1 DEPARTMENT OF CHEMICAL ENGINEERING M.TECH. (FOOD PROCESSING TECHNOLOGY) PROGRAMME (FULL TIME AND PART TIME) Choice Based Credit System (CBCS) REGULATIONS AND SYLLABUS R1.CONDITION FOR ADMISSION Candidates for admission to the first year of the 4 semesters M.TECH.(Food Processing Technology) Degree in the Chemical Engineering Department shall be required to have passed B.E. Chemical Engineering, B.Tech (Biotechnology / Biochemical Engineering / Agricultural Engineering), B.Sc (Agri)., B.Pharm or M.Sc (Biotechnology / Biochemistry / Microbiology / Botany / Nutrition / Biology / Genetics) or graduates of any other University accepted by the syndicate of Annamalai University as equivalent thereto. They shall satisfy the conditions regarding qualifying marks, age and physical fitness as may be prescribed by the syndicate of the Annamalai University from time to time. The candidates who underwent the degree course under a Part-Time scheme, should possess two years of professional experience after passing the qualifying degree examination. Admission to M.TECH.(Food Processing Technology) part time programme is restricted to those working or residing within a radius of 90 km from Annamalainagar. R2.CREDITS M.Tech.(Food Processing Technology) full-time programme will have duration of four semesters. M.Tech.(Food Processing Technology) Part-Time Programme will have duration of six semesters. The number of credits for each semester for the full-time programme shall be as follows: First and Second Semesters : 20 credits per semester Third Semester : 12 credits Fourth Semester : 13 credits The number of credits for each semester for the part-time programme shall be as follows: First to Fourth Semesters : an average of 10 credits per semester Fifth Semester : 12 credits Sixth Semester : 13 credits The total credits for both the programmes will be 65. For the award of the degree, a student has to earn a minimum of 65 credits.

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2 R3. DURATION OF THE PROGRAMME A student is normally expected to complete the full-time programme in four semesters but in any case not more than four years from the time of admission. A student is normally expected to complete the part-time programme in six semesters but in any case not more than six years from the time of admission. R4. REGISTRATION FOR COURSES A newly admitted student will automatically be registered for all the courses prescribed for the first semester, without any option. Every student shall submit a completed registration form indicating the list of courses intended to be credited during the next semester. This registration will be done a week before the last working day of the current semester. Late registration with the approval of the Dean on the recommendation of the Head of the department along with a late fee will be done up to the last working day. Registration for the thesis phase-I and thesis phase-II shall be done only at the appropriate semesters. R5. ASSESSMENT The break-up of assessment and examination marks for theory and practical subjects is as follows. Practical Theory First assessment (I Mid Term Test) : 15 10 Second assessment (II Mid Term Test) : 15 10 Third assessment : 10 5 Examination : 60 75 The thesis phase-I will be assessed for 40 marks by a committee consisting of the Head of the Department, the guide and a minimum of two members nominated by the Head of the Department. The Head of the Department will be the chairman. 60 marks are allotted for the thesis work and viva voce examination at the end of the pre-final semester. The same procedure will be adopted in the final semester also. R6. STUDENT COUNSELLOR To help the students in planning their course of study and for general advice on the academic programme, the Head of the department will attach a certain number of students to a member of the faculty who shall

function as student counsellor for those students throughout their period of study. Such student counsellors shall advise the students, give preliminary approval for the courses to be taken by the students during each semester and obtain the final approval of the Head of the department.

3 R7. CLASS COMMITTEE For each semester, separate class committees will be constituted by the respective Heads of departments. The composition of the class committees for each semester except the final semester shall be as follows : Teachers of the individual courses. A project co-ordinator (in the prefinal and final semester committee only) who shall be appointed by the Head of the department from among the project supervisors. One Professor or Reader, preferably not teaching the concerned class, appointed as chairman by the Head of the department. The Head of the department may opt to be a member or the chairman. All student counsellors of the class, and the Head of the department (if not already a member) or any staff member nominated by the Head of the Department may opt to be special invitees. The class committee shall meet four times during the semester. The first meeting will be held within two weeks from the date of class commencement in which the type of assessment like test, assignment etc. for the third assessment and dates of completion of the assessments will be decided. The second meeting will be held within a week after the completion of the first assessment to review the performance and for follow-up action. The third meeting will be held within a week after the second assessment is completed to review the performance and for follow-up action. The fourth meeting will be held after all the assessments except the examination are completed for all the courses, and at least one week before the commencement of the examinations. During this meeting the assessment on a maximum of 40 marks will be finalised for every student and tabulated and submitted to the Head of the department for approval and transmission to the Controller of examinations. R8. WITHDRAWAL FROM A COURSE A student can withdraw from a Course at any time before a date fixed by the Head of the department prior to the second assessment, with the approval of the Dean of the Faculty on the recommendation of the Head of the department.

4 R9. TEMPORARY BREAK OF STUDY A student can take one time temporary break of study covering the current semester and / or the next semester with the approval of the Dean on the recommendation of the Head of the Department, not later than seven days after the completion of the second assessment test. However, the student must complete the entire programme within the maximum of four years for full-time and six years for part-time. R10. MOVEMENT TO THE PRE-FINAL SEMESTER A minimum of 24 credits must be earned by the student to move to the prefinal semester. The results of the final semester will be withheld until the student passes all the previous semester examinations. R11. SUBSTITUTE ASSESSMENTS A student who has missed, for genuine reasons accepted by the Head of the department, one or more of the assessments of a course other than the end of semester examination, may take a substitute assessment for any one of the missed assessments. The substitute assessment must be completed before the date of the fourth meeting of the respective class committees. A student who wishes to have a substitute assessment for a missed assessment must apply to the Head of the department within a week from the date of the missed assessment. R12. ATTENDANCE REQUIREMENTS

To be eligible to appear for the examination in a particular course, a student must put in a minimum of 80% of attendance in that course. However, if the attendance is 75% or above but less than 80% in any course the authorities can permit the student to appear for the examination in that course on payment of the prescribed condonation fee. A student who withdraws from or does not meet the minimum attendance requirement in a course must re-register for and repeat the course. R13. PASSING AND DECLARATION OF EXAMINATION RESULTS All assessments of all the courses on an absolute marks basis will be considered and passed by the respective results passing boards in accordance with the rules of the University. The marks for each course shall be converted to the corresponding letter grade as follows. Thereafter, computation of the grade point average (GPA) and cumulative grade point average (CGPA), and preparation of the grade cards shall be done.

