SYLLABI FOR BACHELOR OF ENGINEERING (FOOD TECHNOLOGY)
EXAMINATIONS 2014-2015
SCHEME OF TEACHING AND EXAMINATION

<table>
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<tr>
<th>Paper</th>
<th>Subject</th>
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L: Lectures/Week
T: Tutorials/Week
P: Practical Hours/Week
C: Number of Credits
NC: No Credits

Note: Mid Term marks includes: Evaluation towards one best out of two minor tests (60% of marks), Assignments (20% of the marks), Class Surprise Tests, presentation, class attendance etc. (20% of the marks).
### SCHEME OF TEACHING AND EXAMINATION (2014-2015)

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* The Comprehensive Viva Voce-I Examination (Paper FT 455) will cover the subjects taught during the First, Second, Third and Fourth Semesters.
### SCHEME OF TEACHING AND EXAMINATION (2014-2015)

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**Total**

| 18 | 5 | 11 | 30 | 290 | 460 | 750 |
### SCHEME OF TEACHING AND EXAMINATIONS (2014-2015)

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*There will be 6-8 weeks’ compulsory industrial training after 6th semester theory examination during summer vacation. Every student will submit the Industrial Training report within one month from the start of teaching of the 7th Semester. After that it will be evaluated by the team of Training & Placement Officers.*

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<td>Process Modeling &amp; Simulation Lab.</td>
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<tr>
<td>FT 855</td>
<td>Viva Voce-II (Comprehensive)</td>
<td>-</td>
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<td></td>
<td><strong>Total</strong></td>
<td>9</td>
<td>3</td>
<td>9</td>
<td>20</td>
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</table>

All independent/self study courses shall be graded in terms of ‘S’ (Satisfactory) or ‘X’ (Repeat).

Requirement for the award of B.E. (Food Technology) is of 200 credits.
SYLLABUS FOR
BACHELOR OF ENGINEERING (FOOD TECHNOLOGY)
FIRST SEMESTER

Paper Title: MATHEMATICS-I (Theory)
Paper Code : FT 101      Max. Marks: 50      Credits : 4      Time: 3 hours
Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Convergence and divergence of infinite series and some simple problems, trigonometric and exponential functions of a complex variable, hyperbolic functions, separations into real and imaginary parts, summation of series (“C+IS” method only).
Successive differentiation, expansion of function, applications of maxima and minima of a function of two or more variables, curves in polar co-ordinates, angle between radius vector and tangent line, curvature, partial differentiation, Asymptotes singular and multiple points, curve tracing.

SECTION-B

Definite integrals and their properties, definite integrals as the limit of a sum of the fundamental theorem of integral calculus, determination of areas and lengths of curves, volumes and surfaces and solids of revolution. Double and triple integrals with their simple applications.
Solution of ordinary differential equations of first order and first degree with simple applications of engineering problems.

Books Recommended:

Introduction to Biology and its branches.
Prokaryotic and Eukaryotic cells.
Histology: Plant and Animal tissues, Muscles in animals.
Photosynthesis of Plants.
Digestion of foods in animals.
Organisms and their environments – Ecosystems.
Growth and development in plants and animals.
Relevance of Microbiology in preservation of foods. Composition of microbial world. Branches of Microbiology. Microscopes and their application in Microbiology.
Morphology and physiology of virus, bacteria, yeast, molds and algae. Growth, nutrition and reproduction.

SECTION-B
Isolation and identification of microorganisms. Pure cultures and their characteristics.
Generation of energy and its uses in biosynthesis.
General principles of bacterial genetics, DNA as genetic material, Mutations and their Chemical basis, recombinant DNA technology.
- Strain improvement by mutations, recombinant DNA technology
- Application of recombinant DNA technology, recombinant products available in the market, in pipeline and at laboratory scale.
- Physical and chemical methods of control of microorganisms. Microbial integrations. Food industry waste as fermentation substrate.

Books Recommended:
Classification of organic compounds: IUPAC nomenclature, Structural isomerism, Cis-trans isomerism. Shapes and Molecular orbital structures of compounds containing C, N and O. Conformations of alkanes. Organic reagents and reaction intermediates structures of dienes, pyridine, pyrrole, aromatic compounds. Optical isomerism, Chirality and optical activity; Enantiomers, Diastereomers, Meso-and Racemic compounds. Resolution of racemic mixture. Asymmetric synthesis, Walden Inversion, Configuration (D and L nomenclature), Absolute configuration (R and S nomenclature)

Chemistry of hydrocarbons: House synthesis, halogenation of alkanes, free radical mechanism, orientation, reactivity and selectivity. Cracking effect of structure on physical properties of compounds. Alkenes, catalytic hydrogenation, dehydration of alcohols, dehydrohalogenation, Saytzeff rule, electrophilic addition reactions, peroxide effect, mechanism of allylic substitution, acidity of 1-alkynes, conjugated dienes, 1,2-and 1,4-additions, free radical and ionic mechanisms of addition polymerisation reactions, ring-opening reactions of cyclopropane and cyclobutane, chemistry of benzene and alkylbenzenes, aromatic electrophillic substitution reactions, Friedel-Crafts reactions

SECTION-B

Delocalisation: Concept of aromaticity, stability of cycloalkanes, resonance concept, inductive and mesomeric effects, directive effects, activating and deactivating groups. Hydrogen-bonding.

Chemistry of functional groups: Alkyl and aryl halides, nucleophilic substitution, synthetic utility of Grignard reagents and alkyl lithiums, mechanism of Grignard reactions of alcohols, benzylalcohol, acidity of phenols epoxy compounds, Anisole nucleophilic addition, benzaldehyde, acetophene, benzophenone, aldol condensation, acidity of acids, alkyl and aryl amines.

Synthetic utility of diazonium salts, basicity of amines, multistep synthesis.

Books Recommended:


5. Mukherji & Singh: Reaction mechanism in organic chemistry, Macmillan India Ltd.,

Paper Title: INTRODUCTION TO FOOD TECHNOLOGY (Theory)
Paper Code : FT 104 Max. Marks: 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A
Definition of food, food science, and food technology. Professional bodies both in India and abroad dealing with food technology.
General introduction of food preservation. Historical developments.
Contamination of foods by microorganisms from natural sources, spoilage of different foods – general principles, causes and spoilage and growth of microorganisms in foods. Food intoxicants, mycotoxins, food poisoning and food infections-investigation of a food borne disease outbreak.
Contamination, preservation and spoilage of different foods like milk and milk products, meat and meat products, vegetables and fruits, cereal and cereal products, sugar and sugar products.
Food containers: rigid and flexible: glass, metal, plastic, packaging system characteristics and advantages.

SECTION-B
Preservation of foods by: pasteurization, sterilization, drying, radiation, refrigeration, freezing, sugar, salt, chemicals, radiation, microorganisms. Intermediate moisture foods. Fortification and enrichment of foods.
Recent trends in food processing and preservation: Introduction to high pressure processing, Hurdle technology, Ohmic heating etc.
General principles of food hygiene in food handling, personals, food processing plants. Impurities in water and its treatment. Sanitation facilities and procedures in food processing plants.
Application of mathematical techniques to describe food processing operations such as drying, rheology, degradation of nutrients and pigments during processing and storage. Use of semi-log and log-log paper.

Books Recommended:
1 Potter, N.N. : Food Science, CBS publication, New Delhi, 2005.
2 Desrosier and Desrosier : Technology of Food Preservation CBS publication, New Delhi, 2006.

Paper Title: PHYSICAL CHEMISTRY (Theory)
Paper Code : FT 105 Max. Marks: 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Solutions: Ideal and non-ideal solutions, Raoults’s law, change of free energy, enthalpy, and entropy on mixing of liquids, distillation of binary solutions. Partially miscible liquids such as Phenol-water, triethylamine-water, and Nicotine-water systems. Henry's law, Nernst distribution law, Colligative properties of dilute solutions. Abnormal molar mass, degree of dissociation and association of solutes.

Chemical Kinetics: Rate equation of reactions of various orders, rate mechanism, kinetics of complex reactions. Concept of energy barrier and energy of activation. Theories of reaction rates, measurement of extent of reaction, zero order reactions. Rates of flow systems. Lindemann theory of unimolecular reactions.


