### SCHEME OF TEACHING AND EXAMINATION (FIRST AND SECOND SEMESTER)

<table>
<thead>
<tr>
<th>TheorY</th>
<th>Subject</th>
<th>Teaching Hours per week</th>
<th>Exam Marks</th>
<th>Sessional Marks</th>
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<td>Food Engineering</td>
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L: Lectures/week  
T: Tutorial/Week  
P: Practicals Hours/Week  
C: Number of Credits
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**Practicals**

| 2.2.1  | Food Processing and Analysis | - | - | 2 | 1 | 25 | 25 |

**Total**

|        |              | 15 | 5 | 4 | 21 | 250 | 275 | 525 |
### SCHEME OF TEACHING AND EXAMINATION (THIRD & FOURTH SEMESTER)

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<td>30 15</td>
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#: Preliminary thesis will be evaluated on the basis of seminar presentations and discussions and the candidate shall be awarded ‘S’ grade i.e. satisfactory for continuation or else ‘X’ grade i.e. unsatisfactory.

- List of Electives (FT 3.2) (Any one to be offered)
  1. Advanced Food Microbiology
  2. Advanced Food Biotechnology
  3. Food Rheology and Texture
  4. Thermal and Non Thermal Processing of Foods
  5. Nanotechnology
  6. Industrial Pollution Control and Abatement

NOTE:

The student is required to make seminar presentation(s) of the results achieved before the submission of the thesis.
1. The Post Graduate Student Research Committee (PGRC) of the Institute will evaluate the Thesis.

The constitution of the committee is as under:

a. Chairperson of the institute
b. Senior professor of the institute
c. Supervisor(s)
d. External examiner

2. The PGRC will evaluate the final thesis based on an open house presentation by the student, which will be attended by the faculty members, PG students and other research scholars of the institute.

3. No marks are assigned to Preliminary Thesis and Thesis evaluation work. On successful completion and presentation of Research Seminars, the candidate will be awarded ‘S’ grade i.e. satisfactory or else ‘X’ grade i.e. unsatisfactory.

4. Requirement for the award of M.E. in Food Technology degree is 75 credits with minimum CGPA of 6.0 and successful completion of thesis work.
SYLLABUS FOR M. E. (FOOD TECHNOLOGY) **FIRST SEMESTER**

**FT 1.1 Food Engineering**

Paper Title: Elective (Theory)

Paper Code : FT 1.1; 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**

Freezing of foods, prediction of freezing time.


**Reference Books**


**FT 1.2 Biochemical Engineering**

Paper Title: Elective (Theory)

Paper Code : FT 1.2; 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**


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.

Downstream processing, primary, secondary and tertiary products.

Production of industrial products, case study of few products. Wastewater engineering. Genetically modified foods.

Reference Book


FT 1.3 Food Safety and Quality Management

Paper Title: Elective (Theory)

Paper Code: FT 1.3; 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

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

Concept of quality management, objectives, importance & functions of quality control, quality management systems in India, sampling procedures and plans, food safety & standard act 2006, domestic regulations, global food safety initiative, various organization dealing with inspection, FSSAI and its role. Traceability and authentication, certification & quality assurance (PFA, FPO, MMPO, MPO, AGMARK, BIS), labeling issues, international scenario, international food standards.
SECTION B

Quality assurance, total quality management, GMP/GHP, GLP, GAP, stationary & hygienic practices, HACCP, quality manuals, documentation & audit, Indian & international quality systems & standards like ISO, food CODEX, export import policy, export documentation, laboratory quality procedures and assessment of laboratory performance, applications in different food industries, food adulteration & food safety, IPR and patent.

FAO/WHO food standards, Food Additives, Contaminants, Pesticide Residues, Residues of Veterinary Drugs, Food Labeling, Organically Produced Food, Food Derived by application of Biotechnology.


Application of Chromatographic methods: Gas chromatography and liquid chromatography.

Mass spectrometry, Immunological Assay (Elisa, PCR) in food analysis.

Reference Books:

FT 1.4 Selected topics of Cereals, Oilseeds and Pulses

Paper Title: Elective (Theory)

Paper Code : FT 1.4; 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

World production and trade of grains. Status of cereal, pulses and oil seeds in Indian economy. General chemistry of starch. Degardation products and starch derivatives. Use of starch in food.


