M.Sc in Food Science

SYLLABUS (2014-16)

CENTER FOR FOOD SCIENCE & TECHNOLOGY

SAMBALPUR UNIVERSITY

JYOTI VIHAR

Courses of Studies for the M. Sc Food Science & Nutrition Examination
(Under Course Credit Semester System)
Effective from First Semester Examination, 2014-15

FIRST SEMESTER

Course No.	Title	Credit Hour
FS. 411	Food and Food products	4 (Theory)
FS. 412	Food Microbiology	4 (Theory)
FS. 413	Food Chemistry	4 (Theory)
FS. 414	Basic Concepts of Nutrition	4 (Theory)
FS. 415	Practical related to 411&412	2 (Practical)
FS. 416	Practical related to 413&414	2 (Practical)
	Total	20

SECOND SEMESTER

Course No.	Title	Credit Hour
FS. 421	Food ingredients, Additives and Neutraceuticals	4 (Theory)
FS. 422	Techniques in Food Analysis	4 (Theory)
FS. 423	Food Safety and Quality Control	4 (Theory)
FS. 424	Food Processing and Preservation	4 (Theory)
FS. 425	Practical related to 421 & 422	2 (Practical)
FS. 426	Practical related to 423 & 424	2 (Practical)
	Total	20

THIRD SEMESTER

Course No.	Title	Credit Hour
FS. 511	Food Packaging and Post harvest Technology	4 (Theory)
FS. 512	Statistical Methods in Food Science	4 (Theory)
FS. 513	Food Biotechnology	4 (Theory)
FS 514	Elective Paper(Any one) (a) Beverages and Snacks Technology (b) Diary Technology (c) Food Engineering	4 (Theory)
FS 515	Practical related to all theory papers	2 (Practical)
FS. 516	Term paper/Review paper 2	
	Total	20

FOURTH SEMESTER

Course No.	Title	Credit Hour
FS. 521	Mid-Term Presentation (Dissertation)	2
FS 522	Final Dissertation & Viva-voice	12+2
FS. 523	Seminar	2
FS. 524	Industrial Tour Report	2
Total		20

Instruction to Paper Setters

1. In theory papers questions will be set unit-wise with 2 questions from each unit (total 8 questions).The students shall answer any one question from each unit.
2.60% of the questions shall be long-answered type and 40% short-answered

FIRST SEMESTER

Course No: FS. 411 Food and Food Products 4CH

UNIT-1

Cereals: Structure of cereal grains, composition, processing, nutritional value and storage of some common cereals (Rice, Wheat);Pulses: composition, nutritive value and storage of some common pulses(Bengal gram, Black gram, Horse gram, Green gram); Nuts & oil seeds: processing, nutritional value of some common nuts(Ground nut, Almond, Cashewnut),some common sources of oil (Ground nut, Sesame, Sunflower&mustard).

UNIT-II

Fruits: Composition, Processing, nutritive value, fruit ripening and storage of citrus fruits, processing of jam and jellies; Vegetables: Classification, composition, processing, nutritive value of some common vegetables; Spices: Composition, flavoring compounds, processing, nutritive value, adulteration of some common spices of India.

UNIT-III

Meat: Structure, composition, classification, nutritive value, tenderization and curing of meat; Poultry: composition, classification, nutritive value and processing; Egg:Structure, composition, classification, nutritive value and processing; Fish: composition, classification, nutritive value and processing.

UNIT-IV

Milk and milk products: composition, properties and nutritional importance of milk, processing of milk, study of some common milk products (cheese, ice cream, yoghurt); Beverages: processing of some common beverages (tea, coffee); Sugar and confectionary: composition, nutritive value, crystallization, caramellization, hydrolysis; Indian confectionary, Chikki: source of energy.

References:

1. Food Facts and Principles -N. ShakuntalaManay& M. Shadaksharaswamy, New Age International (P) Limited, New Delhi.
2. Food Science – B.Srilakshmi, New Age international (P) Limited, New Delhi.
3. Essentials of Food & Nutrition-M.Swaminathan-vol I &vol II.
4. Nutrition: An Integrated Approach- Pike & Brown
5. Principles of Nutrition E.D Wilson,K.H.Fisher&M.C.Faqua
6. Food Science- N.Potter&J.H.Hotchkiss- CBS Publishers & Distributors, New Delhi.
7. Encyclopedia of Food Science(1-3 volume) Anmol Publications.

Course No: FS. 412 Food Microbiology 4CH

UNIT-1

Introduction to food Microbiology: Growth and survival of microorganisms in foods (Yeast, Mould, Bacteria) ;Spoilage organism of milk, fruits, vegetables, grains, oilseeds, meat and poultry Factors affecting growth of microorganism: Intrinsic, Extrinsic; Physical and chemical methods to control microorganisms.