SECTION-B

Photochemistry: Laws of photochemistry, principles of photochemical excitation, quantum efficiency, Kinetics of photochemical reactions

Electrochemistry: Conductance of electrolytic solutions, transference number and its determination, Kohlrausch’s law of independent migration of ions, Interionic attraction theory, activity and activity coefficients of strong electrolytes, ionic equilibria. Ionization of water, ionization constants of weak acids and weak bases, hydrolysis, pH, commonion effect, solubility product and salt effect.

Electrochemical Cells: Reversible and irreversible cells, e.m.f. and its measurement, cell reactions and e.m.f., thermodynamics of electrode potentials, half-cell potential and its determination, Nernst equation, concentration cells, liquid junction potential, determination of activity coefficients from cell potential data, potentiometric titrations.

Books recommended:

4. Rose, J.: Dynamics of Physical Chemistry, Lond Pitman
Paper Title: ENGINEERING MECHANICS (Theory)
Paper Code : FT 106    Max. Marks: 40    Credits : 3    Time: 3 hours
Course Duration: 35 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

**Force System**: Introduction, force, principle of transmissibility of a force, resultant of a force system, resolution of a force, moment of force about a line. Varigon's theorem, couple, resolution of force into force and a couple, properties of couple and their application to engineering problems.

**Equipments**: Force body diagram, equations of equilibrium and their applications to engineering problems, equilibrium of two forces and three-force member.

**Structure**: Plane truss, perfect and imperfect truss, assumption in the truss analysis, analysis of perfect plane trusses by the method of joints, method of section and graphical method.

**Friction**: State and kinetic friction, laws of dry friction, co-efficient of friction, angle of friction, angle of repose, cone of friction, frictional lock, friction of flat pivot and collared thrust bearings, friction of journal-bearing, friction in screws, derivation of equation $\frac{T_1}{T_2} = \mu_c A$ and its application.

**Distributed Forces**: Determination of centre of gravity, centre of mass and centroid by direct integration and by the method of composite bodies, mass moment of inertia and area moment of inertia by direct integration and composite bodies method, radius of gyration, parallel axis theorem, Pappus theorems, polar moment of inertia.

SECTION-B

**Dynamics**: Rectilinear motion, plane curvilinear motion-rectangular co-ordinates, normal and tangential coordinates.

**Kinetics of Particles**: Equation of motion, rectilinear motion and curvilinear motion, work energy equation, conservation of energy, impulse and momentum, conservation of momentum, impact of bodies, co-efficient of restitution, loss of energy during impact.

**Kinematics of Rigid Bodies**: Concept of rigid body, types of rigid body motion, absolute motion, introduction to relative velocity, relative acceleration (Corioli’s component excluded) and instantaneous centre of zero velocity. Velocity and acceleration polygons for four bar mechanism and single slider mechanism.

**Kinematics of Rigid Bodies**: Equation of motion, translatory motion and fixed axis rotation, application of work energy, principles to rigid bodies conservation of energy.

**Vibration**: Classification, torsional free vibrations-single rotor and two rotar systems. Spring mass system-its damped (linear dash pot) and undamped free vibrations, spring in series and parallel, simple problems.

**Books Recommended:**

3. Hidgen, Stiles: Statics and Dynamics, Longman
**Paper Title**: BIO-SCIENCES LAB (Practical)  
**Paper Code FT 151**  
**Max. Marks**: 50  
**Credits**: 2

Use of microscopic technique for identification of microorganisms on the basis of cell morphology and specific staining technique.
Isolation of pure cultures of bacteria, yeasts, moulds and taxonomic identification on the basis of morphology and physiology.
Preparation of nutrient broth and media with agar, gelatin and specific media for culture of microorganisms.
Microorganisms are Ubiquitous and concept of aseptic conditions while cooking
Gram’s Staining
Dilution’s, pour plating, spread plating, streaking
Media preparation & sterilization.
Microbial growth determination by - O.D. and Viable Counting.
Phenol-Coefficient: Concept and Determination of those of germicides available in market.
Microbiological assay of water.
Enzyme production and assay.
Measurement of activity of anti-microbial agents for the control of microorganisms in foods.

**Paper Title**: ORGANIC CHEMISTRY LAB. (Practical)  
**Paper Code FT 152**  
**Max. Marks**: 50  
**Credits**: 2

1. Lab – Safety
2. Preparation of Benzamide & Aspirin-Purification, determination of melting point and percentage yield.

**Paper Title**: ENGINEERING GRAPHICS-1 LAB (Practical)  
**Paper Code FT 153**  
**Max. Marks**: 25  
**Credits**: 1

Introduction to Engineering Graphics, Methods of projections, Theory of orthographic projection.
Conventional practices, dimensioning as per BIS SP 46-1988
Pictorial sketching
Projection of points, lines and planes on principal planes
Projection on auxiliary planes

**Recommended Books**

1. James D. Bethune : AutoCAD, Pearson Publishers

**Paper Title**: PHYSICAL CHEMISTRY LAB. (Practical)  
**Paper Code FT 154**  
**Max. Marks**: 50  
**Credits**: 2

1. Surface tension of liquids using Stalagmometer and calculation of Parachor values.
2. Distribution of Iodine between water and carbon tetrachloride.

3. Kinetics of the hydrolysis of methylacetate in the presence of hydrochloric acid.

4. Adsorption of acetic acid on activated charcoal.

5. Viscosity of liquids and composition of a binary solution.

6. Conductometry
   - Variation of equivalent conductance and specific conductance on dilution.
   - Dissociation constant of acetic acid.
   - Solubility of sparingly soluble salts.
   - Conductometric titrations of HCl vs NaOH and acetic acid vs NaOH.

7. Potentiometric titration of HCl vs NaOH and acetic acid vs NaOH and determination of dissociation constant of acetic acid.

8. Colorimetry
   - Verification of Lambert-Beer Law.
   - Determination of concentration of solution of KMnO₄/K₂Cr₂O₇.
   - Determination of composition of Fe-Salicylic Acid Complex by Job’s Method.

Books Recommended:

Syllabus for Bachelor of Engineering (Food Technology)  
Second Semester

Paper Title: Mathematics-II (Theory)  
Paper Code: FT 201  Max. Marks: 50  Credits : 4  Time: 3 hours  
Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A  
Relationship between cartesian, cylindrical polar and spherical polar co-ordinate systems: standard forms of equation of sphere, cone, cylinder.  
Matrices: Rank of matrix, elementary transformation, Eigen-values, Eigen-vectors, Cayley-Hamilton Theorem.  

SECTION-B  

Vectors:  
Gardient, Divergence, Curl, Statement of Green’s Gauss and Stoke’s Theorem and their simple applications.  
Linear Differential Equations with constant Coefficients, Homogeneous Linear Equations, method of variation of Parameters, Simultaneous Liner Differential Equations with Constants Coefficients.

Books Recommended:

Paper Title: Chemistry (Inorganic) (Theory)  
Paper Code: FT 202  Max. Marks: 50  Credits : 4  Time: 3 hours  
Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

Section A  
1. Quantum theory and atomic structure: Introduction to wave mechanics, the Schrodinger equation, the Schrodinger equation as applied to hydrogen atom, the origin of quantum numbers and shapes of orbitals.
2. **Chemical Bonding**: Molecular orbital and valence bond theories of bond formation and application of molecular orbital theory to the formation of homonuclear and heteronuclear diatomic molecules.

3. **The Solid State**: A recapitulation of close packing of spheres, structures of NaCl, CsCl, ZnS, CaF$_2$, crystal defects and applications of defect structures (transistors, rectifiers, photovoltaic cells and computer chips).

4. **Coordination Compounds: Part 1**: Werner’s theory, effective atomic number, bonding of transition metal complexes: valence bond theory, crystal field theory, crystal field splitting in tetrahedral, octahedral and distorted octahedral (square planar) crystal fields. Thermodynamic aspects of coordination compounds (crystal field stabilisation energies of octahedral and tetrahedral complexes, spectrochemical series).

5. **Coordination Compounds: Part 2**: Kinetic aspects of coordination compounds (substitution reactions in complexes with coordination number 4 and 6 and their mechanism - $SN^1$, $SN^2$). Magnetic behaviour of complexes – Para magnetism, diamagnetism, ferromagnetism and antiferromagnetism and measurement of magnetic susceptibility of complexes by Guoy’s method.

**Section B**

6. **Organometallic Compounds**: Nomenclature, types of ligands and bonding in organometallic compounds, use of organometallics in industry.

7. **Inorganic Polymers**: Types of inorganic polymers, polyphosphazenes, polysiloxanes – their structures and properties.

