank's equation; Freezing systems; Direct contact systems, air blast immersion; Changes in foods; Frozen food properties; freezing time, factors influencing freezing time, freezing/thawing time	
	Freeze concentration: Principles, process, methods; Frozen food storage: Quality changes in foods during frozen storage; Freeze drying: Heat mass transfer during freeze drying, equipment and practice.	02
Unit 3	Expression and Extraction: liquid-liquid extraction processes, types of equipment and design for liquid-liquid extraction, continuous multistage counter current extraction	01
	Leaching: process, preparation of solids, rate of leaching, types of equipment, equilibrium relations	01
Unit 4	Crystallization and dissolution: Theory and principles, kinetics, applications in food industry, equipment for crystallization	02
Unit 5	Distillation: Principles, vapour-liquid equilibrium, continuous flow distillation, batch/differential distillation, fractional distillation, steam distillation, distillation of wines and spirits	02
Unit 6	Baking: Principles, baked foods, baking equipment; Roasting: Principles of roasting, roasting equipment;	02
Unit 7	Frying: theory and principles, shallow or contact frying and deep fat frying, heat and mass transfer in frying, frying equipment; Puffing: Puffing methods, puffing equipment	02
Unit 8	Blanching: Principles and equipment; Pasteurization: Purpose, microorganisms and their reaction to temperature and other influences,	02
	Methods of heating, design and mode of operation of heating equipment, vat, tubular heat exchanger, plate heat exchanger	02
Unit 9	Sterilization: Principles, process time, T-evaluation, design of batch and continuous sterilization, different methods and equipment	02
	UHT sterilization, in the package sterilization, temperature and pressure patterns, equipment for sterilizing goods in the package	02
	Aseptic processing: principles, analysis of thermal resilience, duration mathematics of conduction heating	02
	Thermal processing and microbial death curves; Homogenization, Emulsification.	02

List of Practicals

S. No.	Title of Experiment
1	Study of working principle open pan and vacuum evaporator and estimation of heat/mass balance during concentration of liquid foods
2	Study of single effect evaporator and estimation of heat/mass balance during concentration of liquid foods

3	Study of multiple effect evaporator and estimation of heat/mass balance during concentration of liquid foods
4	Effect of sample particle size and time on solvent extraction process
5	Effect of temperature on crystallization rate of sugar
6	Study of freezers/ Design problems on freezers
7	To study freezing of foods by different methods IQF freezing
8	Determination of freezing time of a food material
9	To study simple distillation process and determine the rate of distillation
10	To study the effect of leavening agent/ time- temperature on baking process
11	To study the process of roasting/ To study the effect of time- temperature combination on roasting
12	Determination of oil uptake by the food product during frying
13	Study on qualitative changes in the fried food product
10	To study the puffing/ popping characteristics of selected grains
11	To determine the efficacy of a blanching process
12	To determine time-temperature combination for a blanching process
13	To determine the efficacy of a sterilization process
14	Numerical problem on thermo bacteriology (D, Z and F)
15	Determination of F value for a product in can/ retortable pouch
16	Study of sterilizer /blancher/ pasteurizers/ fryers/ homogenizers/ irradiators
17	Visit sugar processing industry

Suggested Reading

R. Paul Singh and Dennis R. Heldman. 2014. Introduction to Food Engineering, 5th Ed. Elsevier, Amsterdam, The Netherlands.

R.L. Earle. 2004. Unit Operations in Food Processing. The New Zealand Institute of Food Science & Technology, Nz.

Warren L. McCabe, Julian Smith, Peter Harriott. 2004. Unit Operations of Chemical Engineering, 7th Ed. McGraw-Hill, Inc., NY, USA.

Albert Ibarz and Gustavo V. Barbosa-Cánovas. 2003. Unit Operations in Food Engineering. CRC Press, Boca Raton, FL, USA.

Christie John Geankoplis. 2003. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th Ed. Prentice-Hall, NY, USA.

George D. Saravacos and Athanasios E. Kostaropoulos. 2002. Handbook of Food Processing Equipment. Springer Science+Business Media, New York, USA.

J. F. Richardson, J. H. Harker and J. R. Backhurst. 2002. Coulson & Richardson's Chemical Engineering, Vol. 2, Particle Technology and Separation Processes, 5th Ed. Butterworth–Heinemann, Oxford, UK.

P. Fellows. 2000. Food Processing Technology: Principles and Practice, 2nd Ed. CRC Press, Boca Raton, FL, USA.

R. K. Sinnott. 1999. Chemical Engineering, Vol. 6, Chemical Engineering Design, 3rd Ed. Butterworth-Heinemann, Oxford, UK.

Kenneth J. Valentas, Enrique Rotstein and R. Paul Singh. 1997. Handbook of Food Engineering Practice. CRC Press, Boca Raton, FL, USA.

Robert E. Treybal. 1980. Mass Transfer Operations, 3rd Ed. McGraw-Hill Book Company, Auckland, USA.

5. Processing Technology of Dairy Products (FPT 242) 3 (2+1)

(32 Lectures + 16 Practicals)

Units	Topics	Lectures
Unit 1	Cream: Basic aspect, Classification, manufacture of different types of cream, processing of cream; Classification of dairy products; Butter: Definition, composition; processing and production steps, overrun, butter making machines, quality testing of table butter, butter- defects, causes and their prevention, packaging and storage	**02** **04**
Unit 2	Butter oil and ghee: Definition, composition, processing, equipment, quality tests; Paneer and Cheese: Definition, composition, types, processing steps, process flow diagram, equipment, quality defects, causes and prevention, packaging and storage.	**04** **04**
Unit 3	Ice cream and frozen desserts: Definition, composition, types, Processing steps and flow diagram, equipment, quality testing, defects causes and prevention, packaging and storage.	**02** **04**
Unit 4	Condensed and Dried milk: Definition, composition, role of milk constituents in condensed milk, manufacture of condensed milk, types of standards for dried milk Manufacture of SMP and WMP using roller and spray drying, instantization, recent developments in drying, quality testing, defects, causes and prevention, packaging and storage	**03** **04**
Unit 5	Traditional Indian Dairy Products: Definitions, compositions, processing, packaging, storage, equipment and quality testing; By- products of dairy industry and their utilization.	**03** **02**

List of Practicals

S. No.	Title of Experiment
1	Preparation of butter/ table butter
2	Preparation of ghee
3	Preparation of paneer
4	Preparation of Chhana
5	Preparation of selected type of cheese
6	Preparation of ice-cream and selected frozen desserts
7	Preparation of condensed milk
8	Preparation of spray dried milk powder
9	Preparation of selected Indian dairy products
10	Preparation of Mawa/khoa
11	Preparation of mawa/khoa based products
12	Preparation of Shrikhand
13	Preparation of whey drink
14	Preparation of halwa/ kheer etc.
15	Determination of selected quality parameters of selected dairy products
16	Visit to dairy plant

Suggested Reading

A. Kanekanian. 2014. Milk and Dairy Products as Functional Foods. John Wiley & Sons, Ltd., UK.

Adnan Y. Tamime. 2009. Milk Processing and Quality Management. Blackwell Publishing Ltd., UK.

Pieter Walstra, Jan T.M. Wouters, Tom J. Geurts. 2006. Dairy Science and Technology, 2nd Ed. CRC Press, Boca Raton, FL, USA.

Sukumar De. 2005. Outlines of Dairy Technology. Oxford University Press, New Delhi.

H.G. Kessler. 1981. Food Engineering and Dairy Technology. Verlag A. Kessler, Fraising (F.R. Germany).

Y.H. Hui. 1993. Dairy Science and Technology Handbook, Vol. I, II and III. Wiley-VCH, USA.

Aneja, R. P.; Mathur, B. N.; Chandan, R. C.; Banerjee, A. K., 2002, Technology of Indian Milk Products: Handbook of Procees Technology Modernization for Professionals Entrepreneurs and Scientists, Dairy India Yearbook

6. Processing Technology of Legumes and Oilseeds (FPT 243) 3 (2+1)

(32 Lectures + 16 Practicals)

Units	Topics	Lectures
Unit 1	Present status and future prospects of legumes and oilseeds; Morphology of legumes and oilseeds; Classification and types of legumes and oilseeds	**02**
	Chemical composition, nutritional value and anti-nutritional compounds in legumes and oilseeds; Methods of removal of anti- nutritional compounds	**02**
Unit 2	Pulse milling: Home scale, cottage scale and modern milling methods, machines, milling quality, milling efficiency	**03**
	Factors affecting milling quality and quantity; Problems in dhal milling industry	**03**
Unit 3	Nutritional changes during soaking and sprouting of pulses; Cooking quality of dhal, methods, factors affecting cooking of dhal;	**03**
	Quick cooking dhal, instant dhal; Soybean milk processing and value addition; Fermented products of legumes	**03**
Unit 4	Oil seed milling: Ghanis, hydraulic presses, expellers, solvent extraction methods, machines,	**02**
	Milling quality, milling efficiency, factors affecting milling quality and quantity; Problems in oil milling industry;	**01**
Unit 5	Desolventization	**01**
	Refining of oils: Degumming, neutralization, bleaching, filtration, deodorization, winterization and their principles and process controls;	**03**
	Hydrogenation of oils; New technologies in oilseed processing;	**03**
Unit 6	Utilization of oil seed meals for different food uses: High protein products like protein concentrates and isolates;	**03**
	By-products of pulse and oil milling and their value addition.	**03**

List of Practicals

S. No.	Title of Experiment
1	Determination of physical properties of legumes and oil seeds
2	Determination of proximate composition of selected pulses and oilseeds
3	Determination of nutritional quality of selected pulses and oilseeds
4	Study of mini dhal mill
5	Study of mini oil mill
6	Preconditioning of pulses before milling
7	Preconditioning of oilseeds before milling
8	Removal of anti-nutritional compounds from selected pulses and oilseeds
9	Laboratory milling of selected pulses and its quality evaluation
10	Laboratory milling of selected oilseeds and its quality evaluation
11	Laboratory refining of selected oils
12	Laboratory hydrogenation of selected oils
13	Study of cooking quality of dhal
14	Processing of composite legume mix and preparation of value added products
15	Processing of soy milk and value added products
16	Visit to commercial dhal mills and oil mills

Suggested Reading

Guriqbal Singh, Harbhajan Singh Sekhon, Jaspinder Singh Kolar and Masood Ali. 2005. Pulses. Agrotech Publishing Academy, Udaipur.