UNIT-II

Biochemical changes caused by microorganisms; microbes in food fermentation, putrefaction, lipolysis; Antagonism and synergism in microorganism; Microbiology of food preservation: heat processing, irradiation, high pressure processing, low temperature storage, chemical preservatives, modification of atmosphere and control of water activity

UNIT-III

Food hygiene and sanitation:Food poisoning and food borne illness (Bacterial& non-bacterial), and their control. Contamination during handling and processing and its control; Method for microbial examination of food: indicator organisms, direct examination, cultural techniques, Rapid methods in detection of microorganisms.

UNIT-IV

Food Fermentations;Microbes in foodfermentation: yeast, lactic acid bacteria and mould ;Fermented foods based on milk, meat and vegetables (yoghurt, sauerkraut, tofu, temphe, vinegar, soyasaus and others); Probiotics and prebiotics and concept of synbiotics

References:

1. Food Microbiology – M.R.Adams&M.O.Moss, New Age International (P) Limited, New Delhi.

2. Food Facts and Principles -N. ShakuntalaManay& M. Shadaksharaswamy, New Age International (P) Limited, New Delhi.
3. Food Science – B.Srilakshmi, New Age international (P) Limited, New Delhi.
4. Food Microbiology – William C.Frazier, Tata McGraw Hill publishing Company limited, New Delhi.
5. Food processing and Preservation – G. Subhalakshmi&Shobha A. Udipi, New Age International (P) Limited, New Delhi.
6. General Microbiology – Power &Daginawala, Himalaya Publishing House, Mumbai. (vol-II)
7. Basic Food Microbiology – G. Banwart, CBS Publishing & Distributors.
8. Modern Food Microbiology – Jay, James, Aspen publishers.
9. Microbiology- M.I.Pelezar&R.D.Reid McGraw Hill Book Company, New York.
10. Food Hygiene & Sanitation – S.Roday- Tata McGraw Hill, New Delhi.
11. Food Science- N.Potter&J.H.Hotchkiss- CBS Publishers & Distributors, New Delhi.
12. A first course in food analysis: A.Y.Sathe, New Age International (P) Ltd Publishers.
13. Food poisoning & food hygiene: Hobbs &Giebert& Edward, Anmol Publications.
14. Modern Food Microbiology: J.M.Hay, CBS Publications & Distributions.
15. Food Adulteration: S.C.Wason.
16. Nutritional & toxicological aspects of food processing; Eds Walker &Walker &Quattrucci, E Toy loss & Francis, New York.
17. Food Hazards & Food Hygiene- S.Yadav.
18. Toxicological aspects of food: Eds. Miller Elsevier -scientific publications.
19. Food Quality Assurance: AVI Publications, W.A.Gould.
20. Quality control in food industry: Food science & technology: A series of monographs, Academy Press, London.
21. Food Analysis: Theory & practice-Y. Pomeranz&C.E.MeLoan, CBS Publications & Distributaries, New Delhi.

Course No: FS. 413 Food Chemistry 4CH

UNIT-1

Water: physical properties, structure of water molecule, types, water activity in food industry, effect of water on food storage, water activity in food packaging, importance of water in food industry; Vitamins: classification, fat soluble and water soluble vitamins; Minerals: types, nutritive value of minerals; Enzymes: properties, classification, kinetics and mechanism.

UNIT-II

Amino acids and its classification, essential amino acids; Proteins: properties, classification, structure of proteins (primary, secondary, tertiary), protein denaturation, Biosynthesis of proteins, protein function.

UNIT-III

Carbohydrates: classification and chemical structure of carbohydrate; chemical properties, chemical reactions, nutritive roles of carbohydrate, important carbohydrates(glucose, starch, agar, glycogen, PVP, pectindextran); Lipid: role of lipid, fatty acids, oil, fats, waxes their physiochemical properties, structure and classification of lipids.

UNIT-IV

Metabolism: metabolic pathways, regulation of metabolic pathways, metabolism of carbohydrates, glycolysis, formation of pyruvate, citric acid cycle; metabolism of lipids: oxidation of fatty acids, urea cycle, role of hormones and vitamins in metabolism

References:

1. Belitz&Grosch.,Food Chemistry, Springer.
2. Aurand, L.W. and Woods, A.E. 1973. Food Chemistry. AVI, Westport.
3. Birch, G.G., Cameron, A.G. and Spencer, M. 1986. Food Science, 3rd Ed. PergamonPress, New York.
4. Fennema, O.R. Ed. 1976. Principles of Food Science: Part-I Food Chemistry. Marcel Dekker, New York.
5. Meyer, L.H. 1973. Food Chemistry. East-West Press Pvt. Ltd., New Delhi.Potter, N.N. 1978. Food Science. 3rd Ed. AVI, Westport.
5. Bamji MS, Rao NA & Reddy V. 2003. *Textbook of Human Nutrition*.Oxford& IBH.
6. Belitz HD.1999. *Food Chemistry*. Springer Verlag.DeMan JM. 1976. *Principles of Food Chemistry*. AVI.
7. Fennema OR.1996. *Food Chemistry*. Marcel Dekker.
8. Meyer LH. 1987. *Food Chemistry*. CBS.
9. Swaminathan M. 1974. *Essentials of Foods and Nutrition*. Vol. II. Ganesh& Co.
10. Joslyn, M.A. Ed. 1970. Methods in Food Analysis. Academic Press, New York.
11. King, R.D. Ed. 1978. Developments in Food Analysis Techniques-1. Applied Science Publishers Ltd., London.

