

COURSE CURRICULUM
M.Tech. (Food Technology)



COLLEGE OF FOOD TECHNOLOGY
MARATHWADA KRISHI VIDYAPEETH
PARBHANI - 431 402

2009 - 2010

Proforma – A
Semester-wise Course Layout
for M.Tech. Degree Programme
Since 2009-2010

as per
Recommendations of
National Core Group (NCG)
ICAR, New Delhi

Proposed for
DICCC Meeting

Presented by
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Professor [CAS] & Head
College of Food Technology

M.A.U., Parbhani
Revised
M.Tech. [Food Technology]
Degree Programme
Since 2009-2010

As per NCG Recommendations
Overall Course Layout

Sr. No.	Credit Courses (CC)	Prerequisite Credits
1	Major	20
2	Minor*	12 (Common)
3	Supporting#	06 (Un common)
4	Course Seminar	01
	Total Compulsory Credit (CC)	39
Six Courses on NCCC i.e. Non-Credit Compulsory Courses		

* Minor Courses in the revised syllabus notified in three independent groups should be considered as supplementary to the major field where external evaluation of comprehensive theory examination is a salient feature and hence to be common. One course from each group needs to be offered.

However, Supporting Courses in the revised syllabus can be compared with earlier minor courses. Being uncommon, supporting courses can easily be adjustable according to need of student/ department and not to be evaluated by the comprehensive examination

Proposed Credit Layout for M. Tech. Degree

Residential requirement = 2 years (4 semesters)

Semester	Credits Courses					Noncredit courses	Total credits
	Major	Minor	Supporting	Seminar	Research work/ Thesis		
First	09	07	--	--	--	02	18
Second	07	05	03	--	--	02	17
Third	04	--	03	01	--	02	10
Fourth	--	--	--	--	20	--	20
Total	20	12	06	01	20	06	65

Crucial events for M. Tech. Degree Programme

1. Second Semester: Completion of Res. Project (by end of semester).
2. Third Semester:
 - i. Compre. Theory Exam. by external evaluation for major and minor courses (at mid of semester).
 - ii. Data processing & Synopsis Presentation in Board of Studies (BOS)
 - iii. Thesis submission (From end of semester).
3. Fourth Semester:
 - i. Thesis submission (up to 1st fortnight of semester).
 - ii. Thesis evaluation by external Examiner.
 - iii. Viva-voce exam (Month prior to end of sem.)
 - iv. Submission of Final Thesis (15 days prior to sem. end).
 - v. Issue of Transcript Certificate (Within 5 days after Sem. End)

Semester Wise Course Layout

Course Layout for First Semester

No. of Courses	Credit Courses	No. of Credits
I. Major Courses		
Three	Three courses of 9 Credits i) FST-601 Advances in Food Chemistry and Nutrition (2+1) ii) FST-602 Modern Food Microbiology (2+1) iii) FST-603 Advances in Food Engineering (2+1)	09
II. Minor Courses		
Three	Three courses of 7 Credits iv) FST-612 Nutraceuticals and Health Foods (2+1) v) FST-619 Cold Chain Management (2+0) vi) FST-620 Food Supply Chain Management (1+1)	07
III. Non-credit Compulsory Courses (NCCC)		
Two	Two courses of 2 credits vii) PGS-501 Library and Information Services (0+1) viii) PGS-504 Basic Concepts in Laboratory Techniques (0+1)	02
Total courses eight	Major Courses 3+ Minor courses 3+ NCCC courses 2	18

N.B. – M. Tech. [Food Technology] need base, specified minor courses are proposed by NRC

Crucial Academic Activities to be undertaken during 1st Semester:

1. Formation of Student Advisory Committee (SAC) – 3 members (2 from major and 1 from minor)
2. Submission of Course Plan Work (CPW)
3. Assignment of Supporting courses and Research Titles.
4. Approval of Outline of Research Work (ORW) by Board of Studies (BOS)

Course Layout for Second Semester

No. of Courses	Credit Courses	No. of Credits
I. Major Courses		
Three	Three courses of 7 Credits i) FST-604 Food Processing (2+0) ii) FST-605 Food Packaging (1+1) iii) FST-607 Food Quality Systems and Management (2+1)	07
II. Minor Courses		
Two	Two course of 5 credits iv)FST-632 Beverages Technology (1+1) v) FST-634 Grain Storage Technology (2+1)	05
III. Supporting Courses		
One	One Course of 3 credits vi)FST-532 Computer Applications in Food Industry (1+2)	03
IV. Non-Credit Compulsory Courses (NCCC)		
Two	Two courses of 2 credits vii) PGS-502 Technical Writing and Communications Skills (0+1) viii) PGS-503 Intellectual Property and Its Management In Agriculture (1+0)	02
Total courses eight	Three major + Two minor + One supporting +Two NCCC	17

N.B. -

Crucial Academic Activities to be undertaken during 2nd Semester:
Conduction of Research Project