A. Chakraverty. 2008. Post Harvest Technology of Cereals, Pulses and Oilseeds, 3rd Ed. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

Frank D. Gunstone. 2008. Oils and Fats in the Food Industry. John Wiley and Sons, Ltd., West Sussex, UK.

Fereidoon Shahidi. 2005. Bailey's Industrial Oil & Fat Products, 6th Ed., Vols. 1 to 6. John Wiley and Sons, Inc. Hoboken, New Jersey, USA.

Amalendu Chakraverty, Arun S. Mujumdar, G.S. Vijaya Raghavan and Hosahalli S. Ramaswamy. 2003. Handbook of Post Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA.

K.M. Sahay and K.K. Singh. 2001. Unit Operations of Agricultural Processing, 2nd Ed. Vikas Publishing House Pvt. Ltd., Noida.

7. Processing of Spices and Plantation Crops (FPT 244) 3 (2+1)

(32 Lectures + 16 Practicals)

Units	Topics	Lectures
Unit 1	Production and processing scenario of spice, flavour and plantation crops and its scope	**01**
Unit 2	Major spices: Post harvest technology, composition Processed products of spices: Ginger, chilli, turmeric, onion and garlic, pepper, cardamom.	**02** **02**
Unit 3	Equipment for cryogenic grinding	**01**
Unit 4	Minor spices: Herbs, leaves and spartan seasonings and their processing and utilization; All spice, Annie seed, sweet basil; Caraway seed, cassia, cinnamon Clove, coriander, cumin, dill seed; Fennel seed, nutmeg, mace, mint marjoram. Rosemary, saffron, sage; Savory, thyme, ajowan; Asafetida, curry leaves	**02** **02** **02** **02**
Unit 5	Post-harvest technology for Tea, coffee, cocoa	**02**
Unit 6	Vanilla and annatto processing	**02**
Unit 7	Post-harvest technology and processing of areca nut, cashew nut, oil palm, coconut	**02**
Unit 8	Flavours of minor spices; Flavour of major spices	**02**
Unit 9	Spice oil and oleoresins: Extraction techniques; Super critical fluid extraction of spices	**03**
Unit 10	Standard specification of spices; Standards like ESA, ASTA, FSSAI and maintenance of quality by fumigation, CAS and ETO sterilization	**02** **01**
Unit 11	Functional packaging of spices and spice products By-products of plantation crops and spices	**02** **02**

List of Practicals

S. No.	Title of Experiment
1	Chemical analysis of select spices: Moisture, valuable oil,
2	Physical analysis of select spices: specific gravity, refractive index, acid value
3	Identification and characterization of flavouring compounds of spices
4	Valuable oil determination
5	Extraction of oil from clove/ pepper
6	Extraction of oil from cardamom/ chilli
7	Extraction of oleoresins: Turmeric/ ginger, pepper, clove
8	Extraction of oleoresins: pepper/ clove
9	Peperine estimation in pepper oleoresin
10	Steam distillation of spices
11	Determination of curcumin content in turmeric
12	Study of standard specification of spices
13	Packaging study of spices
14	Preparation of curry powder
15	Extraction of active ingredients by TLC, HPLC and GC
16	Visit to spice industry

Suggested Reading

K.G. Shanmugavelu. Spices and Plantation Crops. Oxford & IBH Publishing Co., New Delhi

J.W. Purseglave, E.G. Brown, C.L. Green and Robins. Spices, Vol. I and II. SRJ Academic Press, New Delhi.

J.S. Pruthi. 2001. Spices and Condiments – Major Spices of India. National Book Trust, New Delhi.

J.S. Pruthi. 2001. Spices and Condiments – Minor Spices of India. National Book Trust, New Delhi.

Kenji Hirasa and Mitsuo Takemasa. 1998. Spice Science and Technology. Marcel Dekker, NY, USA.
H. Panda. Handbook on Spices and Condiments (Cultivation, Processing and Extraction). Asia Pacific Business Press Inc., New Delhi.
S. Gupta. Handbook of Spices and Packaging with Formulae. Engineers India Research Institute, New Delhi.

8. Business Management and Economics (FBM 241) 2 (2+0)
(32 Lectures)

Units	Topics	Lectures
Unit 1	Definitions, management principles, scientific principles, administrative principles;	1
	Maslow's Hierarchy of needs theory	1
Unit 2	Functions of management: Planning, organizing, staffing, directing, controlling;	2
	Organizational structures, principles of organization;	1
	Types of organization: Formal and informal, line, line and staff, matrix, hybrid	2
Unit 3	Introduction to economics: Definitions, nature, scope, difference between microeconomics and macroeconomics;	2
	Theory of demand and supply, elasticity of demand, price and income elasticity;	3
	Markets: Types of markets and their characteristics	2
Unit 4	National income: GDP, GNP, NNP, disposable personal income, per capita income, inflation;	2
	Theory of production: Production function, factors of production.	2
	Law of variable proportions and law of returns to scale	2
Unit 5	Cost: Short run and long run cost, fixed cost, variable cost, total cost, average cost, marginal cost, opportunity cost;	2
	Break even analysis	2
Unit 6	Finance management: Definition, scope, objective;	1
	Different systems of accounting: Financial accounting, cost accounting, management accounting	3
Unit 7	Human resource management: Definitions, objectives of manpower planning, process, sources of recruitment, process of selection;	2
	Corporate social responsibility: Importance, business ethics	2

Suggested Reading

L.M. Prasad. 2001. Principles and Practices of Management, 9th Ed. S. Chand & Sons, New Delhi.
Koontz Harold. Principles of Management. Tata McGraw-Hill Education Private Limited, New Delhi.
P.C. Thomas. Managerial Economics, 9th Ed. Kalyani Publishers.
K.K. Dewett and M.H. Navalur. Modern Economic Theory. S. Chand & Sons, New Delhi.
P. Subba Rao. Human Resource Management. Himalaya Publications.
S.P. Jain. Financial Accounting. Kalyani Publications, Ludhiana.

PED 241	NCC/NSS/Physical Education	1 (0+1)*

***** Non-Credit Course

SEMESTER V

1. Instrumental Techniques in Food Analysis (FQA 351) 3 (1+2)

32 Lectures + 16 Practicals)

Units	Topics	Lecture
Unit 1	Concepts of food analysis; Rules and regulations of food analysis	1
Unit 2	Principles and methodology involved in analysis of foods: Rheological analysis, textural profile analysis of foods	2
Unit 3	Methods of analysis: Proximate constituents: Total fat, crude fiber, protein, moisture, minerals analysis; adulterations	1
Unit 4	Principles and methodology involved in analytical techniques: spectroscopy, ultraviolet visible, infrared spectroscopy atomic absorption and emission, florescence mass spectroscopy Food compositional analysis and applications in the food industry	1 1 1 1
Unit 5	Chromatography: Principle of chromatography, classifications, (Adsorption, column, partition, gel-filtration, affinity, ion-exchange, size-exclusion method) gas-liquid, high performance liquid chromatography; Ion chromatography and others	1 1 1
Unit 6	Separation techniques: Dialysis, electrophoresis, sedimentation, ultra-filtration, ultracentrifugation, iso-electric focusing,	2
Unit 7	Chemically sensitive semiconductor devices: Solid-state sensors for pH, acidity, amperometric, potentiometric and; Acoustic sensors,	2
Unit 8	Rapid microbiological methods: Overview, Conductance/impedance techniques for microbial assay; chemosensors, biosensors, immunosensors	2

List of Practicals

S. No.	Title of Experiment
1	Sampling plan; Sample collection and preparation for analysis
2	Quality evaluation of raw materials: meat products
3	Quality evaluation of raw materials: Fruits products
4	Quality evaluation of raw materials: vegetables products
5	Quality evaluation of raw materials: cereals products
6	Quality evaluation of raw materials: dairy products
7	Quality evaluation of raw materials: poultry products
8	Analysis of wheat flour
9	Quality evaluation of food products for color and taste of marketed products (sweet)
10	Quality evaluation of food products for color and taste of marketed products (carbonated drinks)
11	Quality evaluation of food products for color and taste of marketed products (Processed food)
12	Quality evaluation of food products for color and taste of marketed products (Chili powder)
13	Estimation of phytic acid using spectrophotometer
14	Separation of amino acids by two-dimensional paper chromatography
15	Analysis of heavy metals using atomic absorption spectrophotometer (marcury)
16	Analysis of heavy metals using atomic absorption spectrophotometer (lead)
17	Analysis of heavy metals using atomic absorption spectrophotometer (arsenic)
18	Analysis of heavy metals using atomic absorption spectrophotometer (tin)
19	Identification of organic acids by paper electrophoresis
20	Identification of organic acids by paper electrophoresis
21	Identification of organic acids by paper electrophoresis
22	Estimation of vitamins (A) using HPLC
23	Estimation of vitamins (thiamine) using HPLC
24	Estimation of vitamins (riboflavin) using HPLC
25	Estimation of vitamins (nicotinamide) using HPLC
26	Estimation of lycopene using HPLC
27	Estimation of betacarotein using HPLC
28	Estimation of vitamins A using HPLC
29	Analysis of foods for drug residues in milk

30	Analysis of foods for drug residues in milk product
31	Analysis of foods for pesticide residues in fruit
32	Analysis of foods for pesticide residues in vegetable
33	Analysis of foods for pesticide residues in spices
34	Spectrophotometric method of total chlorophyll (A & B)
35	Gel-electrophoresis for analytic techniques; Quantitative determination of sugars and fatty acid profile by GLE
36	Fatty acid profiling using gas chromatograph

Suggested Reading

S. Suzanne Nieisen. 2010. Food Analysis Laboratory Manual, 2nd Ed. Springer, NY, USA.

Semih Ötles. 2009. Handbook of Food Analysis Instruments. CRC Press, Boca Raton, FL, USA.

Da-Wen Sun. 2008. Modern Techniques for Food Authentication. Elsevier Inc., Burlington, MA, USA.