8. **Role of Metals in Biological Systems**: Bio-inorganic Chemistry of Iron – Heme proteins & Non-Heme iron proteins; bioinorganic chemistry of cobalt-vitamin B$_{12}$ and metalloenzymes.

9. **Metal Toxicology**: Toxic effects of heavy metals with special reference to Cd, Pb, Hg and As.

10. Theory of quantitative inorganic analysis.

**Books Recommended:**

**Paper Title**: BIOCHEMISTRY & NUTRITION (Theory)

**Paper Code**: FT 203  
**Max. Marks**: 50  
**Credits**: 4  
**Time**: 3 hours

**Course Duration**: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Introduction to biochemical science, Enzymes and coenzymes. Introduction, definition, nomenclature, classification, numbering structure and functions of water-soluble enzymes, energy-rich compounds, active sites, mechanism of enzymes action, effect of temperature, pH, enzyme concentration and substrate concentration on the rate of enzyme reaction, specificity of enzymes, enzyme inhibition, kinetics of enzymes action, activation of enzymes, nature and functions of enzymes involved in digestion.

Metabolism of Carbohydrates: Respiratory quotient, Embden-Meyerhoff pathway, Cori and Cori Cycle, Kreb's Cycle, electron transport chain, oxidative phosphorylation.

Metabolisms of Lipids: Digestion and absorption of lipids, fatty liver, lipotropic agent, oxidation pathway, methylmalonyl Co- pathway metabolism of ketone bodies, energy balance.


SECTION-B

Nucleic Acids and their Components: Bases, nucleotides and nucleotides (cyclic also). Structures of different types of RNA and DNA. Physiochemical properties of DNA and RNA. Nucleoproteins. Replication, Transcription and Translation.

Biotechnological Concepts: Vectors used for recombinant DNA technology. Application of cloned DNA, Screening of newly synthesized DNA.


Books Recommended:

1. Lehninger : Biochemistry, Mac Millan Publisher.
2. Stryer : Biochemistry, Freeman Publisher.
Relativity: Frames of reference, Michelson – Morley experiment, Galilean and Lorentz transformation, Lorentz Fitz Gerald contraction, time dilation, postulates of special theory of relativity, variation of mass with velocity, mass energy relation.

Mechanics: Surface tension, how to calculate surface tension for a drop, experimental determination of surface tension by Jaeger’s method.

Viscosity: Coefficient of viscosity, critical velocity, Poiseuille’s equation for flow of a liquid through a tube, motion in viscous medium, Reynolds number, Bernoulli’s equation and its applications: venturimeter and pitot tube.

Physics of Materials: Magnetic materials, classification of materials, ferromagnetism, ferri and anti ferromagnetism, hysteresis. Superconductivity, Meissner effect, thermodynamics of superconducting transitions, qualitative idea of BCS theory.

SECTION-B

Optics: Ultrasonics: production, detection and uses of ultrasonics.

Interference: Formations of colours in thin films, Newton’s rings, Michelson interferometer.

Diffraction: Diffraction at a single slit, double slit diffraction grating, its theory, dispersive power and resolving power.

Polarization: Polarization by reflection, scattering, absorption and double refraction. Quarter wave and half wave plates, production and analysis of plane, circular and elliptically polarized light.

Fiber optics: Basic principle, step index and graded index fiber, qualitative idea of signal distortion and dispersion, transmission losses, fiber optics sensors and their applications.

Laser: Elementary ideas, He-Ne and Ruby laser, uses.

Holography: Basis principle, theory.

Quantum Physics: Difficulties with classical physics, blackbody radiation, photoelectric effect, Compton effect, Debroglie hypothesis, uncertainty principle, time dependent and independent Schrodinger’s equation, properties of well behaved wave function. Operators and their expectation value. X-ray diffraction and Bragg’s law.

Books Recommended:


Paper Title: MATERIAL AND ENERGY BALANCE (Theory)
Paper Code : FT 205 Max. Marks: 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Review: Stoichiometric and composition relationship gas laws; Gaseous mixtures, vapor pressure, humidity, etc.

Material Balances for Non-reaction systems including balances involving recycle and by-pass streams.

Material Balances for Reacting systems including balances involving recycle and purge streams.
SECTION-B

Combustion Calculations.
Energy balances on nonreactive and reactive systems.

*Books Recommended:*


**Paper Title:** *ENVIRONMENTAL STUDIES (Theory)*

**Paper Code : FT 206 Only Qualifying Exam. Credits :nil**

**Course Duration:** 22 Lectures of one hour each.

The Multi-disciplinary nature of Environmental Studies: Definition, scope and importance; need for public awareness.

Ecology and Ecosystems: Definition of ecology: Structure and function of ecosystem; Producers, conserver and decomposers; Energy flow in the ecosystem; Ecological succession; Food chains, food webs and ecological pyramids.

Introduction, types, characteristic features, structure and function of the following ecosystems: Forest ecosystem; Grassland ecosystem; Desert ecosystem; Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries).

Biodiversity and its conservation: Introduction - Definition: Genetic species and ecosystem diversity. Value of biodiversity: Consumptive use, productive use, social, ethical, aesthetic and option values; Biodiversity at global, National and local levels; India as a mega-diversity nation; Hotspots of biodiversity; Threats to biodiversity: Habitat loss, poaching of wildlife, man wildlife conflicts; Endangered and endemic species of India; Conservation of biodiversity; In-situ and Ex-situ conservation of biodiversity.

Natural Resources: Natural resources and their conservation:
(a) Air Resources: Features, composition, structure; air quality management.
(b) Forest Resources: Use and over-exploitation, deforestation, case studies, timber extraction, mining, dams and their effects on forests and tribal people.
(c) Water Resources: Use and over utilization of surface and ground water, floods, drought, conflicts over water, dams benefits and problems; water quality management; manager of water resources e.g. rivers, lakes, ground water, etc. Fluorosis and arsenic problems.
(d) Mineral Resources: Draw on and exploitation, environmental effects of extracting and using mineral resources, case studies.
(e) Food Resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
(f) Energy Resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies.
(g) Land Resources: Land as a resource, land degradation: Man induced landslides, solid erosion and desertification.
Role of an individual in conservation of natural resources and prevention of pollution; Equitable use of resources for sustainable lifestyles; Disaster management: Floods, earthquake, cyclone and landslides.
Environment Pollution: Definition - Air pollution: Definition, causes, effects and control measures: Air Quality Management; Air Pollution Case Studies.
Water Pollution: Definition, causes, effects and control measures; Case studies; Water Quality Management: Definition, causes, effects and control measures.
Marine pollution.
Thermal pollution.
Soil pollution: Definition, causes and control measures: Case studies.
Noise pollution.
Nuclear hazards waste management.
Waste management through cleaner technologies: Reuse and recycling of wastes.
Solid waste management: Causes, effects and control measures of urban and industrial wastes, hazardous waster; bio-medical waste; Role of an individual in prevention of pollution; Pollution case studies.
Disaster Management: Floods, earthquake, cyclone and landslides.
Social issues and the Environment: From Unsustainable to Sustainable development; Urban problems related to energy; Water conservation, rain water harvesting, watershed management; Resettlement and rehabilitation of people: Its problems and concerns. Case studies; Environmental ethics: Environmental value relationships; Environmental ethics and species preservation; Climate change: Global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. Wasteland reclamation; Consumerism and waste products. Legislation to Protect the Environment: Environmental Protection Act; Air (Prevention and Control of Pollution) Act; Water (Prevention and Control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; Environmental Impact Assessment (EIA); Environmental Management Systems (EMS); Environmental Information Systems (EIS); P.I.L: Public Hearing and Role of NGO's; ISO 9000 and 14000; Issues involved in enforcement of environmental legislation; Public awareness.
Environmental Economics: Environment and standard of living.

Paper Title: **ENGINEERING GRAPHICS-II LAB (Practical)**

Paper Code FT 251  Max. Marks : 25  Credits : 1

Projection of solids, solid modeling
Section of solids
Elementary development and intersection of solids
General introduction to isometric views
Applications: Drawing of threaded fasteners and assembly drawing using 1st angle/3rd angle projections.
Introduction and application to CAD software.