12. Morris, C.J. and Morris, P. 1976. Separation Methods in Biochemistry 2nd Ed. PitmanPub., London.
13. Plummer, D.T. 1971. An Introduction to Practical Biochemistry. Mc-Graw Hill Pub.Co., New York.
14. Raghuramulu, N., Madhavan Nair, K., and Kalyanasundaram, S. Ed. 1983. A Manual of Laboratory Techniques. National Institute of Nutrition, ICMR, Hyderabad.
15. AOAC International. 2003. *Official methods of analysis of AOACInternational*. 17th Ed. Gaithersburg,MD,USA, Association ofAnalytical Communities.
16. Kirk RS & Sawyer R. 1991. *Pearson's Chemical Analysis of Foods*. 9th Ed.Longman Scientific & Technical.
17. Leo ML. 2004. *Handbook of Food Analysis*. 2nd Ed. Vols. I-III.
18. Linden G. 1996. *Analytical Techniques for Foods and Agricultural Products*. VCH.
19. Macleod AJ. 1973. *Instrumental Methods of Food Analysis*. Elek Sci.Marcel Dekker.
20. Nielsen S. (Eds.). 1994. *Introduction to Chemical Analysis of Foods*. Jones & Bartlett.
21. Pomrenz Y &Meloan CE. 1996. *Food Analysis - Theory and Practice*. 3rdEd. CBS.
22. Ranganna S. 2001. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*. 2nd Ed. Tata-McGraw-Hill.
23. Robinson JW. 1970. *Undergraduate Instrumental Analysis*. Marcel Dekke

Course No: FS. 414 Basic Concepts of Nutrition 4CH

UNIT-1

Food as a source of nutrients: classification of nutrients; functions, recommended dietary allowances, sources, and effect of deficiency of macro nutrients (carbohydrate, fats and proteins).& micro nutrients (Vitamins & Minerals); (A, B complex, C,D,E & K)& all mineral elements , importance of water & Roughages in the diet.Water & electrolytes balance.

UNIT-II

Nutritional Needs: Nutrition during infancy, childhood, adolescence and adult, nutrition during pregnancy& lactation, nutrition in later maturity period, nutrition and infection, nutrition and immunity, nutrition & stress.

UNIT-III

Nutritional Assessment: Assessment of nutritional status by direct & indirect methods, use of various methods for the assessment of nutritional status, anthropometric assessment, clinical examination, bio-physical or radiological measurement, functional assessment, laboratory &biochemical assessment, dietary assessment, vital health statistics.

UNIT-IV

Nutritional problems: food intake and its regulation, food pattern, population and food production, malnutrition, background problem of malnutrition in India ecology of malnutrition, effect of malnutrition on vulnerable society, impact of malnutrition on national development, major to combat malnutrition, national nutrition policy and programmes, National and International agencies in combating malnutrition.

References:

1. Human Nutrition and Dietetics – S. Davidson & R. Passmars.
2. Normal and Therapeutic Nutrition – C.H. Robinson, Oxford & IBH Publishing Co. Calcutta.
3. Essentials of Food and Nutrition – M. Swaminathan, vol. I & II, The Bangalore printing and Publishing Co. Ltd.
4. Human Nutrition and Dietetics – Davidson, Passmore, East wood, English Language Book Society (ELBS).
5. Nutrition and Dietetics – S.A.Joshi; Tata McGraw-Hill Publishing Company Limited, New Delhi.
6. Nutrition an Integrated approach – Pike and Brown
7. Dietetics – B.Srilakshmi; New age International (P) Limited, New Delhi.
8. Nutrient Requirements and Recommended Dietary Allowances for Indians – Indian Council of Medical Research, National Institute of Nutrition, Hyderabad.
9. Text Book of Human Nutrition – Mahtab. S. Bamji; N.Pralhadrao&Vinodini Reddy, Oxford & IBH Publishing Co. Pvt.Ltd
10. Principles of Nutrition – Fisher and Fuqua, wiley eastern Private Limited, New Delhi.

Course No: FS. 415 Practical related to 411&412 2CH

Course No: FS. 416 Practical related to 413&414 2CH

SECOND SEMESTER

Course No: FS. 421 Food Ingredients, Additives & Nutraceuticals 4CH

Unit-1

Properties of foods: Physical properties(solutions, vapor pressure, boiling point, freezing point, osmotic pressure, viscosity, surface and interfacial tensions, specific gravity),Acids, Bases and Buffers, chemical bond, colloids; Food preparation: Objective and method of cooking, cooking media, changes in cooking, microwave cooking, solar cooking;

UNIT-II

Food pigments and colors: Some common pigments used in food industry (chlorophylls, flavonoids, synthetic colors, carotenoids& others); Flavors: types of flavor, flavor compounds, extraction principles of flavor, smell sensation, texture sensation, visual appearance, sensation of taste.