S. Suzanne Nieisen. 2003. Food Analysis, 3rd Ed. Kluwer Academic, New York, USA.

2. Food Storage Engineering (FPE 351) 3 (2+1)

(32 Lectures + 16 Practical)

Units	Topics	Lecture
Units 1	**Introduction** Importance of scientific storage systems, post-harvest physiology of semi-perishables and perishables, climacteric and non-climacteric fruits, respiration, ripening, changes during ripening, ethylene bio-synthesis	4
Units 2	**Damages** Direct damages, indirect damages, causes of spoilage in storage (moisture, temperature, humidity, respiration loss, heat of respiration, sprouting), destructive agents (rodents, birds, insects, etc.), sources of infestation and control	4
Units 3	**Storage structures** Traditional storage structures, improved storage structures, modern storage structures, godown layout, staking pattern and rodent proof godown design; Farm silos: Horizontal silos, tower silos, pit silos, trench silos, size and capacity of silos	3
Units 4	**Storage of grains** Respiration of grains, moisture and temperature changes in stored grains; conditioning of environment inside storage through ventilation	3
Units 5	**Aeration and stored grain management** Purposes of aeration, aeration theory, aeration system design, aeration system operation	3
Units 6	**Storage pests and control** Damage due to storage insects and pests, its control, seed coating, fumigations, etc.; Damage caused by rodents and its control	3
Units 7	**Storage of perishables** Cold storage, controlled and modified atmospheric storage, hypobaric storage, evaporative cooling storage, conditions for storage of perishable products, control of temperature and relative humidity inside storage	6
Units 8	**Design of storage structures** Functional and structural design of grain storage structures, pressure theories, pressure distribution in the bin, grain storage loads, pressure and capacities, warehouse and silos, BIS specifications, functional, structural and thermal design of cold stores.	6

List of Practicals

S. No.	Title of Experiment
1	Visits to traditional storage structures
2	Layout design, sizing, capacity and drawing of traditional storage structures

3	Measurement of respiration of fruits/grains in the laboratory
4	Study on fumigation
5	Visits to FCI godowns
6	Design of grain godowns for particular capacity and commodity
7	Drawing and layout of grain godown for particular commodity and capacity
8	Visits to cold storage
9	Design of cold storage for particular capacity and commodity
10	Drawing and layout of cold storage for particular commodity and capacity
11	Visits to CA storage
12	Design of CA storage for particular capacity and commodity
13	Drawing and layout of CA storage for particular commodity and capacity
14	Visits to evaporative cooling system for storage
15	Storage study in the MAP

Suggested Reading

P.H. Pandey. 2014. Principles and Practices of Agricultural Structures and Environmental Control. Kalyani Publishers, Ludhiana.

Myer Kutz. 2007. Handbook of Farm, Dairy, and Food Machinery. William Andrew, Inc., Norwich, NY, USA.

A.M. Michael and T.P. Ojha. 2004. Principal of Agricultural Engineering, Vol. I. Jain Brothers, New Delhi.

L.W. Newbaver and H.B. Walker. 2003. Farm Buildings Design. Prentice-Hall Inc., New Jersey, USA.

Jayas D.S., White N.D.G., Muir, W.E. 1994. Stored Grain Ecosystems. Marcel Dekker, New York.

J. Whitaker. 2002. Agricultural Buildings and Structures. Reston Publishing Home, Reston, Virgenia, USA.

G. Boumans. 1985. Grain Handling and Storage. Elsevier Science Publishers, Amsterdam, The Netherlands.

C.W. Hall. 1980. Drying and Storage of Agricultural Crops. The AVI Publishing Company, Inc., Westport, Connecticut, USA.

Donald B. Brooker, F.W. Bakker-Arkema, Carl W. Hall. 1974. Drying and Storage of Grains and Oilseeds. The AVI Publishing Company, Inc., Westport, Connecticut, USA.

3. Food Process Equipment Design (FPE 352) 3 (2+1)

(32 Lectures + 16 Practical)

Units	Topics	Lecture
Units 1	Materials and properties: Materials for fabrication, mechanical properties, ductility, hardness, corrosion, protective coatings, corrosion prevention linings equipment, choice of materials, material codes	3
Units 2	Design considerations: Stresses created due to static and dynamic loads, combined stresses, design stresses and theories of failure, safety factor, temperature effects, radiation effects, effects of fabrication method, economic considerations	3
Units 3	Design of pressure and storage vessels: Operating conditions, design conditions and stress; Design of shell and its component, stresses from local load and thermal gradient, mountings and accessories	2
Units 4	Design of heat exchangers: Design of shell and tube heat exchanger, plate heat exchanger, scraped surface heat exchanger, sterilizer and retort	2
Units 5	Design of evaporators and crystallizers: Design of single effect and multiple effect evaporators and its components; Design of rising film and falling film evaporators and feeding arrangements for evaporators; Design of crystalliser and entrainment separator	3
Units 6	Design of agitators and separators: Design of agitators and baffles; Design of agitation system components and drive for agitation	3
Units 7	Design of centrifuge separator; Design of equipment components, design of shafts, pulleys, bearings, belts, springs, drives, speed reduction systems	3

Units 8	Design of freezing equipment: Design of ice-ream freezers and refrigerated display system	3
Units 9	Design of dryers: Design of tray dryer, tunnel dryer, fluidized dryer, spray dryer, vacuum dryer, freeze dryer and microwave dryer	3
Units 10	Design of extruders: Cold and hot extruder design, design of screw and barrel, design of twin screw extruder	3
Units 11	Design of fermenters: Design of fermenter vessel, design problems	2
Units 12	Hazards and safety considerations: Hazards in process industries, analysis of hazards, safety measures, safety measures in equipment design, pressure relief devices.	2

List of Practicals

S. No.	Title of Experiment
1	To perform the tension test on metal specimen (M.S., C.I.)
2	To observe the behavior of materials under load
3	To calculate the value of E, ultimate stress, permissible stress, percentage elongation etc and fracture points of
4	Design problems on applications of work and energy
5	Design problems on applications of linear and angular momentum
6	Study on shear force and bending moment diagrams and its applications
7	Design of pressure vessel
8	Design of shell and tube heat exchangers and plate heat exchanger
9	Design of sterilizers and retort
10	Design of single and multiple effect evaporators
11	Design of rising film and falling film evaporator
12	Design of crystallizer
13	Design of dryers
14	Design of extruders
15	Design of fermenters
16	Design of drive systems
17	Determination/assessment of fabrication cost of processing equipment

Suggested Reading

R. Paul Singh and Dennis R. Heldman. 2014. Introduction to Food Engineering, 5th Ed. Elsevier, Amsterdam, The Netherlands.

Albert Ibarz and Gustavo V. Barbosa-Cánovas. 2003. Unit Operations in Food Engineering. CRC Press, Boca Raton, FL, USA.

George D. Saravacos and Athanasios E. Kostaropoulos. 2002. Handbook of Food Processing Equipment. Springer Science+Business Media, New York, USA.

R. K. Sinnott. 1999. Chemical Engineering, Vol. 6, Chemical Engineering Design, 3rd Ed. Butterworth-Heinemann, Oxford, UK.

Kenneth J. Valentas, Enrique Rotstein and R. Paul Singh. 1997. Handbook of Food Engineering Practice. CRC Press, Boca Raton, FL, USA.

Peter F. Stanbury, Allan Whitakar and Stephen J. Hall. 1995. Principles of Fermentation Technology, 2nd Ed. Elsevier Science Ltd., Burlington, MA, USA.

J.F. Richarson and D.G. Peacock. 1994. Coulson & Richardsons's Chemical Engineering, Vol. 3, Chemical &Biochemical Reactors & Process Control, 3rd Ed. Elsevier Butterworth-Heinemann, Amsterdam, The Netherlands.

James R. Couper, W. Roy Penney, James R. Fair and Stanley M. Walas 2012 Chemical Process Equipment: Selection and Design. Elsevier Inc

Mahajani, V. V. and Umarji, S. B., Process equipment design, Macmillan.

Bhattacharyya, B. C., Introduction to Chemical Equipment design, CBS Publishers and Distributors.

Geankoplis C. J. Transport processes and unit operations, Prentice-Hall

4. Deign and formulation of foods (FPT 351) 3 (2+1)

(32 Lectures + 16 Practicals)

Units	Topics	Lectures
Unit 1	Nutrients and their function, food classification and their nutritive value, anti-nutritional factors present in food	**04**
Unit 2	Concept of different food groups, recommended dietary allowances (RDA) for Indians	**03**
Unit 3	nutrition for infant, pre-school & school children, adult, pregnant and lactating women, old age people	**05**
Unit 4	Production and formulation of Indian traditional sweet and snack food products, steps for quality improvement and value addition	**05**
Unit 5	Therapeutic diets – Principles & objectives of diet therapy, diet for patient suffering from Diabetes mellitus, osteoporosis, cardiac problem, gastrointestinal disorder, Diet planning and use of exchange list in nutrient calculation	**06**
Unit 6	Functional foods - definition and concepts; design of functional foods; Nutraceuticals food - definition and concepts, design of nutraceutical foods	**04**
Unit 7	Recent trends in food formulation; antioxidant rich food products; concepts for formulation of foods for drought and disaster afflicted; defence services, sportsmen, space food	**05**

List of Practicals

S. No.	Title of Experiment
1	To study the principles and planning menu
2	Value added product from Aonla
3	Quality analysis and cost evaluation of processed product from Aonla
4	Process development of nutria-rich food for pregnant and lactating women
5	Preparation of soya milk and drying of its by product (Okara)
6	Preparation of fermented milk product blended with soya milk
7	Preparation of ready to serve (RTS) instant soup mix using soya products (okara powder)
8	Preparation of sugar free Indian Traditional Sweet (kajukatli)
9	Preparation of functional food (cookies) using chiaseeds
10	Preparation of whey beverage
11	Preparation Indian Traditional Snack (*khakhra*) fortified with flax seed and green leafy vegetables
12	Production of unripe mango beverage
13	Formulation and preparation of Probiotic/ synbiotic fermented dairy products
14	Preparation of ready-to-serve (RTS) instant halwa powder from unmarketable potatoes powder
15	Qualitative analysis of given oil sample (Oxidative Rancidity)
16	Visit to Food Processing Industries/ Khadhya Khurak – Food Processing Expo

Suggested Reading

C Gopalan, BV Ramshastri, S C Balasubramaniam, 1989, Nutritive Value of Indian Foods National Institute of Nutrition, Hyderabad

M Swaminathan, 1974, Essentials of Nutrition, Ganesh Co.