Recommended Books

1. James D. Bethune: AutoCAD, Pearson Publishers

Paper Title: INORGANIC CHEMISTRY LAB. (Practical)
Paper Code FT 252 Max. Marks: 50 Credits: 2

1. Volumetric Analysis
   (i) Redox Titrations:-
       Titrations involving
       (a) KMnO₄ (Estimation of C₂O₄²⁻)
       (b) K₂Cr₂O₇ (Estimation of Fe²⁺/Fe³⁺)
       (c) Iodine [Iodometry & Iodimetry] (Estimation of Cu²⁺, AsO₃³⁻ and Sb³⁺)
   (ii) Complexometric Titrations- Determination of Zn by EDTA titration.

2. Gravimetric Analysis
   (a) Estimation of Ba²⁺/SO₄²⁻ as BaSO₄
   (b) Estimation of Fe²⁺/Fe³⁺ as Fe₂O₃

Paper Title: BIOCHEMISTRY & NUTRITION LAB. (Practical)
Paper Code FT 253 Max. Marks: 50 Credits: 2

Analytical techniques in Bio-Chemistry, isolation and purification of enzyme, Determination of activity of enzyme, preparation, specificity, inhibition and kinetics of enzymatic reaction.
Detection and estimation of amino acid by paper and column chromatography. Assessment of nutritive value of foods.

Paper Title: PHYSICS LAB. (Practical)
Paper Code FT 254 Max. Marks: 25 Credits: 1

Coefficient of viscosity of water, milk, juices, etc by flow through a capillary tube, surface tension of water by Jaeger’s method. Mechanical equivalent of heat by calendar and Borne’s apparatus.
Books Recommended:

Paper Title: BEHAVIORAL SCIENCES AND COMMUNICATION SKILLS (Practical)
Paper Code FT 255 Max. Marks : 25 Credits : 1

1. Need and Importance: Need of good communication skills, Presentation skills – with and without physical media (Computer and Multimedia Projector), Communication skills in a group – Group discussion, communication skills in an employment interview, Communication skills and proper body language, Professional and Social etiquette, Professional meeting skills.

2. Role Playing: Role playing as an event comparer, Role playing as Chairman, Role playing as team leader. The workshop would involve learning of practical skills to develop and perfect communication ability. Students would be required to give presentations both as an individual and in a team. Group discussions would be held to develop the communication skills while in a group.
Role playing would require the students to practice the knowledge and expertise gained in communication skills to various situations where they would be required to perform the roles mentioned.
The students would be evaluated on the basis of their communication skills, participation in various activities and on the ability to work in a team.

Books Recommended:
Paper Title: MECHANICAL OPERATIONS (Theory)  
Paper Code : FT 301  
Max. Marks: 50  
Credits : 4  
Time: 3 hours  
Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A


- Motion of particle through a fluid: Stoke’s Newton’s law. Free and hindered setting.
- Setting tank and double cone classifiers
- Batch and continuous thickeners
- Settling chamber, cyclone, filter bag and electrostatic precipitators.

SECTION-B

Filtration: Plate and frame filter press, continuous rotary vacuum filter, filter aids, theory of filtration for non-compressible cakes.

Centrifugation: Tubular bowl centrifuge, disk centrifuge and batch basket centrifuge.


Mixing and Agitation: Basic ideas and characteristics of mixing equipment power consumptions scale-up.

Conveying: Mechanical and pneumatic conveying systems, storage & handling of materials.

Books Recommended:

1. McCabe, Warren L., Smith, Juluain C. and Harroit, Peter  

2. Foust, Alan S., Wenseli, Leonard A., Clump, Curtis W., mans, Louis and Anersen, L. Bryce  

3. Coulson, J.M. and Richardson, J.F.  

4. Gupta, Santosh K.  

5. Badger, Walter L. and Banchero, Julius T.  

6. Brown, C.G.  
Paper Title: FOOD CHEMISTRY (Theory)
Paper Code: FT 302  Max. Marks: 50  Credits: 4  Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Moisture in foods: Hydrogen bonding, bound water, water activity.

SECTION-B

Lipids: Classification. Occurrence in foods and composition, identification of natural fats and oils in foods. Physical (melting point, softening point, slipping point, short melting point, specific gravity, refractive index, smoke-flash and fire point, turbidity point) and chemical properties. Flavor changes in fats and oils.
Vitamins: Occurrence and chemistry of various vitamins: A, B, C, D, E, K. Losses during processing and storage.
Food Additives: Types; Methods for safety level analysis, color additives legislation.

Recommended Books.
2  Food chemistry: Fenamma
3  Food Chemistry: de Man

Paper Title: FLUID FLOW (Theory)
Paper Code: FT 303  Max. Marks: 50  Credits: 4  Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Fluid Statics: Normal forces in fluids, Pressure Measurements, Forces on Submerged bodies, Buoyancy and Stability.

**SECTION-B**

*Dimensional analysis* and its Applications to Fluid Flow.

*Flow of compressible fluids*: Compressible flow and flow through nozzles.

*Flow Measurements*: Pilot tube, Orifice, Venturi, Rotameter and Notches, wet gas metre etc.

*Fluid Machinery*: Classification and Performance of Pumps, Turbines, Compressors, and Blowers, Selection and Specification, Net positive Suction Head.

**Books Recommended:**


**Paper Title:** ENVIRONMENTAL ENGINEERING (Theory)

**Paper Code:** FT 304   Max. Marks: 50   Credits : 4   Time: 3 hours

**Course Duration:** 45 Lectures of one hour each.

**Note for the Paper setter:** The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

**SECTION-A**

Ambient air and water standards. Principal sources of pollution.

Inter-relationship between energy and environment pollution. Prevention of environmental pollution through conservation, raw material substitutions, process and equipment modifications. A case study on the concept of zero discharge.

**Air Pollution:**

- Principal air pollutants and their usual sources.
- Effect of air pollutants on human health, animals, vegetation and materials.
- Atmospheric dispersion of air pollutants, temperature inversions, Estimation of pollutants by Gaussian plume model.
- Process and equipments used for the control of particulate pollutants.

**SECTION-B**

**Water Pollution:**

- Types of water pollutants, their sources and effects.
- BOD and COD
- Waste water treatment techniques and equipments, flocculation, skimming, floatation, etc.
- Primary Treatment-through settling.
- Secondary Treatment-Aerobic and anaerobic digestion, activated sludge process, trickle filter and oxidation ponds.
Solid wastes: Control and disposal, sanitary landfill, incineration, pyrolysis gasification and recycling.

Books Recommended:


Paper Title: COMPUTER PROGRAMMING LAB. (Practical)

Paper Code FT 351     Max. Marks : 25   Credits : 1

C++ fundamentals

• Control statements
• Loops and Decisions: Relation operators, Iterations: While Loop, for Loop, do Loop, Decisions: if statement, if else statement, nested if else statement, switch statement. Logical operators, other control statements: break statement, continue statement and go to statement.
• Programming and Compiling, Exercises
• Functions

Books Recommended:


Paper Title: FLUID FLOW LAB. (Practical)

Paper Code FT 352     Max. Marks : 50   Credits : 2

1. General study of pipe fittings, valves and other equipments in the unit operations laboratory.
2. Pressure drop for flow through pipelines, valves & fittings.
3. Characteristics of pumps.
4. Flow measurement by the use of orificemeter, venturimeter, rotameter & pitot tube.
5. Flow over weirs and notches.
6. Flow measurement of compressible fluids.

Paper Title: FOOD CHEMISTRY LAB. (Practical)

Paper Code FT 353     Max. Marks : 25   Credits : 1
Preparation of samples for analyses.
Determination of moisture content (wet basis and dry basis).
Ash: total, acid soluble, alkali soluble and water soluble.
Lipids, protein, crude fibre, reducing and non-reducing sugar.
Estimation of ascorbic acid, vitamin-A, chlorophyll, carotenoids etc.
Estimation of iron, copper, lead, tin etc.

Paper Title: ENVIRONMENTAL ENGINEERING LAB. (Practical)
Paper Code FT 354     Max. Marks : 50     Credits : 2

1. To find BOD of water sample.
2. To find COD of waste sample.
3. To find the total dissolved solids (TDS) and its volatile and non-volatile components.
4. To find the total suspended solids (TSS) and its volatile and non-volatile components.
5. To do the chromium separation by different techniques from electroplating wastes.
6. To find the phenol content of water sample and evolution of parameters.
7. To operate the electrodialysis apparatus.
8. To find the biodegradation constant (K) and the effect of timing on it.
9. To use the membrane separation techniques for salt brine and reverse osmosis process for sugar.
10. To use stack monitoring kit to find:
    (a) Efficiency of a cyclone.
    (b) Dust sampling.