5 GRADE 90 to 100 marks : "S" 80 to 89 marks : "A" 70 to 79 marks : "B" 60 to 69 marks : "C" 55 to 59 marks : "D" 50 to 54 marks : "E" Less than 50 marks : "RA" Insufficient attendance : "I" Withdrawn from the course : "W" In order to pass a course the student has to score 24 marks out of 60(end semester examination) and 50 marks out of 100(total marks) for practical and 30 marks out of 75 (end semester examination) and 50 marks out of 100 (total marks) for theory. A student who earns a grade of S,A,B,C,D or E for a course is declared to have successfully completed that course and earned the credits for that course. Such a course cannot be repeated by the student. A student who obtains letter grades I or W in a course must re-register for and repeat the course. A student who obtains letter grade RA in a course has to reappear for the examination in that course. A student who obtains letter grade I or W or RA in thesis phase-I must reregister in the next semester. Registration for thesis phase-II for such students can be done in the subsequent semesters. The following grade points are associated with each letter grade for calculating the grade point average (GPA) and cumulative grade point average (CGPA). S -10; A - 9; B - 8; C - 7; D - 6; E - 5; RA - 0 Courses with grade I and W are not considered for calculation of grade point average (GPA) or Overall grade point average (CGPA). RA grade will be considered for computing GPA and CGPA. A student can apply for re-totaling of one or more of his/her examination answer papers within a week from the date of issue of grade sheet to the student on payment of the prescribed fee per paper. The application must be made to the Controller of Examinations with the recommendation of the Head of the Department. After results are declared, grade cards will be issued to the students. The grade card will contain the list of the courses registered during the semester, the grades scored and the grade point average for the semester. GPA is the sum of the products of the number of credits of a course with the grade point scored in that course, taken over all the courses for the semester, divided by the sum of the number of credits for all courses taken in that semester. CGPA is similarly calculated considering all the courses taken from the time of admission.

6 The results of the final semester will be withheld until the student obtains passing grades in all the subjects of all the earlier semesters. After successful completion of the programme, the degree will be awarded with the following classifications based on CGPA. For first class with Distinction the Student must earn a minimum of 65 credits with in four semesters for full-time and six semesters for part-time

from the time of admission, pass all the courses in the first attempt and obtain a CGPA of 8.25 or above. For First class, the student must earn a minimum of 65 credits within two years and six months for full time and three years and six months for part time from the time of admission and obtain a CGPA of 6.75 or above. For second class the student must earn a minimum of 65 credits within four years for full-time and six years for part-time from the time of admission. R14. RANKING OF CANDIDATES The candidates who are eligible to get the M.Tech.(Food Processing Technology)degree in First Class with distinction will be ranked on the basis of CGPA for all the courses of study from I to IV Semester for M.Tech.(Food Processing Technology)Full time and from I to VI Semester for M.Tech.(Food Processing Technology)Part-Time. The candidates passing with First class and without failing in any subject from the time of admission will be ranked next to those with distinction on the basis of CGPA for all the courses of study from I to IV Semester for M.Tech. (Food Processing Technology) Full time and from I to VI Semester for M.Tech. (Food Processing Technology) Part- Time. R15. ELECTIVES Apart from the various elective courses offered in the curriculum of the branch of specialization, a student can choose a maximum of two electives from any specialization under the Faculty during the entire period of study, with the approval of the Head of the Department and the Head of the department offering the course. R16. TRANSITORY REGULATIONS If a candidate studying under the old regulations M.TECH.(Food Processing Technology)could not attend any of the courses in his/her courses, shall be permitted to attend equal number of courses, under the new regulation and will be examined on those subjects. The choice of courses will be decided by the concerned Head of the department. However he/she will be permitted to submit the thesis as per the old regulations. The results of such candidates will be passed as per old regulations. The University shall have powers to revise or change or amend the regulations, the scheme of examinations, the courses of study and the syllabi from time to time.

7 M.TECH (FOOD PROCESSING TECHNOLOGY) (FULL-TIME) SCHEME OF EXAMINATIONS FIRST SEMESTER Code Subject Period per week Duration of Exam. (Hours) Marks Credit units L Lab D Exam Sess. Total FPT11 Mathematics for Biologists 4 - - 3 75 25 100 3 FPT 12A/12B Biochemistry / Principles of Chemical Engineering 4 - - 3 75 25 100 3 FPT 13 Analytical techniques 4 - - 3 75 25 100 3 FPT 14 Food science 4 3 75 25 100 3 FPT 15 Elective – I 4 3 75 25 100 3 FPT 16 Elective – II 4 3 75 25 100 3 FPT 17 Microbiology& Biochemistry lab 6 4 60 40 100 2 Total 24 6 - 22 510 190 700 20 SECOND SEMESTER Code Subject Period per week Duration of Exam. (Hours) Marks Credit units L Lab. D Exam Sess. Total FPT 21 Food Processing Technology 4 - - 3 75 25 100 3 FPT 22 Food Preservation Technology 4 - - 3 75 25 100 3 FPT 23 Dairy Technology 4 - - 3 75 25 100 3 FPT 24 Food Microbiology 4 3 75 25 100 3 FPT 25 Elective – III 4 3 75 25 100 3 FPT 26 Elective – IV 4 3 75 25 100 3 FPT 27 Food Processing Lab 6 4 60 40 100 2 Total 24 6 - 22 510 190 700 20

8 THIRD SEMESTER Code Subject Period per week Duration of Exam. (Hours) Marks Credit units L Thesis Exam Sess. Total FPT 31 Elective V 4 - 3 75 25 100 3 FPT 32 Elective VI 4 - 3 75 25 100 3 FPT 33 Thesis Phase-I Viva-voce - 15 - 60 40 100 6 Total 8 15 6 210 90 300 12 Elective – I, II, III, IV, V & VI will be chosen from the following list of subjects. FOURTH SEMESTER Code Subject Period per week Duration of Exam.