Course Layout for Third Semester

No. of Courses	Credit Courses	No. of Credits
1. Major Courses		
Two	Two courses of 4 credits i) FST-606 Food Analysis (0+2) ii) FST-608 Equipment Design and Process Control (1+1)	04
II. Minor Courses		Nil
III Supporting courses		
One	One Course of 3 credits iii) FST-533 Business Management and International Trade (3+0)	03
IV Master Seminar (MS from major course)		
	iv) Master Seminar FST-519 (0+1)	01
V. Non-Credit Compulsory Courses (NCCC)		
Two	v) PGS-505 Agricultural Research Ethics and Rural Development Programmes (1+0) vi) PGS-506 Disaster Management (1+0)	02
Total courses five	Major courses 2+ minor courses 0+supporting courses 1+ NCCC 2	10

Crucial Academic Activities to be undertaken during 3rd Semester:

- i) Proposal for conduction of Comprehensive Theory Examination to the Associate Dean and Principal
- ii) Proposal for Panel of Examiners to the Dean
 - a) Thesis Evaluation (External)
 - b) Thesis viva-voce Examination (Internal)
- iii) Data Processing & assessment of tables involved in the thesis by SAC
- iv) Presentation of Thesis seminar (i.e. synopsis) in BOS
- v) Comprehensive Theory Examination for Major and Minor courses (one paper for each course).
- vi) Submission of loose – bond thesis to the office of Associate Dean and Principal

Course Layout for Fourth Semester

No. of Courses	Credit Courses	No. of Credits
	I Major Courses	--
	II Minor Courses	--
	III Supporting Courses	--
	Non-Credit Compulsory Courses (NCCC)	--
	Research Work/ Thesis	20
Total	--	20

Crucial Academic Activities to be undertaken during 4th Semester:

- i) *Submission of Loose – bond thesis: up to first fortnight.
- ii) *Thesis viva voce examination: one month prior to semester end.
- iii) *Submission of final thesis: 15 days prior to semester end.
- iv) A submitted Research paper on thesis work will be highly appreciated at the time of submission of final thesis.

* A completion of M. Tech. degree within two years is an expectation from NCG and not compulsion on each M. Tech. student. However, for enrolment to Ph.D. Courses; it is prerequisite to complete M. Tech. degree within stipulated time as simultaneous admissions are proposed by National Core Group (NSG) for both degree programmes (M. Tech. and Ph.D.) in the month of August. Therefore, an Academic Calendar of two years is proposed for M. Tech. degree to have uniformity with the national level.

SEMESTER I

FST 601 ADVANCES IN FOOD CHEMISTRY AND NUTRITION 2+1 (Major)

Objective

To go beyond basic chemistry and nutrition in to advances with the aim of developing healthy and nutritious foods for normal and special category of population groups.

Theory

UNIT I (Lectures 8)

Interactions among food components and their effect on sensory, nutritional and processing quality, Natural antioxidants, mechanisms of action and their evaluation techniques, Advanced glycation end products and their nutritional significance; Free radical chemistry, reactive oxygen, photosensitized oxidation, metal catalysed reactions. Antioxidants: chemistry and mechanisms of action, techniques of evaluation of antioxidant activity, uses.

UNIT II (Lectures 7)

Water relationships in foods: water activity and its relevance to deteriorative processes in foods (chemical, enzymic, physical and microbial changes). Glass transitions and molecular mobility in foods, their relevance to quality and stability of food products, Food Carbohydrates: structural, analytical, physicochemical, nutritional and functional aspects of small mol. wt. carbohydrates and polysaccharides of plant and microbial origin.

UNIT III (Lectures 7)

Fragrance and flavouring compounds: essential oils, terpenoids-oleoresins biochemical pathways for the production of volatile compounds in specific plant species; Chemical structure, distribution, diurnal and seasonal fluctuations; Intraspecific differences in volatiles oil production, differentiation between geographical origins; Turpentine and terpene industry and, biological Interactions among food components and flavours, Interactions among food flavours and packaging materials, Interactions among food additives and their significance in food processing.

UNIT IV (Lectures 8)

Therapeutic, Parenteral and Geriatric nutrition and relevant food formulations, genetic disorders and nutritional requirements, Gene regulation in secondary metabolism, Tissue specificity (phenyl propanoids) and stress responsiveness (terpenoids indole alkaloids), Compartmentation, storage and transport.

UNIT V (Lectures 5)

Appetite suppressants, phytosterols, polyphenols, phytoestrogens, ω -fatty acids, glucosinolates, non-digestible oligosaccharides, Glycemic index and its role in human nutrition, Prebiotics and probiotics, Chemistry of Alkaloids, Flavonoids and other Phenolics.

Practical

Study browning reactions in model systems, estimation of natural antioxidants in foods. Estimation of the environmental effects on auto oxidation of processed foods, measurement of water activity and plotting of 85 sorption isotherm of selected foods, determination of physical, chemical, enzymatic and microbial changes in relation to water activity, physicochemical and functional properties of carbohydrates, separation and estimation of essential oils and oleoresins, study of interaction among food components, additives and flavours with food packaging, formulation of therapeutic and probiotics foods, determination of Glycemic index of selected foods.

Suggested Readings

Advances in Food and Nutrition Research. Elsevier Book Series.

Aurand LW, Woods A & Wells MR. 1987. *Food Composition and Analysis*. AVI Publ.