K.H. Steinkrauss, 1995, Handbook of Indigenous Fermented Foods, Marcel Dekker.

J Pokorny, N Yanishlieva, and M Gordon, 2001, Antioxidants in Food, Published by Woodhead Publishing Limited, Abington Hall, Abington

N N Potter, and J H Hotchkiss, 1995, Food Science, (5th Edition), Aspen Publishers, Inc., Gaithersburg, Maryland.

Food and Nutrition Bulletin, Vol. 23, 24, 25 and 26. The United Nations University, Press.

G Mazza, 1998, Functional Foods. Biochemical and Processing Aspects, Technomic Publ. Co.

Corrine Robinson, 1975, **Basic Nutrition and Diet Therapy,** Macmillan.

F.P. Antia, 1974, Clinical Dietetics and Nutrition, **Oxford Medicine Publications**

Davidson and Passmore, 1986, Human Nutrition and Dietetics, Churchill Livingstone

5. Processing Technology of Fruits and Vegetables (FPT 352) 3 (2+1)

(32 Lectures + 16 Practicals)

Units	Topics	Lectures
Unit 1	Production and processing scenario of fruits and vegetables in India and world; Scope of fruit and vegetable processing industry in India	**02**
Unit 2	Overview of principles and preservation methods of fruits and vegetables; Supply chain of fresh fruits and vegetables Primary processing and pack house handling of fruits and vegetables; Peeling, slicing, cubing, cutting and other size reduction operations for fruits and vegetables	**02** **03**
Unit 3	Minimal processing of fruits and vegetables; Blanching- operations and equipment	**02**
Unit 4	Canning:- Definition, processing steps, and equipment; Cans and containers, quality assurance and defects in canned products;	**03** **02**
Unit 5	FSSAI specifications and preparation and preservation of juices, squashes, syrups, sherbets, nectars, cordials, etc.; Processing and equipment for above products;	**02** **03**
Unit 6	FSSAI specifications of crystallized fruits and preserves, jam, jelly and marmalades, candies Preparation, preservation and machines for manufacture of above products	**01** **03**
Unit 7	Preparation, preservation and machines for manufacture of chutney, pickles, sauce, puree, paste, ketchup; toffee, cheese, leather, dehydrated, wafers and papads, soup powders;	**02**
Unit 8	Production of pectin and vinegar Commercial processing technology of selected fruits and vegetables for production of various value added processed products	**01** **02**
Unit 9	By-products of fruit and vegetable processing industry.	**02**

List of Practicals

S. No.	Title of Experiment
1	Primary processing of selected fruits and vegetables
2.	Canning of Mango/Guava/ Papaya
2	Qualitative analysis of pectin
3	Determination of salt concentration in processed/ preserved product
4	Determination of sulphurdioxide content in processed/preserved product
5	Preparation of jam from selected fruits
6	Preparation of jelly from selected fruits
7	Preparation of fruit marmalade
8	Preparation of RTS/ nectar
9	Preparation of squash/ crush
10	Preparation of cordial
11	Preparation of anardana
12	Preparation of pickles
13	Dehydration of ginger, onion and garlic
14	Preparation of banana and potato wafers;
15	Preparation of vegetable sauces
16	Preparation of preserves
17	Preparation of banana and potato wafers
18	Preparation of candied fruit and glaced fruit
19	Visit to fruits and vegetables pack house/ canning plant/ vegetable dehydration plant.

Suggested Reading

U.D. Chavan and J.V. Patil. 2013. Industrial Processing of Fruits and Vegetables. Astral International Pvt. Ltd., New Delhi.

S. Rajarathnam and R.S. Ramteke. 2011. Advances in Preservation and Processing Technologies of Fruits and Vegetables. New India Publishing Agency, New Delhi.

Y.H. Hui. 2006. Handbook of Fruits and Fruit Processing. Blackwell Publishing Ltd., Oxford, UK.

W.V. Cruess. 2004. Commercial Fruit and Vegetable Products. Agrobios India, Jodhpur.

Y. H. Hui, Sue Chazala, Dee M. Graham, K.D. Murrell and Wai-Kit Nip. 2004. Handbook of Vegetable Preservation and Processing. Marcel Dekker, Inc., NY, USA.

A.K. Thompson. 2003. Fruit and Vegetables: Harvest, Handling and Storage, 2nd Ed. Blackwell Publishing Ltd., Oxford, UK.

Amalendu Chakraverty, Arun S. Mujumdar, G.S. Vijaya Raghavan and Hosahalli S. Ramaswamy. 2003. Handbook of Post Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA.

R.P. Srivastava and Sanjeev Kumar. 2002. Fruit & Vegetable Preservation: Principles and Practices, 3rd Ed. International Book Distribution Co., Delhi.

P.H. Pandey. 1997. Post Harvest Technology of Fruits and Vegetables. Saroj Prakashan, Allahabad.

Mircea Enachescu Dauthy. 1995. Fruit and Vegetable Processing. FAO Agricultural Services Bulletin No.119. FAO of UN, Rome.

Girdhari Lal, G.S. Siddappa and G.L. Tandon. 1959. Preservation of Fruits and Vegetables. ICAR, New Delhi.

EIRI Board of Consultants and Engineers. Manufacture of Snacks, Namkeen, Papads and Potato Products. EIRI, New Delhi.

6. Bakery, Confectionery and Snack Products (FPT 353) 3 (2+1)

(32 Lectures + 16 Practicals)

Units	Topics	Lectures
Unit 1	Bakery products- Types (bread, biscuit cake), specifications, compositions and ingredients (flour, sugar, fat, shortening, leavening agent etc.)	**03**
	Formulations, processing (mixing, fermentation, rounding, proofing, sheeting, moulding, baking, depanning etc.), equipment, packaging, storage and quality testing of bakery products	**03**
Unit 2	Confectionery and chocolate products: Types, specifications, compositions, ingredients, formulations	**02**
	Processing, equipment, packaging, storage and quality testing of confectionery and chocolate products	**02**
Unit 3	Product quality characteristics	**02**
	Defects, causes and corrective measures	**02**
Unit 4	Extrusion technology and applications in food processing;	**02**
	Snack foods: Types, specifications, compositions, ingredients, Formulations, processing, equipment, packaging, storage and quality testing	**02**
	Snack food seasonings	**02**
		01
Unit 5	Breakfast cereals, macaroni products and malts: Specifications, compositions, ingredients	**03**
	Formulations, processing, equipment for breakfast cereals, macaroni and malts	**03**
	Packaging, storage and quality testing for breakfast cereals, macaroni and malts.	**03**

List of Practicals

S. No.	Title of Experiment
1	Identifications and composition of various ingredients for snacks, bakery and confectionery products
2	Flours, their classifications and characterization
3	Determination of flour gluten
4	Determination of water absorption characteristics and dough development time
5	Determination of dough rising capacity
6	Determination of calcium carbonate in fortified atta
7	Preparation of selected snack items
8	Quality evaluation of selected snack items
9	Preparation of selected bakery items
10	Sensory and textural quality evaluation of selected bakery items
11	Preparation of selected confectionery items
12	Sensory and textural quality evaluation of selected confectionery items
13	Preparation of selected chocolates

14	Packaging and quality evaluation of selected chocolates
15	Preparation of selected extruded products
16	Packaging and quality evaluation of extruded products
17	Preparation of traditional Indian confection
18	Visit to bakery, confectionary and snack units (industry)

Suggested Reading

NIIR Board of Consultants & Engineers. 2014. The Complete Technology Book on Bakery Products (Baking Science with Formulation & Production), 3rd Ed. NIIR, New Delhi.

Peter P. Grewling. 2013. Chocolates & Confections, 2nd Ed. John Wiley & Sons, Inc., Hoboken, New Jersey, USA.

E.J. Pyler and L.A. Gorton. 2009. Baking Science & Technology, Vol. II: Formulation & Production, 4th Ed. Sosland Publishing Company, Kansas City, MO, USA.

E.J. Pyler and L.A. Gorton. 2008. Baking Science & Technology, Vol. I: Fundamentals & Ingredients, 4th Ed. Sosland Publishing Company, Kansas City, MO, USA.

Y.H. Hui. 2007. Handbook of Food Products Manufacturing: Principles, Bakery, Beverages, Cereals, Cheese, Confectionary, Fats, Fruits, and Functional Foods. John Wiley & Sons, Inc., Hoboken, New Jersey, USA.

John J. Kingslee. 2006. A Professional Text to Bakery and Confectionery. New Age International, New Delhi.

Harold Corke, Ingrid De Leyn, Nanna A. Cross, Wai-Kit Nip, Y.H. Hui. 2006. Bakery Products: Science and Technology. Blackwell Publishing Ltd., Oxford, UK.

Joseph Amendola and Nicole Rees. 2003. Understanding Baking: The Art and Science of Baking, 3rd Ed. John Wiley & Sons, Inc., Hoboken, New Jersey, USA.

Duncan Manley. 2000. Technology of Biscuits, Crackers and Cookies, 3rd Ed. Woodhead Publishing Limited, Cambridge, England.

N.L. Kent and A.D. Evers. 1994. Kent's Technology of Cereals: An Introduction for Students of Food Science and Agriculture, 4th Ed. Elsevier Science Ltd., Oxford, UK.

E.B. Jackson. 1995. Sugar Confectionery Manufacture, 2nd Ed. Springer-Verlag, US.

B.W. Minife. 1989. Chocolate, Cocoa, and Confectinery – Science and Technology, 3rd Ed. Chapman and Hall, Inc., New York, USA.

Samuel A. Matz. 1976. Snack Food Technology, 2nd Ed. AVI Publishing Co., Inc., Westport, Connecticut, USA.

US Wheat Associates. Baker's Handbook on Practical Baking.