(Hours) Marks Credit Units L Thesis Exam Sess. Total

Code	Subject	L	Thesis	Duration of Exam (Hours)	Exam	Sess.	Total	Credit Units
FPT 41	Thesis Phase-II Viva-voce	-	-	-	60	40	100	13
Total		-	-	-	60	40	100	13

L – Lecture. Lab – Laboratory. D – Drawing.

ELECTIVES 1. Industrial Drying 2. Food Sterilization methods 3. Cryogenics 4. Food Packaging and cold storage 5. Brewing Technology 6. Oils and Fats 7. Milk and Milk products 8. Mass Transfer Operations 9. Baking Technology 10. Food and Nutrition 11. Computational Techniques 12. Process Instrumentation 13. Introduction to Heat, Mass and Momentum Transfer 14. Fish Processing Technology 15. Fruits and Vegetables Preservation Technology

9 M.TECH (THREE-YEAR PART TIME)FOOD PROCESSING TECHNOLOGY DEGREE PROGRAMME CHOICE BASED CREDIT SYSTEM(CBCS) SUBJECTS OF STUDY AND SCHEME OF EXAMINATIONS

FIRST SEMESTER

Code	Subject	L	Lab.	D	Duration of Exam. (Hours)	Marks Exam	Sess.	Total	Credit units
FPT 11	Mathematics for Biologists	4	-	-	3	75	25	100	3
FPT 12A/12B	Biochemistry / Principles of Chemical Engineering	4	-	-	3	75	25	100	3
FPT 13	Analytical techniques	4	-	-	3	60	40	100	3
Total		12	-	-	9	210	90	300	9

SECOND SEMESTER

Code	Subject	L	Lab.	D	Duration of Exam. (Hours)	Marks Exam	Sess.	Total	Credit units
FPT 21	Food Processing Technology	4	-	-	3	75	25	100	3
FPT 22	Food Preservation Technology	4	-	-	3	75	25	100	3
FPT 23	Dairy Technology	4	-	-	3	60	40	100	3
Total		12	-	-	9	210	90	300	9

10 THIRD SEMESTER

Code	Subject	L	Lab	D	Duration of Exam (Hours)	Marks Exam	Sess.	Total	Credit units
FPT 14	Food science	4			3	75	25	100	3
FPT 15	Elective – I	4			3	75	25	100	3
FPT 16	Elective – II	4			3	75	25	100	3
FPT 17	Microbiology& Biochemistry lab		6		4	60	40	100	2
Total		12	6		13	285	115	400	11

FOURTH SEMESTER

Code	Subject	L	Lab.	D	Duration of Exam. (Hours)	Marks Exam	Sess.	Total	Credit Units
FPT 24	Food Microbiology	4			3	75	25	100	3
FPT 25	Elective – III	4			3	75	25	100	3
FPT 26	Elective – IV	4			3	75	25	100	3
FPT 27	Food Processing Lab		6		4	60	40	100	2
Total		12	6		13	285	115	400	11

FIFTH SEMESTER

Code	Subject	L	Thesis	Duration of Exam. (Hours)	Marks Exam	Sess.	Total	Credit Units
FPT 31	Elective V	4	-	3	75	25	100	3
FPT 32	Elective VI	4	-	3	75	25	100	3
FPT 33	Thesis Phase-I Viva-voce	-	15	-	60	40	100	6
Total		8	15	6	210	90	300	12

11 SIXTH SEMESTER

Code	Subject	L	Thesis	Duration of Exam. (Hours)	Marks Exam	Sess.	Total	Credit Units
FPT 41	Thesis Phase- II Viva-voce	-	-	-	60	40	100	13
Total		-	-	-	60	40	100	13

L – Lecture. Lab – Laboratory. D – Drawing. Elective – I, II, III, IV, V, & VI will be chosen from the following list of subjects.

ELECTIVES 1. Industrial Drying 2. Food Sterilization methods 3. Cryogenics 4. Food Packaging and cold storage 5. Brewing Technology 6. Oils and Fats 7. Milk and Milk products 8. Mass Transfer Operations 9. Baking Technology 10. Food and Nutrition 11. Computational Techniques 12. Process Instrumentation 13. Introduction to Heat, Mass and Momentum Transfer 14. Fish Processing Technology 15. Fruits and Vegetables Preservation Technology *The syllabus for M.Tech. Food Processing Technology (PT) is same as that of M.Tech. Food Processing Technology Full time programme syllabus.

12 SYLLABUS FPT 11.MATHEMATICS FOR BIOLOGISTS Differential equations First order and second order differential equations – applications to biological sciences (case studies) Behavior of solution of Differential Equations Elementary critical points-critical points of non-linear systems Laplace Transformations Laplace transforms-simple properties, Inverse L-T- Convolution theorem-application to solution of ordinary differential equations. Curve fitting and Regression analysis Least square approximation fitting nonlinear curves by least squares-bivariate base correlation and regression applications to biological sciences. Statistical Inference Sampling distribution-tests based on normal and distribution-chi square test for independence of attributes and goodness of fit-ANOVA-applications from biological sciences-case studies. Reference: 1. Arya J C and R W Kardber, Mathematics For Biological Sciences, Prentice Hall International Edn (1979) 2. S.Narayanan T K Manickarachagam Pillay, G.Ramaniah, Advanced Mathematics for Engineering Students, Vol.III S.Viswanathan Pvt. Ltd., (1986) Ch.9. 3. S.C.Gupta and V.K.Kapoor, Elements of Mathematical statistics, S,Chand & sons- NewDelhi (1983) 4. Prem Narain, Statistical Genetics, Wiley Eastern (1990) 5. Elsgolts, L., Differential equations and the calculus of variations – Mir publishers (1970) – ch- 4. 6. Burghes, D.C & Bornie, M.S. Modeling with Differential Equations. Ellis Horwood UK.1982.