Baynes JW, Monnier VM, Ames JM & Suzanne R. 2005. *The Maillard Reaction: Chemistry at the Interface of Nutrition, Aging, and Disease Thorpe*. Annals of the New York Academy of Science.

Birch GG & Lindley MG.1986. *Interactions of Food Components*. Elsevier.

Fennema OR. 1996. *Food Chemistry*. Marcel Dekker.

Kumar A & Gaonkar G. 1995. *Ingredient Interaction: Effect on Food Quality*. Marcel Dekker.

FST 602 MODERN FOOD MICROBIOLOGY 2+1 (Major)

Objective

To expose to the recent advances and applications in the area of food microbiology.

Theory

UNIT I (Lectures 10)

Foods as ecological niches, relevant microbial groups, Microbes found in raw materials and foods that are detrimental to quality, Factors that influence the development of microbes in food, newer and rapid methods for qualitative and quantitative assay demonstrating the presence and characterization of microbes, Stress, damage, adaptation, reparation, death.

UNIT II (Lectures 10)

Microbial growth in food: intrinsic, extrinsic and implicit factors, Microbial interactions, Inorganic, organic and antibiotic additives. Effects of enzymes and other proteins, Combination systems, Adaptation phenomena and stress phenomena, Effect of injury on growth or survival, Commercial available databases.

UNIT III (Lectures 8)

Microbial behaviour against the newer methods of food processing, Adoption and resistance development, Microbes as test organisms, as sensors and as tools for future applications in energy production and food and non-food industrial products.

UNIT IV (Lectures 7)

Modern methods of cell culture: synchronous and co- cell culture, continuous cell culture in liquid and solid media, Cell immobilization and applications, Pre and probiotics cultures.

Practical

Evaluation of microorganism in raw and processed products by using various techniques, Study of factors influencing growth of microorganisms, determination of effects of various preservatives including antibiotics on the suppression of microbial growth, Development of cell cultures using various techniques, production of newer microbial metabolites of industrial importance, development of probiotics in lab.

Suggested Readings

Adams M. 2006. *Emerging Food-borne Pathogens*. Woodhead Publ.

Adams MR & Moss MO. 2000. *Food Microbiology*. Panima.

Easter MC. 2003. *Rapid Microbiological Methods in the Pharmaceutical Industry*.

Harrigan W. 2003. *Laboratory Methods in Food Microbiology*. University of Reading, UK, Elsevier.

James MJ, Loessner MJ & David A. 2005. *Modern Food Microbiology*. 7th Ed. Golden Food Science Text Series.

Pederson CS.1979. *Microbiology of Food Fermentations*. AVI Publ.

Roberts R .2002. *Practical Food Microbiology*. Blackwell Publ.

Rossmore HW. 1995. *Handbook of Biocide and Preservative*. Blackie

Wood JBB. 1999. *Microbiology of Fermented Foods*. Vols. I, II. Blackwell

FST 603 ADVANCES IN FOOD ENGINEERING 2+1 (Major)

Objective

To acquaint with recent advances of Food Engineering and its Processes.

Theory

UNIT I (Lectures 6)

Engineering properties of foods, their significance in equipment design, processing and handling of food and food products, steady state and unsteady state heat transfer, Numerical, graphical and analog methods in the analysis of heat transfer. Solution of unsteady state equations, solar radiation.

UNIT II (Lectures 8)

Mass transfer, molecular diffusion and diffusivity, equilibrium stage process, convective mass transfer co-efficient, mass transfer with laminar and turbulent flow. Design equations for convective mass transfer, simultaneous momentum, Separation by equilibrium stages, immiscible phases, distillation of binary mixtures and multi-component separations.

UNIT III (Lectures 6)

Aerodynamics and hydrodynamic characteristics, drag coefficient, terminal velocity and Reynolds number, application of aerodynamic properties to the separation, pneumatic handling and conveying of food products, material and energy balance.

UNIT IV (Lectures 10)

Thermodynamic properties of moist air, kinetics of water absorption, Evaporation and dehydration of foods, design of single and multi-effect evaporators, mechanics of movement of air through stationary bed, thin layer and thick layer bed drying, simulation models for drying systems, use of weather data for drying operations, design of dryers, New direction in freeze bed drying, cyclic pressure freeze drying. Microwave drying and vacuum drying, efficient drying systems, infrared heating, freezing of foods, freeze concentration and rying, freezing point curves, phase diagrams, methods of freeze concentration, design problems.

UNIT V (Lectures 5)

Theory of ultra-filtration and reverse osmosis, selection and types of membranes and properties, concentration polarization, mathematical description of flow through membrane, application and use in food industry.

Practical

Determination of engineering properties of foods, Design problems on evaporators; measurement of heat transfer using selected heat exchangers in model study, evaluation of mass transfer and estimation of mass transfer coefficient of selected foods in evaporators and dehydrators , separation of immiscible phase using appropriate centrifuge, fractional distillation of multi component mixtures, air classification and determination of particle size index of powdered food materials, study of pneumatic conveyers using fluidized solids, determination of drying rate and curves under various drying conditions, determination of freezing curves for selected fresh fruits and vegetables, application of ultra-filtration and reverse osmosis in processing of fruit juices.