7. ICT Applications in Food Industry (FBM 351) 3 (1+2)

(16 Lectures + 32 Practical)

Units	Topics	Lectures
Unit 1	Importance of computerization in food industry, operating environments and information systems for various types of food industries	1
Unit 2	Introduction to Supervisory control and data acquisition (SCADA)	1
	SCADA systems hardware, firmware, software and protocols, landlines, local area network systems, modems.	1
Unit 3	Spreadsheet applications: Data interpretation and solving problems, preparation of charts, use of macros to solve engineering problems.	1
	Use of add-ins, use of solver	1
Unit 4	Web hosting and webpage design; file transfer protocol (FTP),	1
	Online food process control from centralized server system in processing plant	1
Unit 5	Use of MATLAB in food industry; computing with MATLAB, script files and editor/debugger, MATLAB help system.Problem solving methodologies, numeric, cell, arrays, matrix operations	1
	User defined functions, programming using MATLAB; debugging MATLAB programs,	1

	Applications to simulations; Plotting and model building in MATLAB, X-Y plotting functions, subplots and overlay plots, special plot types, interactive plotting in MATLAB	1
	Function discovery, regression, the basic fitting interface, three dimensional plots	1
	Introduction to Toolboxes useful to Food Industry Curve fitting toolbox, Fuzzy logic toolbox, Neural Network toolbox, Image processing toolbox, statistical toolbox	1
Unit 6	Introduction to computational fluid dynamics (CFD), governing equations of fluid dynamics; Models of flow, substantial derivative, divergence of velocity, continuity, momentum and energy equations; Physical boundary conditions, discretization; Applications of CFD in food and beverage industry;	1
	Introduction to CFD softwares, GAMBIT and Fluent softwares	1
	LabVIEW – LabVIEW environment: Getting data into computer, data acquisition devices, NI-DAQ, simulated data acquisition, sound card, front panel/block diagram, toolbar/tools palette; Components of a LabVIEW application: Creating a VI, data Flow execution, debugging techniques, additional help, context help, tips for working in LabVIEW;	1
	LabVIEW typical programs: Loops, while loop, for loop, functions and sub Vis, types of functions, searching the functions palette, creating custom sub Vis, decision making and file I/O, case structure, select (if statement), file I/O; LabVIEW results: Displaying data on front panel, controls and indicators, graphs and charts, arrays, loop timing, signal processing, textual math, math script.	1

List of Practicals

S. No.	Title of Experiment
1	Introduction to various features in spreadsheet
2	Solving problems using functions in spreadsheets
3	To use Add-Ins in spread sheet
4	statistical data analysis using Analysis Tool pack
5	To solve problems on regression analysis using Analysis Tool pack in spreadsheet
6	To solve problems on optimization using solver package in spreadsheet
7	Introduction to MATLAB
8	Writing code using MATLAB programming, Variables and Array
9	Using Two dimensional Plots and subplots
10	Using Three dimensional Plots and surface functions
11	Writing scripts file Using MATLAB
12	Creating User defined functions in MATLAB
13	Use of Relational and Logical Operators with decision statements
14	For loop and While loops in MATLAB
15	To solve problems using Curve fitting toolbox in MATLAB
16	To solve problems using Curve fitting toolbox in MATLAB
17	To solve problems using Fuzzy logic toolbox in MATLAB
18	To solve problems using Fuzzy logic toolbox in MATLAB
19	To solve problems using Neural Network toolbox in MATLAB
20	To solve problems using Neural Network toolbox in MATLAB
21	To solve problems using Image processing toolbox in MATLAB
22	To solve problems using Image processing toolbox in MATLAB
23	Introduction to GAMBIT software
24	Creation of Geometry for laminar flow through pipe using GAMBIT

25	Introduction to FLUENT software,Import of geometry and application of boundary conditions
26	Solution of problems on laminar flow using FLUENT
27	Introduction to LabVIEW, LabVIEW typical programs
28	LabVIEW: while loop, for loop, functions and sub Vis, types of functions, searching the functions palette, creating custom sub Vis, decision making and file I/O, case structure, select (if statement), file I/O;
29	LabVIEW results: Displaying data on front panel, controls and indicators.
30	LabVIEW results:graphs and charts, arrays, loop timing
31	LabVIEW: signal processing, textual math, math script.
32	Introduction to NI-DAQ.

Suggested Reading

R. Paul Singh. 2014. Computer Applications in Food Technology: Use of Spreadsheets in Graphical, Statistical and Process Analysis. Academic Press, London.

William J. Palm III. 2011. Introduction to MATLAB for Engineers, 3rd Ed. McGraw-Hill Companies, Inc., NY, USA.

Da-Wen Sun. 2007. Computational Fluid Dynamics in Food Processing. CRC Press, Boca Raton, FL, USA.

Nigel Chapman and Jenny Chapman. 2006. Web Design: A Complete Introduction. John Wiley & Sons, USA.

National Instruments Corporation. 2005. Introduction to LabVIEW: 3-Hour Hands-On. NI, Austin, Texas.

David Bailey and Edwin Wright. 2003. Practical SCADA for Industry. Elsevier, Burlington, MA

8. Marketing Management & International Trade (FBM 352) 2 (2+0)

(16 Lectures)

Units	Topics	Lectures
Unit 1	Concept of marketing, functions of marketing	1
	Concepts of marketing management, scope of marketing management	1
	Marketing management process	1
	Concepts of marketing- mix, elements of marketing- mix.	1
Unit 2	Concept of market structure	1
	Marketing environment -Micro and macro environments	1
Unit 3	Consumers buying behaviour, consumerism	1
	Marketing opportunities analysis: marketing research and marketing information systems.	2
Unit 4	Market measurement- present and future demand, market forecasting	1
	Market segmentation, targeting and positioning	1
	Allocation and marketing resources	1
Unit 5	Marketing planning process	1
	Product policy and planning : product-mix, product line, product life cycle	2
	New product development process	1
	Product brand, packaging, services decisions	1
	Marketing channel decisions. Retailing, wholesaling and distribution.	1
Unit 6	Pricing decisions	1
	Price determination and pricing policy of milk products in organized and unorganized sectors of dairy industry.	1
	Promotion-mix decisions.	1
Unit 7	Advertising, how advertising works, deciding advertising objectives	1
	Advertising budget	1
	Advertising message, media planning, personal selling, publicity, sales promotion	1

	World consumption of food: Patterns and types of food consumption across the globe	1
Unit 8	International marketing and international trade, salient features of international marketing	1
	Composition & direction of Indian exports, international marketing environment	1
	Deciding which & how to enter international market	1
Unit 9	Exports- direct exports, indirect exports,Licensing,Joint ventures,Direct investment	1
	Export trends and prospects of food products in India	1
	Government institutions related to international food trade:APEDA, Tea Board, Spice Board, MOFPI, etc.	1
	WTO and world trade agreements related to food business	1

Suggested Reading

Philip Kotler, Kevin Lane Keller, Abraham Koshy, Mithileshwar Jha. 2013. Marketing Management: A South Asian Perspective, 14th Ed. Pearson Education.

Willium J. Stanton. 1984. Fundamentals of Marketing. Tata McGraw-Hill Publication, New Delhi.

C.N. Sontakki. Marketing Management. Kalyani Publishers, New Delhi.

John Daniels, Lee Radebaugh, Brigham, Daniel Sullivan. International Business, 15th Ed., Pearson Education.

Aswathappa. International Business. Tata McGraw-Hill Education, New Delhi.

Fransis Cherunilam. International Business: Text and Cases, 5th Ed. PHI Learning, New Delhi.

SEMESTER VI

1. Food Additives and Preservatives (FQA 361) 2(1+1)

(32 Lectures + + 16 Practicals)

Unit	Topics	Lecture
Unit 1	Intentional and unintentional food additives, their toxicology and safety evaluation;	2
Unit 2	Naturally occurring food additives; Food colors and dyes: Regulatory aspects of dyes, food color (natural and artificial), pigments and their importance and utilization as food color; Processing of natural and artificial food colorants;	1 1 1 1 1
Unit 3	Food preservatives and their chemical action. Role and mode of action of salts, chelating agents, stabilizers and thickeners; Humectants/polyhydric alcohol, anti-caking agent, firming agent, flour bleaching and maturing agents, antioxidants, nutritional and non-nutritional sweeteners;	1 1 1 1 1
Unit 4	Production of enzymes, leavening agents, fat substitutes, flavor and taste enhancers in food processing; Acidity regulators; Emulsifiers.	1 1 1 1

List of Practicals

S. No.	Title of Experiment
1	Evaluation of GRAS aspect of food additives;
2	Estimation of chemical preservatives by TLC (organic and inorganic);
3	Estimation of chemical preservatives by TLC (organic and inorganic);
4	Estimation of chemical preservatives by TLC (organic and inorganic);
5	Identification of food colour by TLC (organic and inorganic);
6	Identification of food colour by TLC (organic and inorganic);
7	Quantitative estimation of added dyes;

8	Quantitative estimation of added dyes;
9	Isolation and identification of naturally occurring food pigments by paper and TLC;
10	Role and mode of action of chelating agent in fruit juice;
11	Role and mode of action of stabilizer and thickener in frozen dairy products (ice-cream);
12	Role and mode of clarifying agent in fruit juices;
13	Role and mode of antioxidant in foods;
14	Role and mode of antioxidant in foods;
15	Role of leaving agent in baked food product;
16	Preservation of food samples using humectants.

Suggested Reading

H.-D. Belitz, W. Grosch and P. Schieberle. 2009. Food Chemistry. 4th Edition. Springer-Verlag, Berlin,Heidelberg.

S.N. Mahindru. 2008. Food Additives: Characteristics, Detection and Estimation. Aph Publishing Corporation, New Delhi.

S.S. Deshpande. 2002. Handbook of Food Toxicology. Marcel and Dekker AG, Basel, Switzerland.