Wheat milling and cleaning equipment, bulgur wheat. Femented and leavened products of wheat, macaroni. Fermented and leavened products from wheat. Dough rheology. Importance of glass transition temperatures in cereal.

Testing of mill stocks by suitable equipment like Amilograph, Extensograph, farinograph etc.

SECTION B

Corn milling, corn flour and other related products, break fast cereal and sugar coating process.

Snacks corn chips, expanded snack products, extrusion cooking of cereal based products.

Milling of barley, oats, rye, sorghum, millets etc. National and international standards of quality of various cereal and cereal based products.

By-products utilization of cereal process industry. Cereal based animal feed, wheat germ, corn oil.

Advanced technology of Milling of pulses.

Reference Books:

1. Kent, N.L. Technology of Cereals, CBS Publisher.
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, AACC, USA.
5. Pandey, P.H. Post Harvest Technology.

1.5. Functional Foods and Nutraceuticals

Introduction to Nutraceuticals/ Functional foods: definitions, synonymous terms, basis for claims for a compound as a nutraceutical, regulatory issues for nutraceuticals including CODEX/FSSAI.

Concept of angiogenesis and the role of health foods, Nutraceuticals for cardiac disease, cancer, diabetes, cholesterol management, oesity, joint pain, immune enhancement, age related macular degeneration, endurance performance and mood disorders-compounds and their mechanisms of action, dosage levels, contradictions if any.

Manufacturing aspects of selected nutraceuticals such as lycopene, isoflavonoids, prebiotics and probiotics, glucosamine, phytosterls etc. Formulation of functional foods containing nutraceuticals-stability and analytical issues, labelling issues.
Chemical testing of nutraceuticals and health foods, interactions of prescription drugs and nutraceuticals, adverse effects and toxicity of nutraceuticals, Nutrigenomics—an introduction and its relation to nutraceuticals.

References Books


SYLLABUS FOR M. E. (FOOD TECHNOLOGY) SECOND SEMESTER

FT 2.1 Food Packaging Technology

Paper Title: Elective (Theory)

Paper Code: FT 2.1; 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 principals of Food Packaging, Types of packaging , Special packaging methods (vacuum, gas and shrink packaging), Function of a package, packaging materials, their structural qualities and performance including moisture and gas transmission, interaction of food and the packaging material. Rigid and flexible packaging materials. Types and roles of active and intelligent packaging. Oxygen, ethylene and other scavengers; antimicrobial food packaging; non-migratory bioactive polymers in food packaging; time-temperature indicators; freshness indicators.

SECTION B

Novel MAP applications for fresh-prepared produce, product safety and nutritional quality; reducing pathogen risks in MAP-prepared produce, detecting leaks in modified atmosphere packaging, MAP with other preservation techniques. Novel packaging and particular products. Active packaging in practice meat, fish, fruits and vegetables, other fresh produce.Laminates, multilayer laminates, testing of packaging materials. Legislative issues relating to active and intelligent packaging, recycling packaging materials,green plastics for food packaging

Packaging-flavour interactions; Food-packaging interactions; characteristics of food-grade packaging material
Books Recommended:


**FT 2.2 Selected Topics of Fruit and Vegetable Technology**

Paper Title: Elective (Theory)

Paper Code : FT 2.2; 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**

Importance of post harvest handling, Composition and nutritive value of fruits and vegetables. Fruit ripening, Spoilage of Fruits and vegetables, Indian environment for fruits and vegetable processing.

Application of recent advanced techniques of fruits and vegetables preservation. Low cost methods of preservation. Cold storage, Osmotic dehydration, Foam mat drying, Freeze drying, microwave heating applications, radiation preservation of fruits and vegetables, Irradiation sources, Spray drying of fruit and vegetable juices, concentrates & powder its Sensory evaluation and packaging.

Use of additives in various fruits and vegetables product development. Application of enzymes in fruits and vegetables processing. Controlled ripening. Nutritional and biochemical changes during post harvest storage, processing and post process storage.
SECTION B


Legislation of processed fruit and vegetable products. Analysis and detection of contaminants and adulterants and quality control. Factory sanitation and hygiene.

Microbiology of fresh and processed products and its control.

Waste utilization and By-products of fruits and vegetable industry.