UNIT-III

Food additives: definition, need and classification of food additives, preservatives, antioxidants, chelating agents, coloring agents, curing agents, Emulsions, flavors and flavor enhancers, leavening agents, nutritional supplements, non-nutritive sweeteners, pH control agents, stabilizer and thickeners, humecants&anti-caking agents, acidulants, buffering salt etc -chemistry, food uses; Indirect food additives , additives and food safety.

UNIT-IV

Nutraceuticals and phytochemicals: definition.Nutraceuticals in controlling diseases. Natural occurrence of certain photochemicals .Antioxidants and flavonoids: omega – 3 fatty acids, carotenoids, dietary fiber, phytoestrogens; Dosage for effective control of disease or health benefit with adequate safety. Care in handling and storage of raw materials with minimal damage to sensitive bioactive compounds; extractive methods for maximum recovery and minimal recovery and minimal destruction of active material.

References:

1. Food Facts and Principles -N. ShakuntalaManay& M. Shadaksharaswamy, New Age International (P) Limited, New Delhi.
2. Branen AL, Davidson PM &Salminen S. 2001. *Food Additives*. 2nd Ed.Marcel Dekker.
3. Gerorge AB. 1996. *Encyclopedia of Food and Color Additives*. Vol. III.CRC Press.
4. Gerorge AB. 2004. *Fenaroli's Handbook of Flavor Ingredients*. 5th Ed.CRC Press.
5. Madhavi DL, Deshpande SS &Salunkhe DK. 1996. *Food Antioxidants:*
6. *Technological, Toxicological and Health Perspective*. MarcelDekker.
7. Morton ID & Macleod AJ .1990. *Food Flavours*. Part A, BC. Elsevier.
8. Nakai S &Modler HW. 2000. *Food Proteins. Processing Applications*.Wiley VCH.
9. Stephen AM. (Ed.). 2006. *Food Polysaccharides and Their Applications*.Marcel Dekker.

Course No: FS. 422 Techniques in Food Analysis 4CH

UNIT-1

Basic instrumentation: Basic calculation for solution preparation and buffer, Principle of sensor (pH meter), Dialysis, ultra filtration, Reverse osmosis. Centrifugation: Principle, Theory (RCF, Sedimentation coefficient) and types. Calorimetry: Bomb calorimeter, differential scanning calorimeter.

UNIT-II

Separationtechnique & analysis: Electrophoresis:Paper & gel electrophoresis, PAGE, isoelectricfocusing,2D electrophoresis, Immuno electrophoresis Chromatography: Theory & Principle, chromatographic parameter(partition coefficient, capacity factor, retention & dead time,
Resolution& their calculation),components of chromatography & types (paper, thin layerpartition) Advance chromatography:GC,HPLC,HPTLC(principle, instrumentation &application).

UNIT-III

Spectroscopic analysis of food components, Principle, instrumentation & application of Colorimetric (colorimeter,colourflex), UV-Vis spectrophotometer, Spetroflurometer, IR,NMR, Mass spectroscopy.

UNIT-IV

Isotopic &immune techniques: Principle & theory of isotopic method, types, measurement &detection of radioactivity, Autoradigraphy, Immuno-techniques, Principle, antigen-antibody interaction, enzymatic immune assay, Different immuno techniques of antigen detection in food sample.

References:

1. Bioinstrumentation by .Veerakumari,
2. Biochemical & Molecular biology techniques. byWilson& Walker,
3. Food Chemistry, Aurand, L.W. and Woods, A.E. 1973.AVI, Westport.
4. Food Science, Birch, G.G., Cameron, A.G. and Spencer, M. 1986.3rd Ed. PergamonPress, New York.
5. Principles of Food Science: Part-I Food Chemistry. Fennema, O.R. Ed. 1976 Marcel Dekker, New York.
6. Food Chemistry. Meyer, L.H. 1973.East-West Press Pvt. Ltd., New Delhi.
7. Food Science. 3rd Ed Potter, N.N. 1978. AVI, Westport.
8. *Textbook of Human Nutrition*. Bamji MS, Rao NA & Reddy V. 2003 Oxford & IBH.
9. *Food Chemistry*. Belitz HD.1999 Springer Verlag.
10. *Principles of Food Chemistry*. DeMan JM. 1976 AVI.
11. *Food Chemistry*. Fennema OR.1996Marcel Dekker.
12. *Food Chemistry*. Meyer LH. 1987.CBS.
13. *Essentials of Foods and Nutrition*. Vol. II. Swaminathan M. 1974 Ganesh& Co.
14. Methods in Food Analysis. Joslyn, M.A. Ed. 1970.Academic Press, New York.
15. Developments in Food Analysis Techniques-1. Applied Science King, R.D. Ed. 1978Publishers Ltd., London.
16. Separation Methods in Biochemistry 2nd Ed Morris, C.J. and Morris, P. 1976. PitmanPub., London.
17. An Introduction to Practical Biochemistry. Plummer, D.T. 1971Mc-Graw Hill Pub.Co., New York.
18. A Manualof Laboratory Techniques. Raghuramulu, N., Madhavan Nair, K., and Kalyanasundaram, S. Ed.1983.National Institute of Nutrition, ICMR, Hyderabad.