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13 FPT 12A. BIOCHEMISTRY Carbohydrates Structure and properties of mono, di, oligo and polysaccharides; complex carbohydrates, TCA cycle, glycolysis, gluconeogenesis, pentose phosphate shunt. Lipids Structure and properties of fatty acids, Glycerolipids, phospholipids, sphingolipids, Glycolipids, steroids. Biosynthesis and degradation of fatty acids and cholesterol. Proteins Structure and properties of amino acids, peptides, proteins and conjugated proteins. Urea cycle. Biosynthesis and degradation of amino acids and proteins. Nucleic acids Structure and properties of purines, pyrimidines, nucleosides, nucleotides, polynucleotides.Ribonuclic acid and deoxyribonucleic acids, nucleoprotrein complexes. Biosynthesis and degradation of purines, pyrimidines and nucleic acids. Metabolic integration and bioenergetics Interconnection of pathways, Metabolic regulation. Bioenergetics , Respiratory chain,ATP cycle, energy rich compounds. Text Books: 1.Nelson cox.,Lehninger's Principles of Biochemistry ,3 rd Edition,Mc Millan Worth , 2000. 2.Murray et .al., Harpers Biochemistry,26 th Edition ,McGraw Hill ,2003 3.Stryer.,Biochemisrty ,Freeman,5 th Edition 2002. 4.Donald Voet .,J.G.Voet,John Willey,Biochemistry 1995. 5.Davidson and sittman.,Biochemistry ,NMS.,4 th Edition .Lippincott .Williams and Wilkins 1999. FPT 12 .B PRINCIPLES OF CHEMICAL ENGINEERING Introduction to Chemical Engineering: A brief introduction to chemical engineering sciences and its role in the design and analysis of chemical processes, An overview of traditional unit operations and processes in the chemical industry. Fundamentals of Fluid Mechanics Properties of Fluids, Fluid Statics – forces at fluid surface, Pressure and measurement of pressure differences; Fluid-Flow concepts and basic equations of fluid flow – continuity equation and Bernoulli's equation; Shear – stress relationships and viscous effects in fluid flow, Non-Newtonian fluids.

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14 Dimensional Analysis and Dynamic Similitude Units and Dimensions; Dimensionless ratios, Kinematic and Dynamic Similitude; Introduction to Dimensionless Analysis – Buckingham Pi theorem; Significance

of dimensionless groups, fluid flow operations. Basic Elements of Transport Phenomena Molecular and Turbulent Transport Mechanisms in Momentum, Heat and Mass Transfer; Concept of Boundary Layer in Fluid Flow; Hagen-Poiseuille equation; Friction factor and its calculation in laminar and turbulent flow. Principles of Heat Transfer: Steady-State Conduction; Convective Heat transfer in fluids; Concept of Heat Transfer Coefficients; Introduction to Mass Transfer: Fick's law of diffusion; diffusion in binary mixtures; convective Mass-Transfer; Interphase mass transfer; film theory of mass transfer and evaluation of mass transfer coefficients; Analogies between momentum, heat and mass transfer – Reynolds and Colburn analogies. Material and Energy Balances in Chemical Processes Stoichiometric and Compositional Relations in Chemical Reactions; Mass and Energy Balance analysis in multistage processes involving chemical reactions and separations – Mass and Energy balance in combustion processes. Text Books: 1. David M.Himmelblau, Basic Principles And Calculations In Chemical Engineering, Prentice-Hall India (5th Ed) 1995. 2. Christie J.Geankoplis, Transport Processes And Unit Operations, Eastern Economy Edition (3er Ed), 1997. 3. McCabe, W.L. & Smith R, Unit Operations In Chemical Engineering, McGraw Hill Inc. (6 th Ed), 2005. 4. Alan S. Froust, L.A.Wenzel, C.W.Clump, L.Maus, L.B.Andersen, Principles Of Unit Operations, J. Wiley & Sons (2 nd Ed.), 1980 FPT 13.ANALYTICAL TECHNIQUES Principles of Spectroscopy: Absorption Spectroscopy; Solvent effects – characteristics of ethidium bromide intercalation in to DNA; Absorption Spectra of proteins – Fluorescence Spectroscopy – Assorted Cell Sorting – Principles; analysis of Protein folding by emission spectroscopy; circular Dichroism and optical rotatory dispersion; NMR – Crystallography; Mass- Spectroscopy Infra-Red, FTIR and Raman Spectroscopy. Microscopy: Microscopic Identification of various microorganisms; phase contrast and confocal microscopy; SEM-TEM microscopy. Methods of Biochemical Analysis: Glucose, Sugars, Carbohydrates, Lipids, Proteins and Nucleotides; Enzymatic Assays of various metabolites.

15 Chomatographic methods of Analysis: Gas Chromatography and Analysis of volatile fatty acids; HPLC and TLC; separation and analysis of biochemical compounds and macromolecules Electrophoresis Techniques: Electrophoresis of Proteins and Nucleic acids; ID and 2D Gels; Pulsed-Field Electrophoresis; Capillary Electrophoresis; Western Blotting; Gel Documentation. Nucleotide and DNA analysis DNA purification; PCR-based analysis; DNA fingerprinting; DNA sequencing. Immuno-techniques: Antiserum Production, Immunofluoroscence, Immuno histo-compatibility ELISA; Localisation of cells in tissues, immunoblotting; Monoclonal antibodies. Analysis of Bioprocesses: Analysis of Biomass; measurement of dry weight and biomass composition; analysis of substrate uptake and product formation rates; Measurement of BOD and COD in Waste-Waters; Gas Analysis for O_2 and CO_2; Flow injection analysis; computerised Data Acquisition of Bioprocesses. Text books 1. Willard and H.Merrit, Instrumental Methods of analysis PHI, 1999. 2. , D.Skoog, Instrumental Methods of analysis , 2000. Reference Book 1. Instrumental Method of Chemical Analysis, Galen W.Ewing McGraw-Hill International edition, V Edition, 1985. 2. Robert de Levie, Principles of Quantitative Chemical Analysis, McGraw Hill International Edition, 1997 3. W.H.Freeman, Readings In Scientific American, 1985-1993. 4. R.Gopalan , P.S.Subramanian and K.Rangarajan ., "Elements of Analytical Chemistry" FPT 14. FOOD SCIENCE INTRODUCTION TO FOOD PROCESSING Biotechnology in relation to the food industry, nutritive value of food, type of microorganisms associated with food, its sources, types and behavior in foods. FOOD PRESERVATION

Bioprocessing of meat, fisheries, vegetables, dairy products, enzyme and chemical used in food processing, biochemical engineering for a flavor and food production. FERMENTED FOOD PRODUCTS Dairy products, meat, fishery, non-beverage plant products, beverages and related of baking.