Suggested Readings

- Charm SE. 1971. *Fundamental of Food Engineering*. AVI Publ.
- Cheryan M. 1998. *Ultra-filtration and Micro-filtration Handbook*. Technomic Publ.
- Duckworth R. 1975. *Water Relations in Foods*. Academic Press.
- Heldman DR & Singh RP.1984. *Food Process Engineering*. AVI Publ.
- Hendrickx and Knorr. Rockland LB & Stewart GF. 1991. *UHP Treatments of Foods*. KA/PP Publ.
- Mohsenin NN. 1986. *Physical Properties of Plant and Animal Materials*. Gordon & Breach Science Publ.
- Rao MA & Rizvi SS.1986. *Engineering Properties of Foods*. Marcel Dekker.
- Robertson GL. 1992. *Food Packaging (Principles and Practices)*. Marcel Dekker.
- Watson EL & Harper JC.1989. *Elements of Food Engineering*. AVI Publ.

FST 612 NUTRACEUTICALS AND HEALTH FOODS 2+1 (Minor)

Objective

To cater to the newly emerging area of nutraceuticals with respect to the types, mechanisms of action, manufacture of selected nutraceuticals, product development, clinical testing and toxicity aspects.

Theory

UNIT I (Lectures 5)

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

UNIT II (Lectures 12)

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

UNIT III (Lectures 8)

Manufacturing aspects of selected nutraceuticals such as lycopene, isoflavonoids, prebiotics and probiotics, glucosamine, phytosterols etc.; formulation of functional foods containing nutraceuticals – stability and analytical issues, labelling issues.

UNIT IV (Lectures 9)

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

Practical

Market survey of existing health foods; identification and estimation of selected nutraceuticals; production and quality evaluation of foods containing nutraceuticals; development of labels for health foods; visit to relevant processing Units

Suggested Readings

Brigelius-Flohé, J & Joost HG. 2006. *Nutritional Genomics: Impact on Health and Disease*. Wiley VCH.

Cupp J & Tracy TS. 2003. *Dietary Supplements: Toxicology and Clinical Pharmacology*. Humana Press.

Gibson GR & William CM. 2000. *Functional Foods - Concept to Product*.

Goldberg I. 1994. *Functional Foods: Designer Foods, Pharma Foods*.

Losso JN. 2007. *Anti-angiogenic Functional and Medicinal Foods*. CRC Press.

Manson P.2001. Dietary Supplements. 2nd Ed. Pharmaceutical Press.
Campbell JE & Summers JL. 2004. *Dietary Supplement Labeling Compliance*.
Neeser JR & German BJ. 2004. *Bioprocesses and Biotechnology for Nutraceuticals*.
Chapman & Hall.
Robert EC. 2006. *Handbook of Nutraceuticals and Functional Foods*. 2nd Ed. Wildman.

FST 619 COLD CHAIN MANAGEMENT 2+0 (Minor)

Objective

To acquaint the students with technology and operational systems of cold chain management in the retail, whole sale and over all supply chain in the food industry.

Theory

UNIT I (Lectures 4)

Introduction, scope and importance of cold chain in food processing industry and retail chain, components of cold chain and integration.

UNIT II (Lectures 5)

Products going in cold chain, their temperature and humidity requirements, packaging needs and their compatibility in cold chain.

UNIT III (Lectures 5)

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

UNIT IV (Lectures 4)

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

Suggested Readings

There are no books on cold chain management but there are chapters in supply chain management books shown in next course.

FST 620 FOOD SUPPLY CHAIN MANAGEMENT 1+1 (Minor)

Objective

Study the concept, applications, systems and practices of food supply chain management in food industry.

Theory

UNIT I (Lectures 5)

Building blocks of supply chain network, performance measures, decisions in supply world and models.

UNIT II (Lectures 4)

Supply chain inventory management, economic order quantity models, reorder point models, multi echelon inventory systems.

UNIT III (Lectures 4)

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

UNIT IV (Lectures 5)

Internet technologies and electronic commerce in SCM related to ERP, procurement, e logistics, internet auctions, e-market, electronic, business process optimization.

Practical

Problems, games and case studies related SCM, Demonstration of various models in decision making, case studies for SCM in processing of fruits/vegetable/milk, case study for export of one perishable and one non-perishable food.

Suggested Readings

Chopra S & Meindl P. 2002. *Supply Chain Management: Strategy, Planning and Operation*. Prentice Hall.

Handfield RB & Nichols EL.1999. *Introduction to Supply Chain Management*. Prentice Hall.

Hopp WJ & Spearman ML. 1996. *Factory Physics: Foundations of Manufacturing Management*. McGraw Hill.

Levi DS, Kaminsky P & Levi ES. 2000. *Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies*. Mc Graw Hill.

Shapiro JF. 2001. *Modeling the Supply Chain*. Duxbury Thomson Learning.

Tayur S, Ganeshan R & Magazine M.1999. *Quantitative Models for Supply Chain Management*. Kluwer Academic Publ.

Viswanadham N. 2000. *Analysis of Manufacturing Enterprises*. Kluwer.