Course No: FS. 423 Food Safety and Quality Control 4CH

UNIT-1

Concept of quality: quality attributes: physical, chemical, nutritional and microbial evaluation and measurement, Sensory evaluation: objective, type, application and limit; Objective evaluation: basic guidelines, physiochemical method, microscopic examination and physical method; Instruments used for quality assessment.

UNIT-II

Food adulteration: common adulterant in food (milk and milk products, edible oils, cereals&pulses, prepared foods, spices, beverages); simple screening, control of food adulteration

UNIT-III

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; Food Safety and Standards Act, 2006

UNIT-IV

Assessment of toxicity of evaluation of limits of contaminants in contexts of food safety; general food safety tips (personal hygiene, water quality, preparation and storage of food); food shopping, eating out in restaurant and dhaba, high risk food.

References:

1. Subash. C Jain, International Marketing, 6th edition.
2. Varshney, R.L and Bhattacharya, B International markaetying management and Indian perspective, Sultan chand and sons, New Delhi.
3. Kohler P, Keller K.L, Koshy A, Jha M, 13th edition 2009, Marketing Management- A South Africa Perspective, Pearson Education, New Delhi.
4. Ramaswamy, V.S and Namakumari ,S.; 4th edition Marketing Manangement –Global Perspective- Indian Content, McMillan Publishers India Ltd, New Delhi.
5. Saxena, Rajan, 3rd edition; Marketing management, Tata McGraw Hill Publishing Company Ltd, New Delhi

Course No: FS. 424 Food Preservation and Processing 4CH

UNIT-1

Basic concept of food processing and preservation: food spoilage &deterioration (microbial spoilage, food enzymes, biotic factors, Abiotic factors); Scope of food processing preservation; principles of food processing and preservation; National and international perspectives. Principle and preservation by low temperature: refrigeration, freezing, CA, MA and dehydro freezing; cold storage, freeze drying: frozen food, processing and preservation by drying: concentration and evaporation and types of dryer and their suitability

UNIT-II

Processing and preservation by heat: (blanching, pasteurization, sterilization, UHT processing, heating, dehydration, canning, microwave heating, baking, roasting, frying, extrusion cooking, dielectric heating,)

UNIT-III

Processing and preservation by non-thermal method : irradiation , high pressure,pulsed electric field,high hydrostatic pressure, Hurdle technology: concept of hurdle technology and its application, Ultrasonic processing: Properties of ultrasonic, application of ultrasonic as processing techniques, GRAS and permissible limits for chemical preservatives, ohmic heating, IR heating; Vacuum drying

UNIT-IV

Uses of enzymes and microorganisms in processing and preservation of foods: food fermentation (lactic acid fermentation & alcoholic fermentation), pickling, smoking, ultrafiltration and reverse osmosis role of enzymes and microorganism in food preservation.

References

1. Arsdel WB, Copley MJ & Morgan AI. 1973. *Food Dehydration*. 2nd Ed. Vols. I, II.AVI Publ.
2. Desrosier NW & James N.1977. *Technology of Food Preservation*. 4th Ed. AVI. Publ.
3. Fellows PJ. 2005. *Food Processing Technology: Principle and Practice*. 2nd Ed. CRC.
4. Jelen P. 1985. *Introduction to Food Processing*. Prentice Hall.

Course No: FS.425Practical related to 421&422 2CH

Course No: FS.426Practical related to 423&424 2CH

THIRD SEMESTER

Course No: FS. 511 Food Post-harvest Technology and Food Packaging 4CH

UNIT-1

Post harvest Technology: Importance, principles & scope of post harvest treatments, value-addition, and traceability; Post harvest technology for cereals, legumes, oilseeds and spices (cleaning, grading, milling), Hydrothermal treatment & conditioning of grains, Modern paddy and wheat parboiling-systems, equipment, Advances in heat transfer and fluid flow in grain processing operations. Crop drying methods/systems and Crop dryers-selection, design and testing.

UNIT-II

Post-harvest of fruits & Vegetables: physiological and biochemical changes in fruits and vegetables; ripening of climacteric and non-climacteric fruits. Physiological post harvest disorders - chilling injury and disease; prevention of post harvest diseases and infestation; Handling and packaging of fruits and vegetables; factors affecting post harvest losses; Standards and specifications for fresh fruits and vegetable.

UNIT-III

Food packaging: Packaging material, packaging system and methods- vacuum packaging, gas flush packaging, aseptic packaging, modified atmosphere packaging (MAP), controlled atmosphere packaging (CAP), active packaging ,retort pouch technology Packages of radiation stabilized foods, microwave packaging, bio-degradable packages, aseptic and edible package.