16 FOOD SPOILAGE Food borne illness, quality control, case studies on Biotechnology in the evolution of food quality, HFCS(High Fructose Corn Syrup) and micro-proteins. FOOD MICROBIOLOGY Utilization of microorganisms in food industry, genetic manipulations, food borne illness. Reference: 1. Lindsay, Willis, Biotechnology Challenges For The Flavour And Food Industries, Elsevier Applied Science, 1988. 2. Roger A., Gordan B., and John T., Food Biotechnology, 1989. 3. George J.B., Basic Food Microbiology, CBS Publishers&Distributors,1987. 4. James M.H., Modern Food Microbiology, CBS Publishers&Distributors,1987. FPT 15.ELECTIVE – I FPT 16.ELECTIVE – II FPT 17.MICROBIOLOGY AND BIOCHEMISTRY LABORATORY Microbiology 1. Maintenance and identification of microorganisms. 2. Biochemistry Characterization 3. Methods of quantification of microorganisms from soil, air and water. 4. Fermentation: growth curve, shake flask bioreactor, importance including off gas analysis. Biochemistry 1. Centrifugation: Ultra/Density gradients and continuous gradients. 2. Adsorption chromatography 3. Ion Exchange chromatography 4. Electrophoresis in Agarose and SDS gels 5. Membrane separation of proteins 6. Extraction of lipids from liver (normal and fatty) and thin layer chromatography 7. Estimation of carbohydrates-glucose and starch 8. Estimation of proteins and nucleic acid 9. Estimation of vitamins. Reference: 1. J.Jayaraman, Lab Manual In Biochemistry, Wiley Eastern Ltd (1981) 2. Bergey's Journal Of Determinative Biotechnology Edn (1986) 3. Collins and Lyne, Microbiological Methods, Butterworths, Singapore (1986),5thEd. 4. Plummer, An Introduction To Practical Chemistry, Tata-McGraw Hill, New Delhi (1987), 3 rd Ed.

17 SEMESTER-II FPT 21.FOOD PROCESSING TECHNOLOGY Introduction to food processing Biotechnology in relation to the food industry; Nutritive values of food; types of microorganisms associated with food, its sources, types and behavior in foods. Rheology and Fluid Flow Introduction, material and energy balance, viscometry, laminar and turbulent flows, calculation of power requirements for pumping of food materials. Thermal Processing of Food Mechanisms of heat transfer, heat transfer coefficients, Thermal inactivation of microorganisms, thermal process evaluations, freezing and thawing of foods. Food Process Operations Evaporation, single and multi-effect evaporation, dehydration of foods, psychrometric charts. Food Processing Operations Drying of foods, tunnel drying, tray drying, spray drying, drum drying, freeze drying, distillation. Mass transfers and Separation Processes Extraction, leaching, filtration, membrane separation, ultra filtration, reverse osmosis and centrifugation. Reference: 1. Toledo, R.T., Fundamentals of food process Engineering operation, Applied Science Publishers, 1979, 2 nd Ed., 2. Brennan,J.G.J.R.Butters, N.D.Cowell, A.EV.Lilly, Food Engineering Operations, Applied Science Publishers,1979,2nd Ed., 3. Heldman, D.R, Food Process Engineering, AVI Publishing Co., USA, 2nd Ed.,1977. 4. Lindsay of Willis Elseveir. Applied Science (1988), Biotechnology Challenges For The Flavour And Food Industry. 5. Roger Angold, Food Biotechnology, Gordon Beech and

Taggart (1959). 6. George J. Banward , Basic Food Microbiology, CBS Publishers (1987). 7. James M. Jay, Modern Food Microbiology, CBS Publishers (1987).

18 FPT 22.FOOD PRESERVATION TECHNOLOGY Food deterioration and its control-shelf life and dating of foods, major courses of food deterioration, some principles of food preservation, control of microorganisms, control of enzymes and other factors. Heat preservation and processing – degrees of preservation, selecting heat treatments, heat resistance of microorganisms, heat transfer and protective effects of food constituents, inoculated pack studies, different temperature-time combinations, heating before and after packaging, government regulations. Cold preservation and processing-distinction between refrigeration and freezing, refrigeration and cool storage, freezing and frozen storage, some additional developments. Irradiation, Microwave and ohmic processing of foods-food irradiation, microwave heating, ohmic heating. Food dehydration and concentration-food dehydration, food concentration, intermediate-moisture foods. Textbook: 1.Norman N. Potter and Joseph.H.Hotchkins, Food Science, V Edition, CBS publishers &distributors New Delhi. References: 1.Desrosier, N.W and J.N Desrosier, Technology Of Food Preservation, 4th Edition. AVI Publishing Co;westport FPT 23.DAIRY TECHNOLOGY Dairy Chemistry-Milk as a food and its composition, properties and uses of some milk constituents-vitamins in milk, sampling of milk, butter and cheese-qualitative exercises and tests-Quantitative Analysis of milk, cream, condensed milk and milk powder-Analysis of butter and cheese. Milk processing –pasteurization of raw milk. Heat exchanger equipments, Various types of heat exchanger-tubular, plate, barrel types of heat exchanger, Milk storage tanks. Milk products – manufacturing process- Milk, cream, butter, evaporated milk, condensed milk concentrated milk, ice cream, milk sherbets and ices, cheese. Skim milk, buttermilk, fermented milk, whey, dried milk products, malted milk powder, filled milk, imitation milk, milk beverage.