Note: Any six of the above mentioned experiments are to be conducted.
SYLLABUS FOR
BACHELOR OF ENGINEERING (FOOD TECHNOLOGY)
FOURTH SEMESTER

Paper Title: MATHEMATICS-III (Theory)
Paper Code : FT 401      Max. Marks: 50  Credits : 4      Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of
8 questions. 4 questions from section A and 4 questions from section B are to be set. The students
will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Solution of differential equations in series with reference to Bessel and Legendre equations, elementary
properties of Bessel and Legendre functions.
Solution of difference equation with constant coefficients.
Formation and classification of partial differential equations, first order linear equations, standard forms
of non linear equations, Charpit’s method, homogeneous linear equations with constant coefficients.
Solution of partial differential equations of engineering interest by method of separation of variables.

SECTION-B

Laplace transform: Definition, Transforms of Elementary functions, Properties of Transforms, Inverse
Transforms, Transform of Derivative Unit. Unit Step Function, Dirac Delta Function & Unit Impulse
function. Period Functions, Application of Transform to the solution of ordinary Differential equations.
Function of complex variable, analytic functions, Cauchy’s theorem, Cauchy’s integral formula,
introduction to Tayler’s series and Laurent’s series, Residues, theorem and its simple applications.

Books Recommended:


Paper Title: FOOD MICROBIOLOGY (Theory)
Paper Code : FT 402      Max. Marks: 50  Credits : 4      Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Contamination of foods by microorganisms from natural sources, spoilage of different foods: general principles, causes and spoilage and growth of microorganisms in foods. Preservation of foods by different preservation methods, contamination, preservation and spoilage of different food products. Food poisoning and food infections – investigation of food borne disease outbreak. Microbiology of individual food products - Dairy products, bread.

SECTION-B


Books Recommended:

2. Stain : General Microbiology.
5. Casida : Industrial Microbiology, John Wiley.

Paper Title: HEAT TRANSFER (Theory)
Paper Code : FT 403 Max. Marks: 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Conduction: Steady state conduction in one dimensional system, general conduction equation, effect of variable thermal conductivity, steady state conduction involving internal heat generation, lagging on pipes, the critical thickness of insulation on pipes, extended surfaces of uniform thickness and fin effectiveness, fin efficiency.

Convection: Free and forced convection, concept of heat transfer co-efficient, dimensionless numbers in free and forced convection, Dimensional analysis, Determination of Heat transfer coefficient using heat and momentum transfer analogies, experimental determination of heat transfer coefficient and common working correlations.
**Radiation Heat Transfer:** Black Body radiation, and grey body radiation, physical mechanism, radiation properties and shape factor, heat exchange between non-black bodies, radiation shields pyrometry and effect of radiation on temperature measurement.

**SECTION-B**

**Condensation and Boiling:** Condensation heat transfer phenomenon, film condensation on vertical plates and cylinders as well as on horizontal cylinders. Effects of non-condensable gases and vapor velocity on condensation, pool boiling, forced convection boiling, working correlations for pool boiling.

**Evaporation:** Types of evaporators, single and multiple effects, single and multiple effects calculations, evaporator capacity, economy, effect of liquid head and boiling point elevation, methods of feeding.

**Heat Exchangers:** Various types of heat exchangers, overall heat transfer coefficients, heat exchanger mean temperature differences, heat exchanger effectiveness and the number of transfer units.

**Books Recommended:**


**Paper Title:** PROCESSING OF CEREALS & PULSES (Theory)

**Paper Code : FT 404** Max. Marks: 50 Credits : 4 Time: 3 hours

Course Duration: 45 Lectures of one hour each.

**Note for the Paper setter:** The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

**SECTION-A**

Composition, structure and quality, characteristics of cereal grains and pulses.


**Millling of Wheat:** Criteria of wheat and flour quality, flour milling, wheat milling machinery. Rheology and Chemistry of dough, Physical dough testing instruments. Technology of baking bread, biscuit, cookies, cakes. Durum wheat and pasta products like macaroni, noodles and spaghetti. Cereal based infant foods.

**SECTION-B**

**Corn Milling:** Dry and wet milling of corn, corn based ready to eat breakfast cereals. Corn oil-processing and utilization, Corn starch modification and uses, Corn sweeteners such as glucose syrup, high fructose corn syrups, dextrose, maltodextrin.

**Millling of Pulses:** Different methods of pulse milling. Pulse milling machinery. Application of enzymes in processing of cereals and pulses processing. Sanitation in the processing plant.
Design of equipment used in milling of wheat, rice, corn and pulses. Plant layout.

Books Recommended:

2. Pomeranz, Y. : Wheat Chemistry and Technology, CHIPS Book, USA.
3. Tanley A. Watson & Paul E. Ramstad : Corn Chemistry and Technology, ADCC, USA.
4. Julliano, B.O. : Rice Chemistry and Technology, AAC C, USA.
5. Pandey, P.H. : Post Harvest Technology.

Paper Title: FUNDAMENTALS OF ELECTRICAL & ELECTRONICS ENGINEERING (Theory)

Paper Code : FT 405 Max. Marks 50 Credits : 4 Time: 3 hours

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

DC Circuits and Single Phase A.C. Fundamentals: General introduction to Electrical Engineering, Kirchoff’s Laws, Mesh and Node analysis, Superposition theorem, Thevenin Theorem, Norton Theorem, Maximum power transfer theorem. Generation of alternating voltages and currents, Equations for AC quantities, cycle, time period, frequency, amplitude, calculation of R.M.S values, Average values for different waveforms, solution and phasor diagram of single phase AC circuit with sinusoidal source of excitation, series and parallel combination of R-L-C circuits.

Three Phase AC Fundamentals: Disadvantages of single phase system, star and delta connection in three phase circuits, relation between line and phasor quantities, power in three phase system, solution of three phase balanced circuits, power and power factor measurement by two wattmeter method.

Electrical Machines: Introduction to magnetic circuits, Basic principle and construction of transformers, E.M.F equation, approximate equivalent circuit, phasor diagram, losses, efficiency and condition for maximum efficiency, open circuit and short circuit test on single phase transformers. Operating principle and construction of three phase induction motors, production of rotating field, concept of slip, frequency etc. Operating principle and construction of DC
generators, types of DC Generators, E.M.F equations, Principle of DC Motors and their applications.

**SECTION-B**

**Semiconductor Diodes and Transistors**: General introduction to Electronics. Concept of stiff Voltage and Current Source. PN Junction, Depletion layer, Barrier Potential, Forward and Reverse Bias, Breakdown voltage, V-I characteristics, Half wave and full wave rectifiers, Zener diode. Introduction to junction transistors, Transistor amplifying action, CB, CE, CC-configuration characteristics.

**Operational Amplifiers**: Block Diagram, characteristics of an ideal OP-AMP, Application of OP-AMP as an Inverting amplifier, Non-Inverting Amplifier, Adder, Differential, Integrating amplifier.

**Digital Electronics**: Binary and Hexadecimal number system, conversion of numbers from one system to other, OR, AND, NOR, NAND, NOT Gates, Universal Gates, Exclusive OR, NOR gates, De-Morgan’s Theorem, Boolean Relations: Commutative, Associative and Distributive Laws. Concept of flip-flops, RS,JK flip flops, shift register.

**Books Recommended**:

2. Nagsarkar, T.K. and Sukhija M.S.
3. Nagrath, I.J. and Kothari, D.P.
: Basic Electrical Engg., TMH, New Delhi.
Paper Title: PARTICLES MECHANICS LAB. (Practical)
Paper Code FT 451     Max. Marks : 50     Credits : 2
1. Pressure drop and two phase flow characteristics in packed and fluidized beds.
4. Constant pressure filtration.
5. Mixing, crushing, grinding, screening and particle size analysis.

Paper Title: FOOD MICROBIOLOGY LAB. (Practical)
Paper Code FT 452     Max. Marks : 50     Credits : 2
Bacteriological examination of foods: General protocol taking the examples of different foods.
Presumptive coliform test of milk, butter, cream, ice-cream and dahi.
Standard plate count for pasteurized milk and ice-cream.
Yeast and mold count for butter, dahi and bread.
To access bacteriological quality of milk by methylene blue reduction test and resazurin reduction test.