UNIT-IV

Packaging Fresh and Processed Food: Packaging requirement for different foods and processing methods-Types, varieties, and trends; protective packaging of foods; packaging of food products sensitive to oxygen, light, moisture; special problems in canned foods; packaging of convenience foods; packaging of food products-fruits and vegetables; packaging requirements of fresh fruits and vegetables; packaging of fruit juices, spices, meat & poultry, fish, seafood; criteria for selection of proper packaging based on the shelf life desired, diary product, beverages, cake and snacks food.

References:

1. Kadar AA.1992. *Post-harvest Technology of Horticultural Crops*. 2nd Ed. Universiity of California.
2. Lal G, Siddapa GS &Tandon GL.1986. *Preservation of Fruits and Vegetables*. ICAR.
3. Pantastico B. 1975. *Post Harvest Physiology, Handling and Utilization of Tropical and Subtropical Fruits and Vegetables*. AVI Publ.
4. Salunkhe DK, Bolia HR & Reddy NR. 1991. *Storage, Processing and Nutritional Quality of Fruits and Vegetables*. Vol. I. *Fruits and Vegetables*. CRC.

5. Thompson AK. 1995. *Post Harvest Technology of Fruits and Vegetables*. Blackwell Sci.
6. Verma LR. & Joshi VK. 2000. *Post Harvest Technology of Fruits and Vegetables*. Indus Publ.
7.Robertson, G.L. Food Packaging: Principles and Practice (2nd ed.), Taylor & Francis 2006
8. Parry R. T. and Blakistone B. A. Principles & Applications of MAP –Springer, New York, 1999
9. Food Packaging Technology Handbook. NIIR Board, National Institute of Industrial Research, 2003
10. Ahvenainen, R. (Ed.) Novel Food Packaging Techniques, CRC Press, 2003
11. Han, J.H. (Ed.) Innovations in Food Packaging, Elsevier Academic Press, 2005
12. Coles, R., McDowell, D. and Kirwan, M.J. (Eds.) Food Packaging Technology, CRC Press, 2003

Course No: FS. 512 Statistical Methods in Food Science 4CH

UNIT-1

Fundamentals of statistics:Research process, experimental research design,Variables, Primary and secondary data, Collection of data, Classification and tabulation of data, Need and usefulness of Diagrams & Graphs, Different types of diagrams and graphs. Frequency distribution*:* Discrete and continuous frequency distribution, population & sample, sampling methods, sampling errors

UNIT-II

Descriptive statistics: Measure of central tendency: (Arithmetic mean, mean ,median, mode), relation between mean median and mode ;Measure of dispersion:Range,Mean deviation & Standard deviation;Skewness and Kurtosis .

UNIT-III

Theoretical Probability Distribution: Binomial, Poisson and normal distribution; Testing of Hypothesis: Null and Alternative Hypothesis, level of significance, Student't' distribution and its application, Chi-square(x^2) test & its application, 'f' test and its application.

UNIT-IV

Correlation, Regression and ANOVA analysis: Types of correlation; simple, partial and multiple correlation, Method of study & testing the significance of correlation coefficient, Rank Correlation, Regression analysis: regression equations and regression lines, Properties of regression lines, regression coefficient, testing the significance of regression coefficient. Analysis of variance (ANOVA): One way and two way classification and their applications.

References:

1. Statistical Methods – S.P.Gupta, Sultan Chand & Sons Publisher- New Delhi
2. Research Methodology, Methods and Techniques – C.R. Kothari Wiley Eastern Limited – New Delhi
3. Elements of Statistics, Theory & Practice – M.Singhal. Lakshmi Narain Agarwal, Educational Publisher – Agra
4. An Introduction to Statistical Methods – C.B.Gupta&V.Gupta- Vikas Publishing House PVT Ltd. New Delhi.
5. Methodology and Techniques of Social Research – P.L.Bandarkar&T.S.Wilkinson –Himalaya Publishing House- Mumbai.
6. Research Methods & Measurements in Behavioural& Social Sciences – G.L.Bhatnagar – Agri. Cole. Publishing Academy, New Delhi.
7. Statistics in Psychology & Education – Henry, E. Garett, David Heley and Co.
8. Experimental Design in Psychological Research – Edwards
9. The Quality of Life: Valuation in social Research – R.Mukherjee – Sage publications, New Delhi
10. Fundamentals of Statistics- D.N.Elhance.
11. Statistics in Psychology & Education-Garrett & Word.
12. Research Method in Behavioural Science-S.M.Mohsin.
13. Methodology of Research-Kulbir Singh Sidhu
14. Zar,Jerrold H.(1998).BiostatisticalAnalysis.PrenticeHal,NJ.
15. Walpole,R and R.Myres(1993).statistics for engineers and scientists,5thedn. Mac Millan,N.Y
16. Wayne,R.ott(1995).Environment statics and data ananlysis.CRC Press.
17. Manly (2001) statics for environment science and management,chapman and hall/CRC.