19 Confectionery and chocolate products, sugar-based confections, Ingredients, chocolate and cocoa products, confectionery manufacturing practices. Steam and use in the dairy, principles of refrigeration, Insulation and cold-storage rooms-homogenizes, pasteurizing Equipment- Atmospheric concentrators; vacuum pan; condenser; the low temperature concentrator, can washing and sterilizing equipment- bulk tanks, principles of operations of can washers. Dairy plant design, construction, materials and utilization. Text Book: 1.Arthur W.Farrall, Engineering For Dairy And Food Products, Wiley Eastern private Ltd,1967. Reference Book 1. Morris B.Jacobs, Food technology 2. Norman N.Potter, Joseph H.Hotchkiss, Food Science, CBS publishers & distributors. 3. Edgar R.Ling, A Text book of dairy chemistry , Chapman And Hall Ltd,1956. FPT 24.FOOD MICROBIOLOGY Food and microorganisms Food as a substrate for microorganisms – microorganisms important in Food microbiology – contamination of foods – General principles underlying spoilage – Chemical changes caused by microorganism. Contamination, preservation and spoilage of different kinds of foods Contamination, preservation and spoilage of cereals and cereal products, sugar and sugar products, Vegetables and Fruits, Meat and meat products, Fish and other sea foods, Eggs, Poultry, Milk and milk products. Spoilage of heated canned foods – Causes of spoilage, Appearance of the unopened container. Grouping of canned foods on the basis of

Acidity. Types of Biological spoilage of canned foods. Foods in related to Disease – Food borne infection & intoxications: Bacterial. Food borne poisoning, infection and intoxications: Nonbacterial. Investigation of food borne Disease outbreaks. Microbiology in food plant sanitation. Food control - Enforcement and control agencies the federal food Drug and cosmetic act. Fermentation and other uses of microorganisms- Fermentations, Microorganisms as direct foods, genetic Engineering.

20 Text Book: 1.W.C.Frazier & D.C.Westhoff, Food Microbiology, Tata McGraw Hill,1986. Reference books: 1.Desrosier, N.W and J.N.Desrosier, Technology Of Food Preservation, 4 th Edn. AVI Publishing co, Westport FPT 25.ELECTIVE-III FPT 26.ELECTIVE-IV FPT 27.FOOD PROCESSING LAB 1. Estimation of carbohydrates, fats, proteins, vitamins in various foods 2. Testing of milk and milk products – physical test, chemical test, biochemical test and bacteriological tests 3. Paddy drying methods – solar dryers – parboiling of paddy – continuous parboiling techniques. 4. Quantitative analysis of cream, condensed milk and milk powder 5. Analysis of Butter 6. Analysis of Cheese 7. Microbial production of citric acid 8. Continuous drying of food products using rotary dryers 9. Methods of Analysis of Dehydrated Foods. 10. Sedimentation and Filtration - Principles and practical applications. 11. Centrifugation, Spray drying, Freeze drying and Vacuum Drying– Principles and practical applications.

21 SEMESTER-III FPT 31.ELECTIVE-V FPT 32.ELECTIVE-VI FPT 33THESIS WORK-PHASE I SEMESTER-IV FPT 41.THESIS WORK-PHASE II-THESIS AND VIVA-VOCE ELECTIVES Electives I,II,III,IV,V and VI will be chosen from the following list of subjects 1.INDUSTRIAL DRYING Fundamentals of drying, Psychrometry, absorption, transport phenomena in porous media. Heat transfer to particles, beds and surfaces, evaporation form drops and surfaces, simultaneous heat and mass transfer, drying characteristics for batch and continuous drying Types, Classification and selection of Industrial dryers – Tray dryers – through - circular dryer – Rotary dryer – pneumatic dryer – fluid bed dryer – spray dryer – indirect agitated dryer – infrared, Freeze and dielectric dryer –drying of Gas Industrial drying, application to such areas as drying of paper, pharmaceuticals, food products and fine chemical Reference: 1. A.W.Gardener, Industrial Drying, Leonard Hill, London, 1970.

22 2. FOOD STERLIZATION TECHNOLOGY Quality factors in foods – appearance factors, Textural factors, Flavor factors, Additional quality factors, Quality standards. Food deterioration and its control – shelf life and dating of food, major causes of food. Deterioration, some principles of food preservations, control of microorganisms, control of enzyme and other factors. Batch sterilization methods – using steam, using electrical heating – simultaneous packing and sterilization – pasteurization – continuous sterilization methods. Sterilizing in can, apples, beets, berries, cherries, corn, foods, fruit juices, grape fruit, lima, beans, olives, peaches, pears, peas, pineapples, preserves, spinach, sweet potatoes and tomatoes. Reference Book: 1.W.V.Cruss, Commercial Fruit And Vegetable Products, II nd Edn.,McGraw-Hill, 1938. 2.Norman N. Potter, Joseph H. Hotchkiss, Food Science, V th Edn.,CBS publishers & Distributors,1996. 3.CRYOGENICS Refrigeration – Principles of Refrigeration, Gas liquefaction, properties

of liquefied gases, significance of extremely low temperatures, Production and measurement of very low temperatures. Cryogenics- History and development, Cryogenic Gases, Production of liquid Helium and Helium refrigeration, storage and handling of liquid helium. Cryogenic thermometry Materials of low temperature applications-Thermal, Electrical and mechanical Properties at low temperatures. Cryostat design – Machinery and Instrumentation, compressors, High pressure systems, Valves, temperature and level control of cryogens. Large scale industrial applications of crogenics – Cryopumping, Rocket, Superconductivity, food preservation and in life sciences. Reference Book: 1. Harold Weinstock ., Cryogenic Technology , Boston Technical Publications.1970 2. Boris V.Kuznetsov ,Theory and design of Cryogenic system.MIR Publishers,1981. 3. C.Rose Innes,.Low Temperature Techniques ,English University Press,1964