Viswanadham N & Narahari Y. 1998. *Performance Modeling of Automated Manufacturing Systems*. Prentice Hall

PGS 501 LIBRARY AND INFORMATION SERVICES 0+1 (NCCC)

Objective

To equip the library users with skills: to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of

information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e-resources access methods.

PGS 504 BASIC CONCEPTS IN LABORATORY TECHNIQUES 0+1 (NCCC)

Objective

To acquaint the students about the basics of commonly used techniques in laboratory.

Practical

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccumets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, water-bath, oil-bath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy.

Suggested Readings

Furr AK. 2000. *CRC Hand Book of Laboratory Safety*. CRC Press.

Gabb MH & Latchem WE. 1968. *A Handbook of Laboratory Solutions*.

Chemical Publ. Co.

SEMESTER II

FST 604 FOOD PROCESSING 2+0 (Major)

Objective

To develop an insight among the students about the existing modern techniques so as to aware them about their methodology and applications in food processing.

Theory

UNIT I (Lectures 10)

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

UNIT II (Lectures 10)

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

UNIT III (Lectures 4)

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

UNIT IV (Lectures 8)

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

Suggested Readings

Barbosa-Canovas 2002. *Novel Food Processing Technologies*. CRC.

Dutta AK & Anantheswaran RC.1999. *Hand Book of Microwave Technology for Food Applications*.

Frame ND. (Ed.). 1994. *The Technology of Extrusion Cooking*. Blackie.

Gould GW. 2000. *New Methods of Food Preservation*. CRC.

Shi J. (Ed) 2006. *Functional Food Ingredients and Nutraceuticals: Processing Technologies*. CRC

FST 605 FOOD PACKAGING 1+1 (Major)

Objective

To provide knowledge about selected trends and development in food packaging technologies and materials aiming at assuring the safety and quality of foodstuffs in order to design an optimized package which satisfies all legislative, marketing and functional requirements sufficiently, and fulfils environmental, cost and consumer demands as well as possible.

Theory

UNIT I (Lectures 4)

Active and intelligent packaging, Active packaging techniques, Intelligent packaging techniques, Current use of novel packaging techniques, Oxygen, ethylene and other scavengers, Oxygen scavenging technology, Ethylene scavenging technology, Carbon dioxide and other scavengers, Antimicrobial food packaging: Constructing an antimicrobial packaging system, Factors affecting the effectiveness of antimicrobial packaging.

UNIT II (Lectures 3)

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

UNIT III (Lectures 3)

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

UNIT IV (Lectures 4)

Packaging-flavour interactions, Factors affecting flavour absorption, role of the food matrix, role of differing packaging materials, Case study: packaging and lipid oxidation, Modeling flavour absorption, Packaging– flavour interactions and active packaging, Novel MAP applications for fresh-prepared produce, Novel MAP gases, Testing novel MAP applications, Applying high O₂ MAP.

UNIT V (Lectures 4)

Modern packaging systems: Green plastics for food packaging, The problem of plastic packaging waste, The range of biopolymers, Developing novel biodegradable materials, Legislative issues, Current applications, Integrating intelligent packaging , role of packaging in the supply chain, Creating integrated packaging, storage and distribution: alarm systems and TTIs, Traceability: radio frequency identification, Recycling packaging materials: The recyclability of packaging plastics, Improving the recyclability of plastics packaging, Testing the safety and quality of recycled material, Using recycled plastics in packaging.

Practical

Determination of GTR and WVTR in different packaging materials, use of oxygen and ethylene scavengers I packaging of fresh fruits, application of anti microbial packaging for moisture sensitive foods, evaluation of pesticide residue migration from package to food, application of MAP and active packaging in selected foods, determination of oxidative changes in packaged foods, comparative evaluation of flexible and rigid packages for fragile foods, packaging of foods under inert atmosphere.

Suggested Readings

- Ahvenainen R. 2001. *Novel Food Packaging Techniques*. CRC.
- Crosby NT. 1981. *Food Packaging Materials*. App. Sci. Publ.
- Mahadeviah M & Gowramma RV. 1996. *Food Packaging Materials*. Tata McGraw Hill.
- Painy FA. 1992. *A Handbook of Food Packaging*. Blackie.
- Palling SJ. 1980. *Developments in Food Packaging*. App. Sci. Publ.
- Rooney ML. 1988. *Active Food Packaging*. Chapman & Hall.
- Sacharow S & Griffin RC. 1980. *Principles of Food Packaging*. AVI Publ.
- Stanley S & Roger CG. 1998. *Food Packaging*. AVI Publ.

FST 607 FOOD QUALITY SYSTEMS AND MANAGEMENT 2+1 (Major)

Objective

To acquaint with food quality parameters and control systems, food standards, regulations, specifications.

Theory

UNIT I (Lectures 12)

Concept of quality: Quality attributes- physical, chemical, nutritional, microbial, and sensory; their measurement and evaluation; Sensory *vis-à-vis* instrumental methods for testing quality.

UNIT II (Lectures 10)

Concepts of quality management: Objectives, importance and functions of quality control; Quality management systems in India; Sampling procedures and plans; Food Safety and Standards Act, 2006; Domestic regulations; Global Food safety Initiative; Various organizations dealing with inspection, traceability and authentication, certification and quality assurance (PFA, FPO, MMPO, MPO, AGMARK, BIS); Labeling issues; International scenario, International food standard.