Reference Books

3. Luh & Woodroof : Commercial Vegetable Processing, AVI Publishing, USA.
4. Woodroof & Luh : Commercial Fruit Processing, AVI Publishing, USA

**FT 2.3 Food Process Equipment Design**

Paper Title: Elective (Theory)

Paper Code : FT 2.3; 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

Design considerations of agricultural and food Processing Equipments: factor of safety, theories of failure, allowable stresses, aterials of Construction.

Introduction to pumps and pipelines. Process plant piping, hygienic considerations and ease of cleaning for insulated as well as un-insulated pipes Introduction to boilers.

SECTION B


Design of membrane separation unit (UF and RO), high pressure processing, pulse electric field processing.

Reference Books


FT 2.4 RESEARCH METHODOLOGY

Paper Title: Elective (Theory)

Paper Code : FT 2.4; 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: Meaning, Features, Objectives/Motives & types of Research; Attributes of good Research, Research Methods and Research Methodology; Research Process, Significance of Research in Managerial decision making.

Research Design: Meaning, Characteristics and various concepts relating to research design and classification of research design, Importance.

Measurement and Scaling: Data Types Nominal, Ordinal and Ratio scale; scaling techniques.

Formulation of Hypothesis: Meaning, Characteristics and concepts relating to testing of Hypothesis (Parameter and statistic, Standard error, Level of significance, type-I and Type-II errors, Critical region, one tail and two tail tests); Procedure of testing Hypothesis. Numerical problems based on chi-square test and Ftest (variance ratio test only).

SECTION – B

Data Collection: Sources of Data-Primary/Secondary Methods of collecting data; direct personal interview, indirect oral interview, information through local agencies, mailed questionnaire method, schedule sent through enumerators; questionnaire and its designing and characteristics of a good questionnaire.

Sampling Design: Meaning and need of Sampling, Probability and non-probability sampling design, simple random sampling, systematic sampling, stratified sampling, cluster sampling and convenience, judgement and quota sampling (non-probability), determination of sample size.

Data Analysis & Interpretation: Introduction to Multivariate analysis- Multiple and partial correlation, multiple regression analysis (with two independent variables), specification of regression models and estimation of parameters, interpretation of results. Analysis of Variance (ANOVA)-One way and Two way ANOVA. Introduction to discriminant analysis and Factor Analysis (Numerical not to be asked)

Report writing: Style/format, contents and essential steps for report writing.
**FT 2.5 Food Product Development**

Paper Title: Elective (Theory)

Paper Code: FT 2.5; 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**


Ideas and innovation in food product development. Life cycle analysis of food products, case studies. Product development process-product strategy, product design and process development, product commercialization, product launch and evaluation.

**SECTION B**


Unit 4


**Reference Books**

   Fuller 2004. New food Product development-from concept to market place, CRC.


SYLLABUS FOR M. E. (FOOD TECHNOLOGY) THIRD SEMESTER

FT 3.1 Analytical Techniques

Paper Title: Elective (Theory)

Paper Code: FT 3.1; Max. Marks 50; Credits: 3; Time: 3 hours

Course Duration: 42 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

Complexometric titrations: Complexes—formation constants; chelates – EDTA, Chelon Effect, EDTA equilibria, effect of pH on EDTA equilibria, EDTA titration curves, endpoint – detection and indicators; Importance of complexometric titrations.

Solvent Extraction: Distribution law, extraction process, factors effecting extraction, technique for extraction, quantitative treatment of solvent extraction equilibria, classification of solvent extraction systems. Advantages and applications of solvent extraction.

Chromatography: Introduction to chromatography, principles, classification of chromatographic techniques, thin layer and paper chromatography – principle and technique.


Thermoanalytical methods: Principle, classification of methods.

TGA – Instrumentation, factors affecting results and analysis of data. applications.

DTG – Instrumentation, analysis of data and applications.

DTA – Principle, Instrumentation and applications

SECTION-B


**NMR**: Principle, chemical shift, spin-spin coupling shift reagents, instrumentation, spectra and molecular structure, identification of organic compounds on the basis of NMR.


AFM/ Atomic Force microscopy – Principle instrumentation and its basic applications

### 1. Books Recommended:


**FT 3.2 Electives:**

**Paper Title**: Elective (Theory)

**Paper Code** : FT 3.2;  Max. Marks 50 ; Credits : 3;  Time: 3 hours

**Course Duration**: 42 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

1. Advanced Food Biotechnology
SECTION A


Technological aspects of industrial production of beer, wine, organic acids, amino acids, vitamins, antibiotics, baker's yeast, single cell protein. Production of bio-flavor, bio-color, bio-preservatives.