Course No: FS. 513 Food Biotechnology 4CH

UNIT-1

Basic tools of r-DNA technology: Restriction endonuclease and DNA ligase, cloning vectors,cloning of foreign DNA, screening of recombinant clone, DNA fingerprinting, PCR technology, DNA sequencing technique, gene transfer methods in plant and animal cells

Trangenics for food production: Development and current status of transgenic crops for: crop improvement and enhanced agronomic performance; food products with enhanced shelf-life; processing and functional quality; nutritional enhancement macro and micro nutrient; molecular farming, plant vacancies and antibodies

UNIT-II

Basic concepts of Bioprocess Technology: Up stream processing, Bioreactor and its operation, optimization of process, scale-up; downstream processing, separation and purification.

Application of enzymes in food processing: enzyme catalyzed bioprocess, enzymatic bioconversions e.g-starch and sugar conversion processes, inter-esterified fat,hydrolysed protein etc. and their downstream processing; baking by amylases; de-oxygenation and de-sugaring by glucose oxidase; beer mashing and chill proofing; cheese production and processing.

UNIT-III

Microbes in food process operations and production: fermentation as a method of preparing and preserving foods; fermented foods and beverages; food ingredients,flavors,colors and additives prepared by fermentation and their purification; microbes and their use in pickling; producing colors and flavors; bioconversion of waste whey, molasses, starch substrates and other food wastes to useful products; bacteriocins from lactic acid bacteria-production and application in food preservation.

UNIT-IV

Biotechnology applications in functional foods: SCP; lipid based nutraceuticals (polar lipid, PUFA) protein-polysaccharides,functional food production- dietary fiber, food gum, emulsifier & surfactant, artificial butter, flavoring agent, alternative sweetener,antioxidants

Safely assessment of genetically modified foods: International and national guidelines; regulations& safely issues related to production, consumption, import/export and labeling of GM foods.Ethical issues concerning GM foods; testing for GMOs; IPR.GMO Act 2004.

References:

1- Bains W.1993.Biotechnology from A to z. Oxford Univ.Press

2- Joshi VK and Pandey A.1999.Biotechnology: Food fermentation.vol.1,2.Eduction publ.

3- Knorr D.1982.Food Biotechnology. Marcel Dekker.

4- Lee BH.1996.Fundamentals of Food Biotechnology.VCH

5- Perlman D.1977-1979.Annual Reports of fermentation processes.

6- Percott SC and Dunn CG.1959.Industrial Microbiology.McGraw Hill.

7- Ward.OP.1989.Fermentaion Biotechnology.Prentice Hall.

Course No: FS. 514 Elective Paper (Any one) 4CH

Beverages and snacks food technology (A)

UNIT-1

Types of beverages and their importance; 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. Specialty beverages based on cocoa, spices, dairy and imitation dairy-based beverages.

UNIT-II

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, wine and related beverages, distilled spirits .Packaged drinking water- definition, types, manufacturing processes, quality evaluation and raw and processed water, methods of water treatment, BIS quality standards of bottled water; flavored water, carbonated water.

UNIT-III

Technology for grain-based snacks: whole grains – roasted, toasted, puffed, popped and flakes, coated grains-salted, spiced and sweetened; flour based – batter and dough based products; *savoury* and *farsans*; formulated chips and wafers, papads, instant premixes of traditional Indian snack foods.

UNIT-IV

Technology for fruit and vegetable based snacks: Chips, wafers; Technology for coated nuts – salted, spiced and sweetened; Extruded snack foods: Formulation and processing technology, colouring, flavouring and packaging.Equipments for frying, Baking and drying, toasting, roasting and flaking, popping, blending, Coating, chipping.

References:

1. Edmund WL. *Snack Foods Processing*. AVI Publ.
2. Frame ND .1994.*The Technology of Extrusion Cooking*. Blackie Academic.
3. Gordon BR.1997 *Snack Food*.AVI Publ
4. Samuel AM.1976. *Snack Food Technology*. AVI Publ.
5. Hardwick WA. 1995. *Handbook of Brewing*. Marcel Dekker.
6. Hui YH. *et al* 2004. *Handbook of Food and Beverage Fermentation Technology*. Marcel Dekker.
7. Priest FG & Stewart GG. 2006. *Handbook of Brewing*. 2nd Ed. CRC.
8. Richard P Vine. 1981. *Commercial Wine Making - Processing and Controls*. AVI Publ.
9. Varnam AH & Sutherland JP. 1994. *Beverages: Technology, Chemistry and Microbiology*. Chapman & Hall.
10. Woodroof JG & Phillips GF.1974. *Beverages: Carbonated and NonCarbonated*. AVI Publ.

Diary Technology (B)

UNIT-1

Present status of milk & milk products in India and Abroad; market milk- Composition of milk of various species, quality evaluation and testing of milk, procurement, transportation and processing of market milk, cleaning & sanitization of dairy equipments. Special milks such as flavoured, sterilized, recombined & reconstituted toned & double toned.

UNIT-II

Condensed milk- Definition, methods of manufacture, evaluation of condensed & evaporated milk; dried milk- Definition, methods of manufacture of skim & whole milk powder, instantiation, physiochemical properties, evaluation, defects in dried milk powder.