UNIT III (Lectures 14)

Quality assurance, Total Quality Management; GMP/GHP; GLP, GAP; Sanitary and hygienic practices; HACCP; Quality manuals, documentation and audits; Indian & International quality systems and standards like ISO and Food Codex; Export import policy; export documentation; Laboratory quality procedures and assessment of laboratory performance; Applications in different food industries; Food adulteration and food safety. IPR and Patent.

Practical

Testing and evaluation of quality attributes of raw and processed foods; Detection and estimation of food additives and adulterants; Quality assurance procedure, GMP, GAP documentation; Preparation of quality policy & documentation, Application of HACCP to products, Preparation of HACCP chart; Preparation of documentation & records, Visit to Units with ISO systems; Visit to Units with HACCP certification; Visit to Units implementing GMP, GAP; Mini-project on preparation of a model laboratory manual.

Suggested Readings

Amerine MA *et al* 1965. *Principles of Sensory Evaluation of Food*. Academic Press.
Early R.1995. *Guide to Quality Management Systems for Food Industries*. Blackie Academic.
Furia TE.1980. *Regulatory Status of Direct Food Additives*. CRC Press.
Jellinek G. 1985. *Sensory Evaluation of Food - Theory and Practice*. Ellis Horwood.
Krammer A & Twigg BA.1973. *Quality Control in Food Industry*. Vol. I, II. AVI Publ.

FST 632 BEVERAGES TECHNOLOGY 1+1 (Minor)

Objective

To provide a technical view of beverages and a full discussion of manufacturing processes in the context of technology and its related chemistry as well as a more fundamental appraisal of the underlying science.

Theory

UNIT I (Lectures 6)

Types of beverages and their importance; status of beverage industry in India; Manufacturing technology for juice-based beverages; synthetic beverages; technology of still, carbonated, low-calorie and dry beverages; isotonic and sports drinks; role of various ingredients of soft drinks, carbonation of soft drinks.

UNIT II (Lectures 3)

Specialty beverages based on tea, coffee, cocoa, spices, plant extracts, herbs, nuts, dairy and imitation dairy-based beverages.

UNIT III (Lectures 6)

Alcoholic beverages- types, manufacture and quality evaluation; the role of yeast in beer and other alcoholic beverages, ale type beer, lager type beer, technology of brewing process, equipments used for brewing and distillation, wine and related beverages, distilled spirits.

UNIT IV (Lectures 3)

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

Practical

Chemical and microbiological analysis of raw water quality; Preparation of regional fruit juices; Preparation of whey-based beverages; preparation of iced and flavoured tea beverage; Preparation of carbonated and noncarbonated soft drinks; Preparation of wine and beer; Preparation of soy milk, fruit milkshakes, herbal beverages; visit to relevant processing units.

Suggested Readings

Hardwick WA. 1995. *Handbook of Brewing*. Marcel Dekker.

Hui YH et al 2004. *Handbook of Food and Beverage Fermentation Technology*. Marcel Dekker.

Priest FG & Stewart GG. 2006. *Handbook of Brewing*. 2nd Ed. CRC.

Richard PV. 1981. *Commercial Wine Making - Processing and Controls*. AVI Publ.

Varnam AH & Sutherland JP. 1994. *Beverages: Technology, Chemistry and Microbiology*.

FST 634 GRAIN STORAGE TECHNOLOGY 2+1 (Minor)

Objective

Expose the students to the large scale handling and storage mechanism of grains, engineering operations and the control of physical, chemical and biological spoilage during storage of grains.

Theory

UNIT I (Lectures 7)

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

UNIT II (Lectures 7)

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

UNIT III (Lectures 7)

Grain storage – principles, moisture movement during bulk storage of grains, pressure distribution in storage bins, methods of aeration, various theories, Physical, chemical, microbiological and sensory changes occurring during storage, Grain storage structures - location and material selection for storage building, Types - traditional, modern; temporary and permanent storage structures; design considerations.

UNIT IV (Lectures 7)

Insects and pests – types, extent of losses during storage, causes and control measures, Insecticides- principles, scope of application in warehouses; requirements, group of active ingredients, choice, toxicity, resistance, application techniques, Fumigants - chemicals, areas of application, choice, toxicity, application rates, exposure time and resistance. Rodenticides - Types and effectiveness and limitations, important moulds and bacteria involved in spoilage of grains; effect on physico- chemical and sensory quality of grains; mycotoxins

UNIT V (Lectures 7)

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

Practical

Determination of bulk density, true density and porosity of grains, Determination of angle of repose and coefficient of friction, Measurement of water activity of grains, Study of designs of storage bins as per capacity requirement, Demonstration of fumigation of grains, Plotting of sorption isotherm and calculation of EMC, Assessment of weight loss due to insects by count and weight method, Detection of visible and hidden infestation of external and internal feeders, Computation of doses of insecticides in warehouse, Visit of commercial godowns, Identification of common storage insects.

FST 532 COMPUTER APPLICATIONS IN FOOD INDUSTRY 1+2 (Supporting)

Objective

Introduce the role of computerization in processing, particularly for communication, process and quality optimization, automation, simulation, designing and manufacture.