2. Food Quality, Safety Standards and Certification (FQA 362) 2 (2+0)

(32 Lectures + + 16 Practicals)

Unit	Topics	Lecture
Unit-1	**Introduction** :Definition, its role in food industry , Quality attributes **Physical properties: Color, visocisity, size and shape:** Definition, color measurement techniques by spectrophotometer, Muncell color system and Lovibond tintometer; Role of viscosity and consistency in food quality :Size and Shape :Size and shape, weight, volume, weight volume ratio, length, width, diameter, symmetry, curvature, area;	1 2 2
Unit-2	**Quality Defects** : Classification, Genetic-physiological defects: Structural, off color, character; Entomological defects: Holes, scars, lesions, off coloring, curled aves, pathological defects; Mechanical defects, extraneous or foreign material defects. Measurement of defects by different techniques	3
Unit -3	**Quality Assessment:** Quality assessment of food materials on the basis of sensory evaluation, Physical, chemical microbiological methods ; Quality of products during processing and after processing: Factors influencing the food qualities: Soil, field practices, harvesting practices, procedures, packaging, transportation, storage, conditions, processing conditions, packaging and storage conditions of finished products.	2 1 2
Unit-4	**Role of QC and QA Quality**: Quality Control, Quality Assurance, Concepts of quality control and quality assurance functions in food industries. **Quality Improvement** Total Quality management : Quality evolution, quality gurus, defining TQM, principals of TQM, stages in implementation, TQM road map. Quality improvement tools, customer focus, cost of quality	2 3
Unit -5	**Food Laws** Food Laws and Standards: National and International food laws Mandatory and voluntary food laws. **FSSAI** Indian Food Regulations and Certifications: Food Safety and Standards Act FSSAI Rules, food adulteration, misbranding, common adulterants in foods, Duties and responsibilities of Food Safety Authorities	2 2 2
Unit -6	**AGMARK, BIS, FPO, Weights and Measures Act ,CODEX** : Agricultural Marketing and Grading Standards (AGMARK), Bureau of Indian Standards(BIS) and their certification, FPO –standards and certification process Weights and Measures Act and Packaged commodity rules Role of CODEX in food safety and standards ,Food safety issues and risk analysis	2 2 2
Unit-7	**FSMS 22000**	3

	Food Safety Management Systems ,ISO 22000 – 2005 and other Global Food safety management systems. Principles, implementation; documentation, types of records; Auditing, certification procedures, certifying bodies, accrediting bodies	

Suggested Reading

Inteaz Alli. 2004. Food Quality Assurance: Principles and Practices. CRC Press, Boca Raton, FL, USA.

Ronald H. Schmidt and Gary E. Rodrick. 2003. Food Safety Handbook. John Wiley & Sons, Inc., Hoboken. New Jersey, USA.

R.E. Hester and R.M. Harrison. 2001. Food Safety and Food Quality. Royal Society of Chemistry, Cambridge, UK

3. Instrumentation and Process Control in Food Industry (FPE 361) 3 (2+1)
(32 Lectures + 16 Practical)

Units	Topics	Lecture
Units 1	Introduction, definitions, characteristics of instruments, static and dynamic characteristics	2
Units 2	Temperature and temperature scales; Various types of thermometers; thermocouples, resistance thermometers and pyrometers	3
Units 3	Pressure and pressure scales, manometers, pressure elements differential pressure	3
Units 4	Liquid level measurement, different methods of liquid level measurement, flow measurement, differential pressure meters, variable area meters	3
Units 5	Weight measurement: Mechanical scale, electronic tank scale, conveyor scale	3
Units 6	Transmission: Pneumatic and electrical, Control elements: control actions, pneumatic and electrical control systems	3
Units 7	Process control: Definition, simple system analysis, dynamic behavior of simple process, Laplace transform, process control hardware	3
Units 8	Frequency response analysis, characteristics, Bode diagram and Nyquist plots and stability analysis	3
Units 9	Controllers and indicators: Temperature control, electronic controllers, timers and indicators, discrete controllers, adaptive and intelligent controllers	3
Units 10	Computer-based monitoring and control: Importance, hardware features of data acquisition and control computer, signal interfacing, examples in food processing	3
Units 11	Introduction of 8051/8085 based system and applications in processing	3
		32

List of Practicals

S.No.	Title of Experiment
1	Study on instrumentation symbols;
2	Study of P&I diagram and flow sheet diagrams in instrumentation.
3	Study of characteristics of Pressure transducers
4	Real-time study of Pressure transducers characteristics with PC
5	Study of Pressure Control by s On/Off Controller
6	Study of characteristics of IC temperature sensor
7	Study of characteristics of Thermocouple.
8	Study of characteristics of Platinum RTD
9	Study of Temperature controlled alarm system
10	Study of Data logger
11	Study of 8051 based programming examples.
12	Study of Programmable Logic Controllers (PLC) Hardware
13	Study of Programmable Logic Controllers (PLC) Ladder programming,
14	To study PLC based control of Multiprocess system

15	Study of various transducers for measurement of pressure ,temperature, flow, combinely
16	Visit to food processing plant and dairy industry.

Suggested Reading

Don W. Green and Robert H. Perry. 2008. Perry's Chemical Engineers' Handbook. McGraw-Hill Co., Inc., NY, USA.

Bela G. Liptak. 2003. Instrument Engineer's Handbook, Vol. I and II, 4th Ed. CRC Press, Boca Raton, FL, USA.

Curtis D. Johnson. 2003. Process Control Instrumentation Technology, 7th Ed. Prentice Hall of India Pvt. Ltd., New Delhi.

D.V.S. Murty. 2004. Transducers and Instrumentation. Prentice Hall of India Pvt. Ltd. New Delhi.

4. Applications of Renewable Energy in Food Processing (FPE 362) 2 (1+1)

(32 Lectures + + 16 Practical)

Units	Topics	Lectures
Units 1	Introduction to energy sources; classification of renewable energy sources, utilization of these sources in food processing sector.	2
Units 2	Solar radiation, measurement of solar radiation, types of solar collectors and their uses; familiarization with solar energy gadgets: solar cooker, solar concentrator, solar dryer, solar steam generator; utilization of solar thermal energy in food processing.	4
Units 3	Solar photovoltaic cells, modules, arrays, conversion process of solar energy into electricity, applications in food industry.	2
Units 4	Biomass and its characterization; briquetting of biomass. Biomass combustion, pyrolysis, gasification and uses of gasifiers in food industry and biodiesel preparation.	3
Units 5	Importance of biogas technology, production mechanism, types of biogas plants, uses of biogas, handling & utilization of digested slurry. Use of food waste for biogas generation and its applications.	3
Units 6	Brief introduction to wind energy, hydroelectric energy, ocean energy	2
	Total	**16**

List of Practicals

S.No.	Title of Experiment
1	Study of solar radiation measuring instruments.
2	Study of solar cooker.
3	Study of solar water heater.
4	Study of solar dryer.
5	Study of solar PV system.
6	Estimation of calorific value of biomass.
7	Estimation of moisture content of biomass.
8	Estimation of ash content of biomass.
9	Estimation of fixed carbon and volatile matter of biomass.
10	Study of briquetting machine.
11	Demonstration of up draft gasifier.
12	Demonstration of down draft gasifier.
13	Demonstration of working of a fixed dome type biogas plants.
14	Demonstration of working of a floating drum type biogas plants.
15	Demonstration of biodiesel preparation.
16	Demonstration of wind measuring instruments.

Suggested Readings

Rai, G.D. 2013. Non-Conventional Energy Sources, Khanna Publishers, Delhi.

Rai, G.D., Solar Energy Utilization, Khanna Publishers, Delhi.

Khandelwal, K.C. & S. S. Mahdi. 1990. Biogas Technology- A Practical Handbook.

Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Non-Conventional Energy Sources, Himanshu Publications.
Tiwari, G.N. and Ghoshal, M.K. 2005. Renewable Energy Resources: Basic Principles and Applications. Narosa Pub. House. Delhi.
Rathore N. S., Kurchania A. K., Panwar N. L. 2007. Renewable Energy, Theory and Practice, Himanshu Publications.

5. Processing of Meat, Fish and Poultry Products (FPT 361) 3 (2+1)
(32 Lectures + 16 Practicals)

Units	Topics	Lectures
Unit 1	Status of meat poultry and fish industry in India; Sources and importance of meat, poultry and fish.	**02**
Unit 2	Structure and composition of muscle, types, classification and composition of fish Pre-slaughter operations and slaughtering operations for animals and poultry.	**01** **02**
Unit 3	Dressing and evaluation of animal carcasses; Factors affecting post-mortem changes, properties and shelf life of meat; Mechanical deboning, grading and aging; Eating and cooking quality of meat.	**02** **02**
Unit 4	Preservation of meat, poultry and fish by chilling, freezing, pickling, curing, cooking and smoking, canning, dehydration, radiation, chemical and biological preservatives. Novel methods: Low dose irradiation; High pressure treatment, hurdle barrier concept for- meat, poultry and fish Meat tenderization; Meat emulsions; Fish protein concentrates (FPC), fish protein extracts (FPE), fish protein hydrolysates (FPH);	**02** **01** **02**
Unit 5	Meat cutting and handling; Preparation, preservation and equipment for manufacture of smoked meat and its quality evaluation Preparation, packaging and equipment for manufacture of dehydrated meat products and their quality evaluation; Preparation, preservation and equipment for manufacture of meat sausages and their quality evaluation; Surimi process, traditional and modern surimi production lines, quality of surimi products, comparison of surimi and fish mince products Problems on mass balancing of ingredients in formulation of value added meat products; Abattoir design and layout;	**02** **02** **03** **01** **01**
Unit 6	Eggs: Structure, composition, quality characteristics, processing, preservation of eggs Processing and preservation of poultry meat and chicken patties, Preparation protocols of indigenous products: Fish sauce and paste	**02** **03**
Unit 7	By-products of meat, poultry, fish and eggs and their utilization; Safety standards in meat/ fish industry: HACCP/ISO/MFPO/FSSAI/ Kosher/Halal, EU hygienic regulations and ISO 9000 standards.	**02** **02**

List of Practicals

S.No.	Title of Experiment
1	Pre-slaughter operations of meat animals and poultry birds
2.	Slaughtering and dressing of meat animals
3	Study the anatomy of poultry
4	Study of different primal meat cuts/ dressing of fish
5	Cutting and handling of meat/fish
6	Preservation of meat/fish by freezing
7	Preservation of meat/ fish by curing and pickling
8	Preservation of meat/ fish by dehydration
9	Evaluation of quality and grading of raw and boiled eggs
10	Preservation of egg by thermo stabilization
11	Preparation of value added poultry/meat/ egg
12	Evaluation of meat quality by determination of ERV and WHC
13	Evaluation of meat quality by determination of pH and dye reduction test

14	Estimation of TVB and TMA
15	Protein estimation by Folin-Lowrey's method
16	Determination of iodine value
17	Canning of meat/ egg/poultry/ fish products
18	Visit to abattoir

Suggested Reading

Vikas Nanda. 2014. Meat, Egg and Poultry Science & Technology. I.K. International Publishing House Pvt. Ltd., New Delhi.