UNIT-III

Cream- Definition, classification, composition, cream separation, sampling, neutralization, sterilization, pasteurization & cooling of cream, evaluation, defects in cream; Butter- Definition, composition, classification, methods of manufacture, theories of churning, evaluation, defects in butter. Ice cream- Definition, composition and standards, nutritive value, classification, methods of manufacture, evaluation, defects in ice cream, and technology aspects of softy manufacture.

UNIT-IV

Cheese: Definition, composition, classification, methods of manufacture, cheddar, Gouda, cottage and processed cheese, evaluation, defects in cheese.Indigenous milk products - Present status, method of manufacture of *yoghurt, dahi, khoa, burfi, kalakand, gulabjamun, rosogolla, srikhand, chhana, paneer, ghee, lassi*etc; probiotic milk products.

References:

1. Aneja RP, Mathur BN, Chandan RC & Banerjee AK. 2002. *Technology of Indian Mil Products*. Dairy India Publ.
2. Dey. S.1980. *Outlines of Dairy Technology*. Oxford Univ. Press. New Delhi
3. Henderson JL. 1971. *Fluid Milk Industry*. AVI Publ.
4.Rathore NS *et al.* 2008. *Fundamentals of Dairy Technology - Theory & Practices*. HimanshuPubl
5. Spreer E. 1993. *Milk and Dairy Products*. Marcel Dekker.
6.Walstra P. 1999. *Dairy Technology*. Marcel Dekker.
7. Walstra P. (Ed.). 2006. *Dairy Science and Technology*. 2nd Ed. Taylor &Francis.
8. Web BH, Johnson AH &Lford JA. 1987. *Fundamental of DairyChemistry*. 3rd Ed. AVI Publ.
9. Considine, D.M. Ed. 1982. Foods and Food Production Encyclopaedia, VNR, NewYork.
10. MaCrae, R., Robinson, R.K. and Sadler, M.J. Ed. 1993. Encyclopedia of Food Science, Food Technology and Nutrition Academic Press, London.
11. Robinson, R.K. (2 vol. set). 1986. Modern Dairy Technology Elsevier Applied Science,UK.
12.Rosenthal, I. 1991. Milk and Milk Products. VCH, New York.

13. Warner, J.M. 1976. Principles of Dairy Processing. Wiley Eastern Ltd. New Delhi.
14. Yarpar, WJ. and Hall, C.W. 1975. Dairy Technology and Engineering AVI, Westport.

Food Engineering (c)

UNIT I

Introduction to food engineering & processes: principles of thermodynamics and heat transfer applied to food engineering;. Engineering properties of foods (electrical, Optical, Frictional, Aerodynamic, Rheology, Physical), their significance in equipment design, processing and handling.

UNIT-II

Process Heat Transfer – Thermal properties of food, Modes of heat transfer and overall heat transfer; Fourier's law, steady state and unsteady state conduction; heat exchange equipment; energy balances; rate of heat transfer; thermal boundary layer; heat transfer by forced convections; heat transfer to flat plate and in non Newtonian fluids; heat transfer in turbulent flow; heating and cooling of fluids in forced convection outside tubes

UNIT III

Mass transfer, molecular diffusion and diffusivity, Fick_s law, diffusion in solids, liquids and gases equilibrium stage process, convective mass transfer co-efficient, mass transfer with laminar and turbulent flow. Heat and mass transfer analogy Design equations for convective mass transfer, simultaneous momentum; Application of mass transfer in food processing.

UNIT IV

Refrigeration system; components, refrigerants types, cooling load estimation, refrigeration design and application in food processing., Food chilling and freezing – Precooling and cold storage, freezing point depression; general introduction to enthalpy change during freezing; Plank's equation for predicting rates of product freezing; Cryogenic freezing and IQF.

References:

1. Sahay KM & Singh KK. 1994. *Unit Operation of Agricultural Processing*. Vikas Publ. House.
2. Heldman DR & Singh RP.1995. *Food Process Engineering*. AVI Publ.
3. Rao.D.G,Fundamentals of food engg,PHIpubl
4. Batty, J.C. and Folkman, S.L. 1983. Food Engineering Fundamentals. John wileyandSons, New York.
5. Fennema O.R. Ed. 1985, Principles of Food Science: Part-II Physical Principles of food Preservation. Marcel Dekker, New York.
6. Harper, J.C. 1975. Elements of Food Engineering. AVI, Westport.
7. Heldman, D.R. and Lund, D.B. Ed. 1992. Handbood of Food Engineering marcel,Dekker, New York.
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9. Charm SE, McCabe WL, Smith JC &Harriott P.1993. *Unit Operations ofChemical Engineering*. McGraw Hills.

Course No: FS. 515	**Practical related to all the theory papers**	**2CH**
Course No: FS. 516	**Term paper**	**2CH**

FOURTH SEMESTER

Course No: FS. 521	**Mid-Term Presentation(Dissertation)**	**2CH**
Course No: FS. 522	**Final Dissertation & Viva Voce**	**12+2CH**
Course No: FS. 523	**Seminar**	**2CH**
Course No: FS. 524	**Industrial Tour Report**	**2CH**