Paper Title: CEREALS & PULSES PROCESSING LAB. (Practical)
Paper Code FT 453     Max. Marks : 50     Credits : 2
(PRACTICALS)
- Milling of wheat.
- Evaluation of properties of wheat and milled products - Physical, chemical and rheological.
- Baking of bread, biscuit, cake, pastries.
- Evaluation of baked bread.
- Evaluation of properties of rice (physical and chemical).
- Cooking quality of rice.
- Experiment on parboiling, evaluation of quality.
- Milling of rice, assessment of degree of polishing.
- Milling of pulses.
- Visit to flour mill, rice mill and pulse mill industries.

Paper Title: ELECTRICAL & ELECTRONICS ENGINEERING LAB. (Practical)
Paper Code FT 454     Max. Marks : 50     Credits : 2
1. Overview of the equipments, instruments and procedure to be used, safety precautions and report writing.
2. To study resonance in R-L-C series and parallel circuit.
3. Measurement of power and power factor by three voltmeter method.
4. Measurement of power and power factor by three ammeter method.
5. To measure power and power factor using a single wattmeter in a single phase circuit.
6. Measurement of power and power factor of three phase balanced load by two wattmeter method.
7. To perform open circuit test and short circuit test on a single phase transformer and draw equivalent circuit.
8. To obtain magnetization characteristics of DC Machine
9. Study the forward and reverse biased diode characteristics.
10. Study the CB, CE, CC transistor characteristics.
11. To obtain the waveforms of half wave rectifier circuit on CRO
12. To obtain the waveforms of full wave rectifier circuit on CRO
13. To study the OP-AMP as an Inverting amplifier, Phase Shifter, Integrator, Differentiator.
14. Verification of basic and universal gates.

**Paper Title:** COMPREHENSIVE VIVA-VOCE-I (Practical)
**Paper Code FT 455**  
**Max. Marks : 50**  
**Credits : 2**

The viva-voce examination will be comprehensive and covering mainly subjects covered during the first four semesters.

**Paper Title:** BASIC WORKSHOP TECHNIQUES (PRACTICALS)
**Paper Code FT 456**  
**Qualifying**  
**Credits : NC**

*Carpentry Shop:* Introduction to various types of timber and particle, boards defects in timber, seasoning of wood. Description and use of carpenter's tools, i.e. saws, planes, chisels, adze, etc. Different types of timber in common use, making of lap joint, Bridle joint, dovetail joint and Mitre joint.

*Electric Tools:* Exercise of wiring in link clip and casting and causing wiring of lights with switches in parallels, series and with 2 ways switches. Connecting energy meter, main switch and distribution board, testing a wiring installation for insulation resistance. Relevant Indian Electricity Rules.

*Machine Shop:* Classification of fabrication processes, machine tools and materials, introduction to working of lathe, shapper, milling and drilling machines, power hacksaw, shearing machine and grinding wheel. Simple turning, threading, drilling board and knurling operations on a lathe.

*Welding:* Use of arc welding and gas welding in making different types of joints.
SYLLABUS FOR  
BACHELOR OF ENGINEERING (FOOD TECHNOLOGY)  
FIFTH SEMESTER

Paper Title: **NUMERICAL METHODS IN ENGINEERING**  
Paper Code: FT 501  
Max. Marks: 50  
Credits: 4  
Time: 3 hours

**Course Duration:** 45 Lectures of one hour each.  
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

**SECTION-A**


**SECTION-B**

Numerical Solution of Partial Differential Equations: Finite-Difference Approximation to Laplace’s Equation, Parabolic Equations and Hyperbolic Equations

**Books Recommended:**

Paper Title: **PROCESSING OF FRUITS & VEGETABLES** (Theory)  
Paper Code: FT 502  
Max. Marks: 40  
Credits: 3  
Time: 3 hours

**Course Duration:** 45 Lectures of one hour each.  
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

**SECTION-A**
Physiology of ripening. Effect of physical and chemical treatments on post harvest life of fruits and vegetables. Role of plant growth regulators in post harvest storage, Storage and handling of fresh fruits and vegetables. Preservation of fruits and vegetables by heat treatment, Canning Processing and preservation of fruits and vegetable juices. Preparation of jams, jelly, marmalade, preserves, pickles and vegetable products.

SECTION-B

Design of cleaning, cutting, blanching, and thermal processing equipments. Plant layout.

Books Recommended:
3. Luh & Woodroof: Commercial Vegetable Processing, AVI Publishing, USA.

Paper Title: PROCESSING OF MILK & MILK PRODUCTS (Theory)
Paper Code: FT 503 Max. Marks: 50 Credits: 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A
Chemical composition, nutritive value and physical characteristics of milk and milk products.
Production, processing, distribution and storage of liquid milk.
Technology of manufacture of cream, butter, ghee and ice-cream.
Technology of manufacture of evaporated milk and condensed milk.
Technology of manufacture of cheese and other fermented milk products.

SECTION-B
Fortification of milk products with nutrients, quality standards.
Production of infant milk food.
Utilization of dairy byproducts such as whey, butter-milk etc.
Quality control in milk and milk products including various analytical techniques of determination of milk quality. Milk plant hygiene, sanitation
Design of storage tank, pasteurizer, cream separator, milk evaporator, ice-cream mixer and freezer. Plant layout.

Books Recommended:
3. Eckles: Chemistry & Technology of Milk, CBS Publisher, India.

Paper Title: MASS TRANSFER-I (Theory)

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Paper Code: FT 504
Max. Marks: 50
Credits: 4
Time: 3 hours
Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B. Total of 8 questions. 4 questions from Section A and 4 questions from Section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A
Mass transfer operations, classification of mass transfer operations, choice of separation methods, methods of conducting mass transfer operations, design principles.
Introduction to mass transfer and diffusion, molecular diffusion in gases and liquids, diffusion coefficients for gases and liquids, diffusion in solids, types of solid diffusion.
Mass transfer coefficients, types of mass transfer coefficients, mass transfer coefficients in laminar flow, theories of mass transfer.
Interphase mass transfer, concept of overall mass transfer coefficient.

SECTION-B
Working principle, construction and industrial applications of various gas-liquid contacting equipments like sparged vessels, mechanically agitated vessels, tray towers, packed towers, spray chambers, venturi scrubbers.
Humidification operations, psychometric chart, adiabatic saturation temperatures, wet bulb temperature, adiabatic operations, types of cooling towers.
Principle of drying, batch drying, drying curve, constructional details and working of different dryers.

Books Recommended:

Paper Title: PROCESSING OF OIL SEEDS, OILS & FATS (Theory)
Paper Code: FT 505
Max. Marks: 50
Credits: 4
Time: 3 hours
Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B. Total of 8 questions. 4 questions from Section A and 4 questions from Section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A
Oil milling methods: Ghani, mechanical expeller, hydraulic press, solvent extraction. Refining of edible oils & fats.

SECTION-B
Classification of vegetable oil. Modifications of the properties of oils & fats including chemical and biotechnological processes. Confectionary plastic fats. Preparation of various products.

Books Recommended:
1. Bailey : Fats and Oil, Wiley, USA.

Paper Title: ENGINEERING THERMODYNAMICS (Theory)
Paper Code : FT 605 Max. Marks: 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

SECTION-B
Phase Equilibria:
Partial molar properties, partial molar Gibbs free energy, Chemical potential and its dependence on temperature and pressure Ideal solutions (Lewis-Randel Rule).
Chemical Equilibria:
Equilibrium constant in terms of measurable properties variations of equilibrium constant with temperature and pressure. Adiabatic reactions, Gibbs phase rule, equilibria in heterogeneous reactions.

Books Recommended:

Paper Title : PROCESS PLANT DESIGN -I (Practical)
Paper Code FT 551     Max. Marks : 50  Credits : 2

2. Selection, specification & power requirements of process pumps, fans and blowers.
3. Design of settling equipment like Dor thickeners, dust chambers, cyclone separator & centrifuges.
4. Design of agitated vessels using various types of impellers.
5. Design of conveyor system for solids.

Books Recommended:

Paper Title : FRUITS & VEGETABLES PROCESSING LAB (Practical)
Paper Code FT 552     Max. Marks : 50  Credits : 2

1. Blanching of fruits and vegetables: Effect of temperature, time and selected compounds on blanching.
3. Preparation of jam, marmalade preserve, candy.
4. Preparation of fruit juice concentrate and powder.
5. Preparation of tomato products.
6. Preparation of pickles, chutneys, sauces.
7. Drying of fruits & vegetables.
8. Freezing of fruits & vegetables.
10. Can seaming operation and canning of fruits and vegetables.
11. Visit to a fruit and vegetable processing plant.