Theory

UNIT I (Lectures 10)

Importance of Computerization and IT in Food Industries Computers, operating environments and information systems for various types of food industries; Principles of Communication.

UNIT II (Lectures 12)

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

UNIT III (Lectures 12)

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

Practical

Applications of MS Excel to solve the problems of food technology: Statistical quality control, Sensory evaluation of food, and Chemical kinetics in food processing; Use of word processing software for creating reports and presentation; Familiarization with the application of computer in food industries -Milk plant, Bakery Units, Fruit & Vegetable processing Unit; Familiarization with software related to food industry; Ergonomics application in the same; Visit to Industry and case study problems on computer.

Suggested Readings

Gillett BE. *Introduction to Operation Research* (A Computer Oriented Algorithmic Approach).

Groover MP & Zimmers EW. *CAD/CAM: Computer Aided Design and Manufacturing*.

Singh RP. *Computer Applications in Food Technology*.

PGS 502 TECHNICAL WRITING AND COMMUNICATIONS 0+1 SKILLS (NCCC)

Objective

To equip the students/scholars with skills to write dissertations, research papers, etc.

To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical

Technical writing

Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

Communication skills

Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

Suggested Readings

Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language*. Abhishek, Chandigarh.

Chicago Manual of Style. 14th Ed. 1996. Prentice-Hall of India, New Delhi.

Collins' Cobuild English Dictionary. 1995. Harper Collins, New York.

Gibaldi, Joseph. 2000. *MLA Handbook for Writers of Research Papers*. 5th Ed. Affiliated East-West Press, New Delhi.

Hornby AS. 2000. *Comp. Oxford Advanced Learner's Dictionary of Current English*. 6th Ed. Oxford UP, Oxford.

Krishna Mohan 2005. *Speaking English Effectively*. Macmillan India, New Delhi.

Mills Gordon H & John A Walter. 1970. *Technical Writing*. 3rd Ed. Holt, Rinehart & Winston, New York.

PGS 503 INTELLECTUAL PROPERTY AND ITS MANAGEMENT 1+0 IN AGRICULTURE (e-Course) (NCCC)

Objective

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR), related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

Erbisch FH & Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI, Wallingford.

Ganguli, Prabudha. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill, New Delhi.

India, Ministry of Agriculture. 2004. State of Indian Farmer. Vol. 5. Technology Generation and IPR Issues. Academic Foundation, New Delhi.

Intellectual Property Rights: Key to New Wealth Generation.2001. NRDC and Aesthetic Technologies, New Delhi.

Rothschild, Max & Newman, Scott (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI, Wallingford.

Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya, Delhi.

The Indian Acts - Patents Act, 1970 & amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 & amendments; Layout Design Act, 2000; PPV & FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.

SEMESTER III

FST 606 FOOD ANALYSIS 0+2 (Major)

Objective

To develop an understanding and methodologies of instrumental techniques in food analysis used for objective methods of food quality parameters.

Practical

Texture analysis of foods, Colour measurements in raw and processed foods, Viscosity measurements and its significance in food quality, Water activity measurements and its significance in food quality, Techniques for dough rheology and starch characterization, Surface tension and its significance in food analysis, Enzymatic methods of food analysis, Microscopic techniques in food analysis (light microscopy, SEM, TEM, XRD, particle size analysis, image analysis etc.), Thermal methods in food analysis (Differential scanning calorimetry and others), Chromatographic methods in food analysis and separation, Extraction techniques in food analysis, Fluorimetric and polarimetric techniques in food analysis; Application and operating parameters of Spectrophotometer, AAS, GC, HPLC, NMR, FTIR, GC-MS, LC-MS.

Suggested Readings

- Clifton M & Pomeranz Y. 1988. *Food Analysis - Laboratory Experiments*. AVI Publ.
- Gruenwedel DW & Whitaker JR. 1984. *Food Analysis Principles and Techniques*. Vol. I. *Physical Characterization*. Marcel Dekker.
- Gruenwedel DW & Whitaker JR. 1984. *Food Analysis Principles and Techniques*. Vol. II. *Physicochemical Techniques*. Marcel Dekker.
- Gruenwedel DW & Whitaker JR. 1984. *Food Analysis Principles and Techniques*. Vol. III. *Biological Techniques*. Marcel Dekker.
- Gruenwedel DW & Whitaker JR. 1984. *Food Analysis Principles and Techniques*. Vol. IV. *Separation Techniques*. Marcel Dekker.
- Leenheer AP, Lambert WE & van Bocxlaer JF. 2000. *Modern Chromatographic Analysis of Vitamins*. 3rd Ed. Marcel Dekker.
- Nollet LML. 1986. *Handbook of Food Analysis*. Vol. I. Marcel Dekker.

FST 608 EQUIPMENT DESIGN AND PROCESS CONTROL 1+1 (Major)

Theory

UNIT I (Lectures 7)

Basic Scientific and Engineering principles of equipment design and process control, Properties of substances, chemical equation and stoichiometry, phases and phases rule, material and energy balances, energy balance and open system. Engineering properties of food materials and their significance in equipment design. Principles of CAD and its simple application.