23 4. FOOD PACKAGING AND COLD STORAGES Principles of food packaging – Introduction, Types of containers, Food packaging materials and Forms, Package testing, package with special features, safety of food packaging, Environment consideration. Methods of Food Packaging Food freezing – present importance and potentialities – The principle of Refrigeration – cold storages, sharp freezers and sharp freezing and the Quick freezing systems – Freezing cabinets and walk in freezers, Frozen food locker plants, charge occurring during the preparation, Freezing, Cold storage and thawing of foods – Adaptability of vegetables and vegetable varieties to freezing – the preparation and freezing of meat, poultry and fish – The freezing of Dairy products, precooked frozen foods, the storage, transportation and marketing of frozen foods. The nutritive values of frozen foods – the Microbiology of frozen foods – The importance of quality control of standards in the frozen food industries. Text Books: 1. Donald K.Tressler and Clifford F.Evers, The Freezing preservation of foods. 2ed Ed., The AVI publishing company New York. 2. Norman D. Potter, Joseph. H. Hotchkiss, Food Science, 5 th Ed., CBS Publishers and Distributions, New Delhi. 5. BREWING TECHNOLOGY Carbonated non alcoholic Beverages: Ingredients and manufacture, sugar, reduced calorie and non-nuritive sweeteners, flavorings, colors, acid, water, carbon dioxide, plant layout. Beer – Raw materials and manufacture, malt, Hops, cereal adjuncts, mashing, brewing, fermentation, storage, finishing and packaging, light beer, continuous brewing – Beer microbiology Beer defects and diseases. Wine – Analysis of typical beer, wine varieties, color, sweetness and alcohol content, effervescence, fermentation and other applications naming of wines. Industrial alcohol – Raw materials, fermentation mechanisms – manufacturing process – absolute alcohol. SCP production from the waste liquors from brewing industries – anaerobic digestion of effluents. Distilled spirits – Whiskey, Gin production Text Book: Norman N. Potter, Joseph H. Hotchkiss, Food Science, 5 th edn, CBS publishers and distributors.

24 6. OILS AND FATS Structure and composition of fats and oils – Glycerides - mono, di and triglycerides, fatty acids – saturated and unsaturated - Nonglyceride components of fats and oils. Physical properties of fats and fatty acids – oiliness and viscosity, surface tension, density and expansibility, melting points, thermal properties, smoke, fire and flash points, solubility, optical properties, electrical properties. Reaction of fats and fatty acids – Hydrolysis, esterification, reactions involving carboxyl group and fatty

acid chain, preparation of miscellaneous fatty acid derivatives. Raw material for oils and fat product – sources, utilization and classification of oils and fats, composition and characteristics of individual fats and oils, cooking and salad oils and salad dressings. Plastic softening agents, buffer and margarine – fats in diets – Nutritional function. Reference: Bailey's Industrial Oils And Fat Products, Interscience publishers, a division of John wiley and sons. 7. MILK AND MILK PRODUCTS Fundamentals of Dairy Bacteriology, Contamination of milk and its prevention. Diseases caused by infected milk. Pasteurization techniques Grades of milk – Cultures –fermented milk – human milk- goat milk. Cream- Skim milk- Butter milk – Whey. Homogenized milk – Soft curd milk – Frozen milk – Chocolate milk –Evaporated milk- Condensed milk Dry milk- malted milk- Butter – Oleomargarines, cheese – Ice cream Reduced fat Dairy products. Principles of Dairy tests – General tests, Chemical tests, Biochemical tests Bacteriological tests. Examples in Dairy Arithmetic. Text Books: Lincoln M.Lampert, Milk And Dairy Products, Chemical Publishing Co.,INC New York,

25 8. MASS TRANSFER OPERATIONS Molecular diffusion in fluids and solids, Interphase mass transfer, mass transfer coefficients, Analogies in transport phenomena Principles of gas absorptions, design principles of absorbers, industrial absorbers, HTU, NTU concepts. Humidification and dehumidification principles Vapor liquid equilibrium- simple steam and flash distillation, continuous distillation, McCabe – Theile principles; industrial distillation equipments, HETP concepts. Liquid- liquid equilibrium, Staged and Continuous Extraction, Solid liquid Equilibria, leaching principles. Adsorption Equilibria – batch and fixed bed adsorption, drying – mechanism, drying curves, time of drying, batch and continuous driers Text Books 1,Treybal. R.E. Mass Transfer Operations. 3 rd edition McGraw Hill 1985. 2, McCabe W.L, Smith. J.C. P.Harriot Unit operations of chemical engineering 6 th Edition McGraw Hill 2001. 3,Geankoplis C.J Transport processes and unit operation 3 rd edition Prentice hall of India 2002 9. BAKING TECHNOLOGY Progress of the Baking Industry – processes for yeast – Raised Bakery products, Gas production in yeast – Raised doughs, Gas Retention in yeast Raised Doughs – sour Rye Bread, Cake and cookie production, Development of Staleness, Nutritive properties of Baker's products, Microbiology of Bakery products, "Bleeding" Bread, Mold on Bakery Products, Scouring of Bakery products, packaging. Reference: Moris B.Jacobs, Food Technology Vol-I

26 10. FOOD AND NUTRITION Carbohydrates, lipids ,proteins, Energy Value of Foods and Energy Requirements, Vitamins ,Minerals, Water Balance, the Nutritive Value of foods. Effect of Cooking and Heat processing on the Nutritive Values of Foods. Lathyrism – Recommended Dietary allowances – food groups and the planning of Balanced Diets – infant nutrition and infant foods – nutrition of Pre school Children , school children and Adolescents, Pregnant and lactating mothers and industrial workers . Geriatric Nutrition, obesity, food faddism and faulty food habits, applied nutrition programs, Diet and nutrition in India, prevention of malnutrition in developing countries. Nutritive value of common Indian recipes, Therapeutic diets, Therapeutic Nutrition and diets in fever infectious diseases and constitutional ailments. Processed Supplementary Foods and Novel Foods. Text Book: M .Swaminathan, Handbook Of Food And Nutrition. 11. COMPUTATIONAL TECHNIQUES Numerical solution of algebraic and transient

equations: Review of iteration, bisection, Regula – Falsi and Newton – Raphson methods. Solution of linear simultaneous algebraic equations: Gauss method, Gauss – Siedel iteration, Jacobian method. Numerical Integration: Trapezoidal rule, Simpson's rule, Weddle's rule. Numerical Differentiation: interpolation. Solution of Ordinary differential equations: Taylor's series, Euler's method, Rungi – Kutta method, Predictor corrector method. Numerical solution of Partial differential equations – Jacobi's method, Gauss – Seidal method – Parabolic equations – iterative methods for the solution of equations. Text Book: S.S. Sastry, Introductory Methods of Numerical Analysis, 3rd ed., Prentice Hall, 1999. REFERENCES: 1. Santosh K.Gupta, Numerical Methods for Engineers, New Age International(p) Ltd., 2001. 2. Jain.M.K, Iyengar.S.R.K and R.K.Jain, Numeical Methods for Scientific and Engineering Computation, 3 rd Edn., New Age International(p) Ltd., 1999.