Paper Title : MILK & MILK PRODUCTS PROCESSING LAB (Practical)
Paper Code FT 553     Max. Marks : 50  Credits : 2

1. Physical and chemical analysis of milk & milk products.
2. Testing the adulteration in milk & milk products.
3. Preparation of cream, butter, ghee, ice-cream, milk powder and condensed milk.
5. Visit to a milk processing plant.

**Paper Title: OILS & FATS PROCESSING LAB. (Practical)**

**Paper Code FT 554**
Max. Marks : 25               Credits : 1

1. Determination of oil content of foods by Soxhlet method.
2. Determination of specific gravity of oils and fats.
4. Determination of free fatty acids and acid value of fats and oils.
5. Determination of peroxide value of fats and oils.
7. Determination of melting point and smoke point of fats and oils.
10. Determination of Reichert Neisl number and Polenske value of fats and oils.
11. Determination of oil absorption during deep-oil frying of foods
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Introduction and a brief review of the kinetics of homogeneous reactions.
Interpretation of rate data from constant volume and constant pressure systems.
Single Ideal reactors.
Design for single reactions.

SECTION-B

Design for multiple reactions.
Thermal characteristics of reactors: temperature and pressure effects.
Non-ideality in reactors and its effects on chemical conversion. One parameter models to represent the behaviour of chemical reactors.

Books Recommended:


Paper Title: PROCESS INSTRUMENTATION (Theory)
Paper Code : FT 602 Max. Marks: 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

General Concept: Need and classification of measurements and instruments, Basic and auxiliary functional elements of a measurement system.
Static and Dynamic Characteristics of Instruments:
Static Characteristics: Range and span, accuracy and static error, reproducibility and drift, sensitivity and dead zone.
Dynamic Characteristics: Speed of response and lag, fidelity and dynamic error, dead time.
Temperature measurement:
Thermocouples, metal resistance thermometers and thermistors, optical and radiation pyrometers, radiation receiving elements.
Pressure measurement:
Use of manometers, Bourdon gauge, bellows type gauge. Vacuum measurement—Mcleod gauge, thermoionic type ionization gauge, pirani vacuum gauge. Measurement of pressure in corrosive fluids: Diaphragm seal, liquid seal and purge system.

SECTION-B

Liquid level measurement:
Direct measurement of liquid level—Float & tape liquid level gauge, float and shaft liquid level unit, hydraulic remote transmission of liquid level.
Level measurement in open vessels: Bubbler system, diaphragm box system, air trap system. Level measurement in pressure vessels — Differential pressure manometer, use of liquid seals with a manometer, displacement float liquid level gauge. (6 Hrs.)
Measurement of viscosity, conductivity, humidity and pH.
Density measurement — liquid level method, displacement meter and hydrometer.
Measurement of weight — spring scale, pneumatic force meter and hydrostatic force meter.
Process Instrumentation—Recording instruments, indicating and signaling instruments, control centre, transmission of instrument reading, instrumentation diagrams.

Books Recommended:
1. Eckman, Donald P. : Industrial Instrumentation, CBS Publisher and Distributors, Indian Reprint 2004.

Paper Title: CONFECTIONARY TECHNOLOGY (Theory)
Paper Code : FT 603 Max. Marks: 40 Credits : 3 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A
Types of confectionary goods.
Characteristics and processing of raw materials.
Technology of manufacture of toffee, chocolate, fruit drops, hard-boiled candies, bars, chewing gums, bubble gums and special confectionary goods.

SECTION-B

Books Recommended:

Paper Title: MASS TRANSFER-II (Theory)
Paper Code: FT 604 Max. Marks: 50 Credits: 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A


SECTION-B

Liquid-Liquid Extraction: Ternary Equilibria and its representation on various plots. Selection criteria for solvent, Multistage extraction using partially miscible & immiscible solvents. Stagewise contact for countercurrent and crosscurrent extraction. Constructional details of equipment like mixer-settler, packed columns, pulsed extractor, sieve-tray extractor and centrifugal extractor.

Leaching: Preparation of solid, countercurrent and crosscurrent multistage contact Shank’s system. Constructional details of equipment like Rotocel extractor, Hildebrandt extractor, Bollman extractor, Kennedy Extractor & Beet-Sugar Diffusion battery extractor.

Adsorption: Types of adsorption, nature of adsorbents, equilibria for adsorption systems. Brief manufacture and commercial applications and characteristics for common adsorbents. Stagewise & continuous contacting of fluid and solid phase. Description of contact filtration adsorption system. Hypersorber Ion-exchange system.

Crystallization: Growth and properties of crystals saturation, nucleation, growth of crystals, effect of impurities on crystal formation, effect of temperature on solubility, fractional crystallization, yield of crystals, crystal purity, yield calculation using phase diagram, energy requirements using enthalpy-concentration diagram. Methods of creating super saturation-Meirs supersolubility curve. Mechanism

**Books Recommended:**


Paper Title: **BEVERAGE TECHNOLOGY (Theory)**

Paper Code : FT 605  Max. Marks: 40  Credits : 3  Time: 3 hours

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

**SECTION-A**

Status of the beverage industry in India. Its future prospects.
Technology of manufacture of mineral water.
Technology of manufacture of non-alcoholic beverages: fruits & vegetable juices, soft drinks, dairy beverages, etc.

**SECTION-B**

Technology of manufacture of alcoholic beverages: Beer, wine, whiskey, rum etc.
Technology of manufacture of tea and coffee drinks.
Design of equipments used in manufacturing of beverages. Plant layout.

**Books Recommended:**

1. Woordroof & Phillips : Beverages, AVI Publication, USA.
3. Ranganna : Handbook of Analysis of Fruit and Vegetable Products.

Paper Title: **MASS TRANSFER LAB. (Practical)**

Paper Code FT 651  Max. Marks : 50  Credits : 2

1. Determination of mass transfer coefficients for naphthalene-air system.
2. To determine drying rate curves for different wet solids in a batch drier under constant drying conditions.
3. Fractional approach to equilibrium for liquid-liquid extraction from single drop.
4. Verification of Rayleigh’s equation for differential distillation.
5. Determination of flooding velocities in packed columns.
6. Determination of HETP for packed distillation columns.
7. Study and operation of a pilot sized distillation column under total reflux.
8. Study of different mass transfer equipments.

**Paper Title:** PROCESS PLANT DESIGN –II (Practical)
**Paper Code FT 652**  Max. Marks : 50  Credits : 2

1. Process design and specifications of double pipe heat exchanger, shell and tube heat exchanger, plate type heat exchanger, condenser and reboiler.
2. Equilibrium procurement techniques – experimental and use of thermodynamics for its evaluation and then use in design height of distillation column. Calculations using McCabe Thiele, Plate-to-Plate calculation methods for fractionators, design of batch fractionating columns, design of fractionators internals for sieve-tray.
3. Absorber/Stripper design of stage-wise and continuous contact equipment (packed column), height of column and diameter calculation, design of various internals of absorber/stripper.
4. Process flow sheets, material and energy balance flow sheeting analysis.

**Books Recommended:**


**Paper Title:** BEVERAGE & CONFECTIONARY PROCESSING LAB. (Practical)
**Paper Code FT 653**  Max. Marks : 50  Credits : 2

1. Water hardness, acidity, basicity, chlorination, total dissolved solids, chlorides, iron, phosphorus in water.
2. Determination of alcoholic content in beer and wine using the distillation method.
3. Sulphur dioxide content in juices, squash, wine etc.
4. Acidity and total soluble solids determination in different beverages.
5. Manufacture of whey.
7. Determination of extract in tea leaves.
8. Sensory evaluation techniques and their uses.
SYLLABUS FOR
BACHELOR OF ENGINEERING (FOOD TECHNOLOGY)
SEVENTH SEMESTER

Paper Title: FOOD REGULATION & QUALITY CONTROL (Theory)
Paper Code : FT 701      Max. Marks: 50      Credits: 4      Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of
8 questions. 4 questions from section A and 4 questions from section B are to be set. The students
will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A
General Principles of Quality Control, Quality Attributes: Colour, gloss, viscosity and consistency, size, shape and texture, flavour, taste, sensory evaluation techniques.
Microbiological methods of quality evaluation. Application of Biosensors to check the quality of packaged food products

SECTION-B
Government and trade standards for quality.
Food Laws and Regulations: PFA, FPO, BIS, AGMARK, ISO, etc.
Quality of Different Food Products: Cereals, fruits, vegetables, milk, egg, meat, fish etc.