B.D. Sharma and Kinshuki Sharma. 2011. Outlines of Meat Science and Technology. Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi.

Fidel Toldrá, Y. H. Hui, Iciar Astiasarán, Wai-Kit Nip, Joseph G. Sebranek, Expedito-Tadeu F. Silveira, Louise H. Stahnke, Régine Talon. 2007. Handbook of Fermented Meat and Poultry. Blackwell Publishing Professional, Ames, Iowa, USA.

Joseph Kerry, John Kerry and David Ledward. 2005. Meat Processing-Improving Quality. Woodhead Publishing Ltd., Cambridge, England.

B.D. Sharma. 1999. Meat and Meat Products Technology Including Poultry Products Technology. Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi.

Alan H. Varnam and Jane P. Sutherland. 1995. Meat and Meat Products: Technology, Chemistry and Microbiology. Chapman & Hall, London.

William J. Stadelman and Owen J. Cotterill. 1995. Egg Science and Technology, 4th Ed. Food Products Press, NY, USA.

R.A. Lawrie. 1985. Meat Science, 4th Ed. Pergamon Press, Oxford, UK.

D.P. Sen. 2005. Advances in Fish Processing Technology. Allied Publishers Pvt. Ltd., Delhi.

Brigitte Maas-van Berkel, Brigiet van den Boogaard and Corlien Heijnen. 2004. Preservation of Fish and Meat. Agromisa Foundation, Wageningen.

FAO. 2003. Code of Practices of Canned Fishery products. FAO, UN, Rome.

Brend W. Rautenstrauss and Thomas Liehr. 2002. Fish Technology. Springer-Verlag, US.

G.M. Hall. 1997. Fish Processing Technology, 2nd Ed. Chapman & Hall, London, UK.

6. Processing Technology of Beverages (FPT 362) 3 (2+1)

(32 Lectures + 16 Practicals)

Units	Topics	Lectures
Unit 1	History and importance of beverages and status of beverage industry	**02**
Unit 2	Processing of beverages: Packaged drinking water, juice based beverages, synthetic beverages, still, carbonated	**02**
Unit 3	Low-calorie and dry beverages, isotonic and sports drinks Dairy based beverages Alcoholic beverages, fruit beverages, specialty beverages	**02** **02** **02**
Unit 4	Tea, coffee, cocoa, spices, plant extracts, etc.	**02**
Unit 5	FSSAI specifications for beverages	**02**
Unit 6	Ingredients, manufacturing and packaging processes and equipment for different beverages	**03**
Unit 7	Water treatment and quality of process water	**03**
Unit 8	Sweeteners, colorants, acidulants, Clouding and clarifying and flavouring agents for beverages	**02** **02**
Unit 9	Carbon dioxide and carbonation	**02**
Unit 10	Quality tests and control in beverages	**02**
Unit 11	Miscellaneous beverages: Coconut water, sweet toddy Sugar cane juice, coconut milk, flavoured syrups.	**02** **02**

List of Practicals

S.No.	Title of Experiment
1	Quality analysis of raw water
2	Determination of brix value, pH and acidity of beverages

3	Determination of density and viscosity of caramel
4	Preparation of synthetic beverage
5	Determination of colours in soft drinks by wool technique
6	Preparation of iced and flavoured tea
7	Preparation of instant tea
8	Assessment of purity of carbon dioxide
9	Preparation of carbonated and non-carbonated beverages
10	Preparation of sports drink
11	Preparation of dairy/ fruit based beverage
12	Determination of caffeine in beverages
13	Quality analysis of tea and coffee
14	Preparation of miscellaneous beverages
15	Visit to carbonation unit
16	Visit to mineral water plant.

Suggested Reading

Hans Michael Eblinger. 2009. Handbook of Brewing: Processes, Technology, Markets. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim. Germany.

Y.H. Hui. 2007. Handbook of Food Products Manufacturing: Principles, Bakery, Beverages, Cereals, Cheese, Confectionary, Fats, Fruits, and Functional Foods. John Wiley & Sons, Inc., Hoboken, New Jersey, USA.

Philip R. Ashurst. 2005. Chemistry and Technology of Soft Drinks and Fruit Juices, 2nd Ed. Blackwell Publishing Ltd., Oxford, UK.

Amalendu Chakraverty, Arun S. Mujumdar, G.S. Vijaya Raghavan and Hosahalli S. Ramaswamy. 2003. Handbook of Post Harvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices. Marcel Dekker, Inc., NY, USA.

7. Sensory Evaluation of Food Products (FPT 363) 3 (2+1)

(32 Lectures + 16 Practicals)

Units	Topics	Lectures
Unit 1	Definition and importance of sensory evaluation in relation to consumer acceptability and economic aspects; Factors affecting food acceptance; Terminology related to sensory evaluation;	**03**
Unit 2	Principles of good practice: the sensory testing environment, test protocol considerations,	**02**
Unit 3	Basic principles: Senses and sensory perception, physiology of sensory organs, classification of tastes and odours, threshold value factors affecting senses, visual, auditory, tactile and other responses.	**03**
Unit 4	Flavour: Definition and its role in food quality; Taste: Classification, taste qualities, relative intensity, reaction time, effect of disease, temperature, and taste medium on taste, basic tastes, interaction of tastes;	**03**
Unit 5	Odour: Definition, classification, neutral-mechanisms, olfactory abnormalities, odor testing, techniques, thresholds, odor intensities, olfaction; Visual, auditory, tactile and other senses, vision, audition, oral perception other than taste;	**05**
Unit 6	Factors influencing sensory measurements: Attitudinal factors, motivation psychological errors in judgment, relation between stimulus and perception adaptation;	**03**
Unit 7	Correlation of sensory and instrumental analysis; Requirements of sensory evaluation, sampling procedures; Factors influencing sensory measurements; Interrelationship between sensory properties of food products and various instrumental and physico-chemical tests	**04**
Unit 8	Quality Evaluations Application of sensory testing: sensory evaluation in food product development, sensory evaluation in quality control. Laboratory quality measurement: Types of tests, panel selection and testing environment, serving procedures, instruction to judges, difference tests, directional difference tests, classification of difference tests, two-sample tests, three-sample tests,	**06**

	multisampling tests, comparison of procedures, ranking, scoring, hedonic scaling, dilution procedures, descriptive sensory analysis, contour method, other procedures;	
Unit 9	Consumer measurement: Factors influencing acceptance and preference, objectives of consumer preference studies, information obtained from consumer study, factors influencing results from consumer surveys, methods of approach, development of the questionnaire, types of questionnaires, serving procedures; Comparison of laboratory panels with consumer panels; Limitations of consumer survey.	**03**
	Total	**32**

List of Practicals

S.No.	Title of Experiment
1	Determination of threshold value for basic tastes
2	Odour recognition
3	Determination of threshold value for various odours
4	Perform preference tests: Paired Comparison
5	Perform discrimination tests: Duo-trio
6	Perform discrimination tests: Triangle
7	Perform discrimination tests: Ranking test
8	Selection of judging panel
9	Training of judges, for recognition of certain common flavour and texture defects using different types of sensory tests
10	Descriptive analysis methodology- Perform descriptive sensory test
11	Sensory evaluation of various food products using different scales, score cards etc.
12	Texture profile analysis of selected food product
13	Estimation of color of food product
14	Relationship between objective and subjective methods
15	Designing a sensory laboratory

Suggested Reading

Amerine, M.A., Pangborn, R.M. and Rossles, E.B. 1965. Principles of Sensory Evaluation of Food. Academic Press, London.

Early, R. 1995. Guide to Quality Management Systems for Food Industries. Blackie Academic.

Jellinek, G. 1985. Sensory Evaluation of Food - Theory and Practice. Ellis Horwood.

Lawless, H.T. and Klein, B.P. 1991. Sensory Science Theory and Applications in Foods. Marcel Dekker.

Macrae, R., Rolonson Roles and Sadlu, M.J. 1994. Encyclopedia of Food Science & Technology & Nutrition. Vol. XI. Academic Press.

Maslowitz, H. 2000. Applied Sensory Analysis of Foods. Vols. I, II. CRC Press, Boca Raton, FL, USA.

Piggot, J.R. 1984. Sensory Evaluation of Foods. Elbview Applied Science Publ.

Potter, N.N. and Hotchleiss, J.H. 1997. Food Science, 5th Ed. CBS Publishers, Delhi.

Rai, S.C. and Bhatia, V.K. 1988. Sensory Evaluation of Agricultural Products. Indian Agricultural Statistics Research Institute (ICAR), New Delhi.

Stone, H. and Sidel, J.L. 1985. Sensory Evaluation Practices. Academic Press, London.

Harry, T. Lawless, Hildegarde Heymann. 2010. Sensory Evaluation of Food: Principles and Practices, 2nd Ed., Springer, New York or Dordrecht Heidelberg, London.