27 12. PROCESS INSTRUMENTATION Process variable and measurement – static and dynamic characteristics of instruments. Advantages and limitations of instruments, indicating and recording mechanism, Strip charts and circular charts. Different types of measuring instruments for Temperature, Pressure flow and Level; Description – principles of measuring elements used and characteristic features. Measuring instruments for viscosity, density, turbidity, Humidity and pH; Description and principles of operation measuring elements used characteristic features. Physical and Chemical sensors for the medium and gases – sensors of the physical environment, medium chemical sensors, Gas Analysis. On – line sensors for cell properties, off – line analytical methods – Measurements of medium properties, Analysis of cell population composition. Computers and Interfaces – Elements of digital computers, Computer interfaces and peripheral devices, Software systems. Reference Books: 1, Eckman.D.P, Industrial Instrumentation, Wiley Eastern Ltd., 1984. 2, James E. Bailey and David F. Ollis, Biochemical Engineering Fundamentals, McGraw- Hill Book Company, 2 nd ed., 1986. 13. INTRODUCTION TO HEAT, MASS AND MOMENTUM TRANSFER Mechanism of Transport Processes – Driving forces for transport processes – Definition of fluxes – Transport Phenomena laws. Molecular Transport: Steady state molecular energy transport – Molecular mass transport – Molecular momentum Transport; Transport coefficients – Viscosity, thermal conductivity, diffusivity. Equations of continuity, equation of motion and equation of energy. Modelling of flow systems- flow between parallel plates, flow through pipes, flow over solid surfaces. Conduction in plates and walls, rods and wires, temperature profiles in fins, unsteady state heating and cooling of spheres. Diffusion fluxes, stagnant film diffusion, mass transfer across cylindrical membranes, dissolution of sphere.

28 Convective transport in laminar flow and turbulent flow, heat and mass transfer coefficients, Macroscopic calculations- Application of Bernoullis equation-pressure losses; correlations for heat, mass and momentum transfer, overall heat and mass transfer coefficients, correlations for interfacial areas, heat exchangers, gas absorbers. Text Book: William. J. Thomson, Introduction to Transport Phenomena, Pearson Education Asia, 2001 Reference Book: Bird, Stewart and Lightfoot, Transport Phenomena, Wiley International Ed., II ed., 2002. 14. FISH PROCESSING TECHNOLOGY Fisheries resources for processing and product development. Biochemical composition of fish. Post-mortem changes in fish. Causes of

deterioration – changes in proteins- Methods for quality assessment of fish – sentory evaluation. Chilling fish using ice: Properties of ice, estimation of requirement of ice, storage life of iced fish, manufacture and storage of ice block, flake, tube and chip. Alternatives to direct icing – Refrigerated sea water and chilled sea water systems. Technology of fish freezing – Definitions, physical changes, practical storage life determination – Blanching, Glazing, freezing equipments and freezing, of fish and fish products. Freeze drying process and quality considerations. Bacteriology of fish and shellfish – Principles of bacteriology, Bacteria structure and spore formation. Bacteria in fish spoilage and freezing fish. Proteins and lipids of marine products and their changes during processing and preservation. Fishing drying – fundamentals, water activity and measurement, sorption isotherm. Fish dryers, effect of salt on drying and water activity. Smoked and marinated fishery products, canning of fish advantages, canning process – preparation of raw material, salting, blanching process – filling, exhausting, sealing, can washing, thermal processing, cooling, drying and packing. Sources and control of contamination. Environmental factors – methods of estimating heat resistance. Radiation processing of fish and fish products. Fish silages, Fishery products – Traditional products, fish pickles, Fish sauces, Marinated fish. Diversified and value added fish products. High value commercial products – squalence, Ambergris sea weeds and their industrial uses. Text Book: 1. Fish Processing Technology by K.Gopakumar. Indian council of Agri metural research New Delhi – 2002.

29 15. FRUITS AND VEGETABLES PRESERVATION TECHNOLOGY Principles of preservation. Canning Process of fruits and vegetables, grading washing, peeling, corning and pitting. Blanching. Can filling, processing. Effect of altitude on processing time, pressure and temperature. Effect of acidity on sterilization, cooling. Testing for defects labeling sorting and packing. Canning fruits and vegetables. Fruit juices, squashes and cordials : Equipment for fruit juices Preparation. Double operation presses pulping, Deaerator and flash pasteuriser. Fruit beverages – preparation and preservation. Preservation of fruit juices-by addition of sugar, freezing, drying, carbonation, filtration and other methods. Squashes and cardials. Fruit juice concentrates and powder. Fermented Beverages – wine, champagne. Jam Jellies and marmalades Jams fresh fruits, frozen fruits. Fruits preserved by heat treatment. Sulphitation for storing. Jellies. Fruits for jelly. Extration of pectin. Theory of jelly formation. Strength of pectin jellies packing and storage. Marmalades. Tomato products – Juice, Puree, paste, cockatail ketchup. Chilli sance. Pickles – Pickling and process, keeping quality, causes of spoilage, various types of pickles. Vinegar – Types, method of preparation, raw material, processing and fermentation. Preparation of vinegar post production process and checking spoilage. Drying of fruits and vegetables Sun drying, mechanical dehydration. Process variations, drying processes for vegetables, other methods of dehydration packing and storage. Text Book Preservation of fruits and vegetables G.S. Siddappa. ICAR New Delhi. – 1986.