Books Recommended:

Paper Title: PROCESS ENGINEERING ECONOMICS (Theory)
Paper Code : FT 702      Max. Marks: 50      Credits: 4      Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of
8 questions. 4 questions from section A and 4 questions from section B are to be set. The students
will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A
SECTION-B


Optimum Design: Procedure with one variable, optimum reflux ratio in distillation and other examples.

Preliminary Steps in Plant Design: Plant design factors, project organization, plant location, preliminary data collection, process engineering.

Books Recommended:


Paper Title: PACKAGING TECHNOLOGY (Theory)
Paper Code : FT 703 Max. Marks: 50 Credits: 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A
Basic concepts, function of food package, packaging materials, cellulosic, glass, metal, polymeric composite, rigid, semi-rigid and flexible package forms, adhesive, band and closure, coatings and labels, packaging, product characteristics and packaging requirements, selection of material, form, machinery and method of packaging, package printing, standards and regulations. Active Smart packaging and Edible packaging

SECTION-B
Special problems in packaging of foodstuffs. Biodegradable packaging.
Design of packaging equipments.
Evaluation of packaging materials for different food products and package performance.
Use of Nanocomposites in food packaging

Books Recommended:

SECTION-A
Isolation and Utilization of Enzymes: Purification, immobilization, application of enzyme technology.
Kinetics of Enzyme-Catalyzed Reactions: The substrate, enzyme kinetics, factors affecting enzymatic activity and enzymatic reactions in heterogeneous reactions.
Metabolic Pathways and Energetics of the Cell: The concept of energy coupling, aerobic and anaerobic metabolism, photosynthesis and biosynthesis, transport across cell membranes.
Cellular Genetics and Control: Growth and reproduction of a single cell, alteration of cellular DNA, commercial applications.

SECTION-B
Transport Phenomena in Microbial Systems: Gas-liquid mass transfer, determination of oxygen transfer rates, mass transfer, surface-area correlations for mechanically agitated vessels, scaling of mass transfer equipment, particulate mass transfer, heat transfer.
Design and Analysis of Biological Reactors: The ideal continuous-flow stirred-tank reactor (CSTR), residence time distribution, different types of reactors, relationship between batch and continuous biological reactors. Fermentation technology, product manufacture by fermentation, reactors for biomass production.

Books Recommended:

Paper Title: FOOD QUALITY CONTROL & PACKAGING LAB. (Practical)
Paper Code FT 751 Max. Marks: 25 Credits: 1

Quality Control:
Estimation of product quality with respect to the color, size, shape. Viscosity, texture, flavour, taste, sensor evaluation, market testing of products. Evaluation of food standards.
Packaging:
1. Strength properties of packaging materials.
2. Water vapour and gas transmission rates of flexible packaging materials.
4. Pre-packaging of vegetables.
5. Shrink packaging of poultry.
7. Vacuum and gauge packaging.
Errors analysis, solution of linear and non-linear algebric equations.
Numerical differential & integration.
Interpolation.
Least squares approximation.
Ordinary and partial differential equations.
Development of computer programs based on the above topics using Matlab and their applications in chemical process computations.

Books Recommended:

Selection of topic for the seminar related to food processing. Preparation of technical report on an assigned topic after survey of scientific, technical and commercial literature, using journals, popular articles and other information retrieval methods. Use of computer softwares for report writing. Presentation of the seminar.

Each student will be required to submit a report after each factory visit/training programme throughout the entire course. The reports will be assessed by teachers in charge of the programme.

Each student is required to submit a project report on the design of a food processing plant, selecting the best process with optimum equipment size and operating conditions. The object is to test the ability of the student to apply his entire knowledge of food processing technology principles to conceptualize, analyze and solve the problems. To judge his knowledge and originality and capacity for application of laboratory data in designing food processing plants and to determine the level of his proficiency at the end of the course.
SYLLABUS FOR
BACHELOR OF ENGINEERING (FOOD TECHNOLOGY)
EIGHTH SEMESTER

Paper Title: INDUSTRIAL MANAGEMENT (Theory)
Paper Code : FT 801      Max. Marks: 50      Credits: 4      Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Process of decision making, elements in decision making nature and framework of planning short and long range planning policy formulation organisation structure and behaviour, decentralisation and delegation. line-staff relationship motivation and morale, communication, inter-personal and group behaviour, coordination and direction.

SECTION-B

Purpose, processes and areas of control; control standards, control reports, budget as control device. Economic planning and policy in India, industrial policy, industrial development in India. Position and problems of chemical industries in India.

Books Recommended:

Paper Title: PROCESS DYNAMICS & CONTROL (Theory)
Paper Code : FT 802      Max. Marks: 50      Credits: 4      Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Incentives for chemical process control, design aspects of a process control system. Difference between feedback and feed forward control configuration. Hardware elements of a control system, Block Diagrams.

Laplace transform and transfer functions. Difference between lumped and distributed parameter systems, Dynamic behaviour of first and higher order systems, interacting and non-interacting systems, dead time.

Different modes of control actions and their basic characteristics, controllers and their characteristics, control valve.

SECTION-B
Closed-loop transfer functions, transient response of simple control systems, Routh stability criterion, Root Locus.

Introduction to frequency response: Bode diagrams, control system design by frequency response: Ziegler-Nichols controller settings, stability using frequency response, gain margin and phase margin.

Introduction to advanced control techniques such as cascade control, feed forward control, ratio control, inferential control.

**Books Recommended**


**Paper Title:** PROCESSING OF MEAT, FISH & POULTRY (Theory)

**Paper Code:** FT 803  Max. Marks: 50  Credits: 4  Time: 3 hours

**Course Duration:** 45 Lectures of one hour each.

**Note for the Paper setter:** The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

**SECTION-A**


**SECTION-B**

Fish structure and composition, cold storage, freezing preservation and canning of fish. Pickling of fish, fish protein concentrates, fish meal and by-products of fish processing industry. Sanitation in meat, fish, egg and poultry processing plants.

**Books Recommended:**

Paper Title: MEMBRANE SEPARATION PROCESSES (Theory)
Paper Code: FT 804   Max. Marks: 50   Credits: 4   Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A
Fundamental, mechanism of membrane transport, gaseous diffusion, separation in liquid phase, dialysis, reverse osmosis, ultra filtration, liquid membrane.

SECTION-B
Electromembrane processes, transfer coefficient and its determination, engineering aspects of membrane separation and industrial application.

Books Recommended:

Paper Title: Project Work
Paper Code: FT 851   Max. Marks: Qualifying   Credits: 2

Paper Title: ELECTIVE LAB. (Practical)
Paper Code: FT 852   Max. Marks: 25   Credit: 1

i) PROCESSING OF MEAT, FISH & POULTRY
(a) Fish & Meat: Cutting and handling.
(b) Dressing of poultry.
(c) Evaluation of quality of meat, fish & poultry.
(d) Canning, freezing, dehydration & curing of meat & fish.
(e) Quality of egg & egg powder, egg preservation.
(f) Preparation of pettie, emulsion etc.
(g) Visit to meat, fish & poultry processing industries.

ii) MEMBRANE SEPARATION PROCESSES
(a) Preparation of membranes.
(b) Study of separation characteristics of membranes.
(c) Study of the effective life of membranes.
(d) Liquid membranes (i) emulsion type (ii) supported liquid membrane.
(e) Emulsion membrane: Design of liquid surfactant membrane system to treat industrial effluent.
(f) Concentration of liquid foods such as milk, juices using membranes.
Calibration of temperature, pressure, flow and composition measuring instruments. Study of process characteristics. Investigation of the operation of pneumatic and electronic controller with proportional integral, derivative action. To determine the best setting of a controller with controlling as actual process. To solve first order or higher order differential equations with the help of an analog computer and to study control problems by analog simulation. Selected experiments on isothermal, homogeneous batch and continuous reactors, stirred tank and tubular reactors. Residence time distribution.

Functional design, property estimate as inputs for design. System concepts for computer aided design, computer aided flow sheet design. Process analysis. Process variables selection, equipment design through the selection of free parameters subject to constraints and other parameters, Modular design. Simulation optimality. Dynamic design including control stability. Typical equipments to be considered heat exchanges, distillations factor and process equipments.

**Books Recommended:**

The viva-voice examination will be comprehensive and covering mainly food technology subjects covered during all the semesters including the Eighth Semester.