8. Food Packaging Technology and Equipment (FPT 364) 3 (2+1)

(32 Lectures + 16 Practicals)

Units	Topics	Lectures
Unit 1	Packaging situations in World and India; Need of packaging; Package requirements, package functions; Properties of different packaging materials	**04**
Unit 2	Package materials: Classification of packages, paper as package material, its manufacture, types, advantages of corrugated and paper board boxes, etc.;	**04**
Unit 3	Glass as package material, manufacture, advantages, disadvantages; Metal (Aluminium/ tin/ SS) as package material-manufacture, advantages, disadvantages,	**03**

Unit 4	Plastic as package material, classification of polymers, properties of each plastics, uses of each plastics; Lamination: Moulding-Injection, blow, extrusion; Coating on paper and films; Aseptic packaging: Need, advantages, process, comparison of conventional and aseptic packaging, system of aseptic packaging and materials used in aseptic packaging;	**04**
Unit 5	Permeability: Theoretical considerations, permeability of gases and vapours; Permeability of multilayer materials; Permeability in relation to packaging requirement of foods;	**03**
Unit 6	Intelligent/Smart/Active packaging systems and their food applications, CAP/MAP	**03**
Unit 7	Transport properties of barriers; Simulations of product: Package environment interaction; Packaging of specific foods, mechanical and functional tests on package. Packaging	**04**
Unit 8	Packaging Practices followed for fruits and vegetables and their products, Packaging machines (FFS), Filling machines, vacuum packaging machines	**04**
Unit 9	Labelling requirements, methods of coding and regulation and standards of labelling of food packages	**03**

List of Practicals

S. No.	Title of Experiment
1	Classification of various packages based on material and rigidity
2	Measurement of thickness of packaging materials
3	Measurement of basic weight and grammage of paper and paperboards
4	Measurement of water absorption of paper and paper boards (Cobb Test)
5	Measurement of bursting strength of paper and paper boards
6	Measurement of tear resistance of papers
7	Measurement of puncture resistance of paper and paperboard
8	Drop test, Box compression test;
9	Determination of machine direction, cross direction, top side and wire side of packaging materials
10	Measurement of grease resistance of papers
11	Identification of plastic films
12	Measurement of tensile strength of packaging material
13	Measurement of dart impact resistance for plastic films
14	Determination of seal integrity, ink adhesion
15	Head space analysis of packaged food
16	Determination of lacquer integrity test
17	Determination of gas and water transmission rate of package films
18	Study of vacuum packaging machine, bottle filling machine and form-fill-seal machine
19	Shelf life calculations for food products

Suggested Reading

Gordon L. Robertson. 2014. Food Packaging: Principles and Practice, 3rd Ed. CRC Press, Boca Raton, FL, USA.

Gordon L. Robertson. 2010. Food Packaging and Shelf Life – A Practical Guide. CRC Press, Boca Raton, FL, USA.

Dong Sun Lee. 2008. Food Packaging Science & Technology. CRC Press, Boca Raton FL, USA.

Jung H. Han. 2007. Packaging for Nonthermal Processing of Food. Blackwell Publishing Ltd., Oxford, UK.

Jung H. Han. 2005. Innovations in Food Packaging. Elsevier Science & Technology Books, UK.

Rajia Ahvennainen. 2003. Novel Food Packaging Techniques. CRC-Woodhead Publishing Ltd., Cambridge, England.

Richard Coles, Berek McDowell and Mark J. Kirwan. 2003. Food Packaging Technology. Blackwell Publishing Ltd., Oxford, UK

9. Entrepreneurship Development (FBM 361) 2 (1+1)

(32 Lectures + + 16 Practical)

Units	Topics	Lectures
Unit 1	Entrepreneurship: Importance and growth, characteristics and qualities of entrepreneur	1
	Role of entrepreneurship, ethics and social responsibilities	1
	Entrepreneurship development: Assessing overall business environment in the Indian economy	1
	Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs	1
Unit 2	Globalization and the emerging business/entrepreneurial environment	1
	Concept of entrepreneurship	1
	Entrepreneurial and managerial characteristics, managing an enterprise	1
	Motivation and entrepreneurship development, importance of planning, monitoring, evaluation and follow up, managing competition, entrepreneurship development programs	1
	SWOT analysis	1
	Generation, incubation and commercialization of ideas and innovations	1
Unit 3	Women entrepreneurship: Role and importance, problems	1
	Planning and evaluation of projects: Growth of firm, project identification and selection, factors inducing growth	1
	Project feasibility study: Post planning of project, project planning and control; New venture management; Creativity	1
Unit 4	Government schemes and incentives for promotion of entrepreneurship; Government policy on small and medium enterprises (SMEs)/SSIs	1
	Export and import policies relevant to food processing sector; Venture capital; Contract farming and joint ventures, public-private partnerships	1
	Overview of food industry inputs; Characteristics of Indian food processing industries and export	1

List of Practicals

S. No.	Title of Experiment
1-2	Data collection from market on various projects on food processing and analysis
3-4	Visit to public enterprise (agro-processing/food business centers)
5-6	SWOT analysis of public enterprises
7-8	Visit to private enterprise (agro-processing/food business centers)
9-10	SWOT analysis of private enterprise
11-12	Calculation of project cost and break even analysis for a specific food product enterprise
13-14	Project proposals as entrepreneur – individual and group
15-16	Presentation of project proposals in the class

Suggested Reading

C.B. Gupta and N.P. Srinivasan. 2012. Entrepreneurship Development. S. Chand & Sons, New Delhi.

Anil Kumar, S., Poornima, S.C., Mini, K., Abraham and Jayashree, K. 2003. Entrepreneurship Development.New Age International Publishers, New Delhi.

Gupta, C.B. 2001. Management: Theory and Practice.Sultan Chand & Sons, New Delhi.

Vasant Desai. 2000. Dynamics of Entrepreneurial Development and Management.Himalaya Publishing House New Delhi.

SEMESTER VII

1. Communication and Soft Skills Development (FBM 471) 2 (1+1)
(16 Lectures + 16 Practical)

Units	Topics	Lectures
Unit 1	Communication Skills: Meaning and process of communication	1
	Technical Communication and General Communication	1
	Verbal and non-verbal communication	1
Unit 2	Comprehending an article	2
	Oral presentation skills	2
	Technical writing skills, bibliographic procedures	2
	E-mailing & blogging : writing & etiquettes	1
Unit 3	Individual and group presentations	1
	Impromptu presentation, public speaking	1
Unit 4	Goal setting; Decision making; Career Planning	1
	Tools for job application: Resume, interviews, group discussion	2
	Organizing seminars and conferences	1

List of Practicals

S. No.	Title of Experiment
1-2	Activities for Self development: Etiquette and manners; Break the ice berg – FEAR
3	Activity for development of time management skills
4-5	Leadership & Team building activity
6	Listening, reading, summarizing and abstracting of general/technical articles
7	Extempore
8-9	Public speaking
10-11	Presentation using PowerPoint
12-13	Resume building
14	Group discussions
15-16	Interviewing skills

Suggested Reading

Mamatha Bhatnagar and Nitin Bhatnagar. 2011. Effective Communication and Soft Skills. Person Education.

Meenakshi Raman, Sangeeta Sharma. Technical Communication Principles and Practice

Harold Wallace and Ann Masters. Personality Development. Cengage Publishers.

Andrea J. Rutherford. Basic Communication

2. Project Preparation and Management (FBM 472) 2 (1+1)
(16 Lectures + 16 Practical)

Units	Topics	Lectures
Unit 1	What is project and project Management, Evolution of project management, Forms and environment of project management	1
	Project life cycle	1
	Project Identification, Screening, Project Appraisal, Project Selection, Project Proposal & Project Scope	2
Unit 2	Project Planning	1
	Work break down structure and Network Scheduling	1
	Critical Path Method	1
	Program Evaluation & Review Technique	1
Unit 3	Time-cost relationship in project	1

	Resource Considerations in Projects, Resource Profiles and levelling, limited Resource Allocation	1
	Project Implementation, Monitoring and Control: Project management Process and role of project manager, team building, Leadership in Projects, Organizational and behavioural issues in Project Management	2
	Project Monitoring and Control	1
Unit 4	Project Completion and Review	1
	Project Management - Recent trends and Future Directions	1
	Computers in Project Management	1

List of Practicals

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

Suggested Reading

R. Panneerselvam. 2004. Operations Research, 2nd Ed. International Book House, Mumbai.

Prasanna Chandra. Projects. Tata McGraw-Hill Publication, New Delhi.

John M. Nicholas. Project Management for Business and Technology – Principles and Practices. Pearson Prentice Hall.

Harold Kerzner. Project Management – A System Approach to Planning, Scheduling, and Controlling. CBS Publishers & Distributors.

Prasanna Chandra. Projects – Planning, Analysis, Selection, Financing, Implementation, and Review. Tata McGraw-Hill Publishing Company Ltd.

P. Gopalakrishnan and V.E. Rama Moorthy. Textbook of Project Management. Macmillan

3. Student READY- Experiential Learning Programme-I (FPO 471) 7 (0+7)

and

4. Student READY- Experiential Learning Programme-II (FPO 472) 7 (0+7)

EL provides the students an excellent opportunity to develop analytical and entrepreneurial skills, and knowledge through meaningful hands on experience, confidence in their ability to design and execute project work. The main objectives of EL are:

- To promote professional skills and knowledge through meaningful hands on experience.
- To build confidence and to work in project mode.
- To acquire enterprise management capabilities

The experiential learning programme will be offered for one semester period in the final year. As the programme is enterprise oriented, students and faculty are expected to attend the activities of the enterprise with total commitment, and without any time limit or restriction of working hours for ELP.

Student Rural and Entrepreneurship Awareness Development Yojana (READY) - Experiential Learning with a credit load of 0+14 credit hours through relevant pilot plants for processing of various commodities, preferably on campus. This shall include development of Detailed Project Report on setting up of enterprise in the selected areas of product manufacture and Evaluation of the Module. The experiential learning is intended to build practical skills and entrepreneurship attributes among the students with an aim to deal with work situations and for better employability and self-employment.

EL Activity	No. Of Credits
Orientation and Developing a Business Plan/ Project proposal	02
Identification of the product to be manufactured, Market Survey, Analysis of the existing status of the identified product and targeted market and customer, Innovativeness and Creativity, Preparation of the project proposal with supply chain of inputs, personnel plan, production plan, finance plan etc. and its preparation	
Plan for the Production	02
Organization of resources, Organizing Utility, Sequential grouping of activities, Packaging and storage, Product pricing physical inputs, man hours, depreciation etc.	
Production	06
Regularity in production, Adhering to production plan, Product quality assessment, Maintenance of production records, Team work	
Sales	03
Sales strategy, sales strategy, sales volumes, assessment of sales performance, profit generated including C/B ratio, payback period, etc.	
Documentation and Report Presentation and Evaluation	01
Total Credit	14

5. **Student READY - Research Project (FPO 473) 3 (0+3)**
6. **Student READY – Seminar (FPO 474) 1 (0+1)**

SEMESTER VIII

1. **Student READY - Industrial Tour (FPO 481) 2 (0+2)**
2. **Student READY - Internship/In-Plant Training (FPO 482) 20 (0+20)**