UNIT II (Lectures 7)

Design of Vessels: Codes and regulations, Materials of construction, Design for pressures, Design pressure and temperature loadings, allowable stresses, minimum thickness after forming, corrosion mechanism, corrosion control, Design for internal and external pressure, cylindrical and spherical shell, formed heads, re-enforcement openings.

UNIT III (Lectures 7)

Design of food storage tank, horizontal and vertical silos, insulated and uninsulated, process plant piping: codes and regulations, testing, fabrication requirements, overall economic and safety considerations, heat exchangers: shell and tube heat exchangers, construction codes, general design considerations, clad tube sheet, plate type exchangers, air cooled heat exchangers, heat exchanger cost economics.

UNIT IV (Lectures 7)

Instrument terminology and performance system accuracy, flow sheet symbols, instrument evaluation, electrical, mechanical, magnetic and optical transducers for measurement of process variables like temperature, pressure, flow, level, consistency and humidity, indicating and recording devices: direct acting and servo operated systems, digital indicators, strip and circular chart recorders, electronic data loggers, principles of automatic process control.

UNIT V (Lectures 7)

Process characteristics, controller characteristics, closed loop system, pneumatic and electric controllers, final controlling elements, control valves, valve sizing, electronic actuators, motor drives and controls, introduction to programmable logic controllers (PLC): internal structure, inter facing with sensors and actuators, binary logic diagrams and ladder diagrams, choosing a PLC system.

Practical

Design of short, intermediate length and long cylindrical vessels, Design of spherical vessels, Design of shell and tube, double pipe, scarped surface and spiral tube heat exchangers, Design of jacketed vessels - insulation thickness, corrosion allowance, Study of various transducers for measurement of pressure, flow, level, humidity, temperature, Study of controller and recorder of pasteurizer, the working of controllers in constant temperature water baths, make ladder diagrams and flow sheet diagrams for control logics, Programme a PLC, design a computer interface of a PLC, visit a food processing plant to study data acquisition and process control system.

FST 533 BUSINESS MANAGEMENT & INTERNATIONAL TRADE 3+0 (Supporting)

Objective

To acquaint with techniques of Business Management & International Trade for food sector.

Theory

UNIT I (Lectures 8)

Concept and functions of marketing; concepts and scope of marketing management; concepts and elements of marketing mix.

UNIT II (Lectures 10)

Concept of market structure, micro and macro environments; Consumer behaviour; consumerism; Marketing opportunities- Analysis, marketing research and marketing information systems.

UNIT III (Lectures 10)

Market measurement- present and future demand; Market forecasting; market segmentation, targeting and positioning, Allocation and marketing resources, Marketing Planning Process, Product policy and planning: Product-mix; product line; product life cycle, New product development process. Product brand, packaging, services decisions. Marketing channel decisions, Retailing, wholesaling and distribution, Pricing Decisions, Price determination and pricing policy of milk products in organized and unorganized sectors of dairy industry, Promotion-mix decisions

UNIT IV (Lectures 10)

Advertising; how advertising works? Deciding advertising objectives, advertising budget and advertising message, Media Planning, Personal Selling, Publicity; Sales Promotion, Food and Dairy Products Marketing.

UNIT V (Lectures 10)

International Marketing and International Trade, Salient features of International Marketing, Composition & direction of Indian exports; International marketing environment; Deciding which & how to enter international market; Exports- Direct exports, indirect exports, Licensing, Joint Ventures, Direct investment & internationalization process, Deciding marketing Programme; Product, Promotion, Price, Distribution Channels. Deciding the Market Organization; World Trade Organization (WTO).

Suggested Readings

Chhabra T.N & Suria RK. 2001. *Management Process and Perspectives*. Kitab Mahal.
Jhingan ML. 2005. *International Economics*. 5th Revised and Enlarged Ed. Virnda Publ.
Kotler P. 2000. *Marketing Management*. Prentice-Hall.
Reddy SS, Ram PR, Sastry TVN & Bhavani ID. 2004. *Agricultural Economics*. Oxford & IBH.

**PGS 505 AGRICULTURAL RESEARCH, RESEARCH ETHICS 1+0
AND RURAL DEVELOPMENT PROGRAMMES (e-Course) (NCCC)**

Objective

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory

UNIT I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

UNIT II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

Bhalla GS & Singh G. 2001. *Indian Agriculture - Four Decades of Development*. Sage Publ.

Punia MS. *Manual on International Research and Research Ethics*. CCS, Haryana Agricultural University, Hisar.

Rao BSV. 2007. *Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives*. Mittal Publ.

Singh K. 1998. *Rural Development - Principles, Policies and Management*. Sage Publ.

PGS 506 DISASTER MANAGEMENT 1+0 (NCCC)

(e-Course)

Objective

To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Theory

UNIT I

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion

UNIT II

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

Suggested Readings

Gupta HK. 2003. *Disaster Management*. Indian National Science Academy. Orient Blackswan.

Hodgkinson PE & Stewart M. 1991. *Coping with Catastrophe: A Handbook of Disaster Management*. Routledge.

Sharma VK. 2001. *Disaster Management*. National Centre for Disaster Management, Indi

SEMSTER IV

Research Work / Thesis (0+20)