SECTION B

Production of alcohol, lactic acid and acetic acid from various food materials. Bacteriocin production and its use in food preservation. Biotechnological processes of manufacture of functional foods, nutraceuticals and probiotics.


Reference Books:

2. **Advanced Microbial Technology**

**SECTION A**

Relevance of microbiology as a field of Food technology. Historical milestones in microbial food technology. Morphology and physiology of industrial microorganisms (Bacteria, yeasts, molds and actinomycetes). Isolation : identification and quantitative estimation of microorganisms, Microbiological assay in Microbial nutrition.


Bacterial cell wall biosynthesis. Photoautotrophy, Chemolithotrophy, Methylohythrophy, Calvin cycle.

**SECTION B**

Genetics of some industrial microorganisms, Microbiology of soil, Selection, development and maintenance of cultures.

Chemistry and biosynthesis of microbial products e.g. vitamins, amino acids, enzymes, steroids, antibiotics and polymers. Metabolic regulations in industrial fermentation.

Microbial transformation of alkanes, alkaloids, terpenes, aromatic compounds and naturally occurriopolymers.


**Reference Books:**


3. Food Rheology & Texture

SECTION A

Introduction to rheology of foods: Definition of texture, rheology and psychophysics— their structural basis; physical considerations in study of foods; salient definitions —Stress tensor and different kinds of stresses.

Rheological classification of Fluid Foods : Shear-rate dependence and time dependence of the flow-curve; Non-Newtonian fluids; thixotropy; Mechanisms and relevant models for non-Newtonian flow; Effect of temperature; Compositional factors affecting flow behaviour; Viscosity of food dispersions – dilute and semi-dilute systems, concentration effects.

Comparative assessment of different types of Viscometers, and their Merits and Limitations: Co-axial cylinders, Spindle- or Impeller-type viscometers, Cone-plate viscometer, Capillary viscometers, Falling-sphere viscometer, Vibratory viscometers, Extrusion viscometer, Orifice viscometer.

SECTION B

Rheology of semi-solid and solid food ; Rheological characterization of foods in terms of stress-strain relationship; Viscoelasticity; Transient tests - Creep Compliance and Stress Relaxation; mechanical models for viscoelastic foods: Maxwell, Kelvin, Burgers and generalized models and their application; Dynamic measurement of viscoelasticity.

Large Deformations and failure in foods: Definitions of fracture, rupture and other related phenomena; Texture Profile Analysis; Instrumental measurements – Empirical and Fundamental methods; Rheometers and Texture Analyzers; Measurement of Extensional viscosity; Acoustic measurements on crunchy foods.

Rheological and textural properties of selected food products: Measurement modes and techniques; Effect of processing and additives (stabilizers and emulsifiers) on food product rheology; Relationship between instrumental and sensory data.
Reference Books


4. Thermal and Non-thermal Processing of Foods

SECTION-A

Membrane Technology. Introduction to pressure activated membrane processes: micro filtration, UF, NF, RO and their industrial application. Supercritical fluid extraction. Concept and properties of super critical fluids.

Microwave and radio frequency processing. Definition, advantages, mechanism of heat generation. Microwave blanching. Hurdle technology-Types of preservation techniques and their principles, concept of hurdle technology and its application.

SECTION -B

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

Innovative techniques in food processing. Application of technologies of high intensity light, pulsed electric filed, ohmic heating, IR heating, inductive heating, X-Rays in food preservation. Nano technology: principle and application in foods.

References Books


5. Nanotechnology

6. Industrial Pollution Control and Abatement

SECTION-A
Treatment Methods for water & waste: Sources and characterization of water pollution.

Primary Treatment: gravity separator, equalization tanks, Sedimentation, Flotation

Secondary Treatment – Design of : Upflow Anaerobic, Sludge Blanket (USAB) reactor, Activated Sludge process – Rotating Biological Contactors (RBC), Trickling Filters;


Tertiary Treatment systems: Disinfection etc.

Sludge and solid wastes treatment: Identification of hazardous wastes – disposal and waste minimization, waste management,

SECTION-B

Air Pollution Control: Air pollutants: Sources, effects, temperature inversions, plume behaviour, characterization, stack height, Gaussian Plume design model, Measurement and emission estimates, Isokinetic Sampling.

Control methods: Particulate emission control methods, gravitational settling chambers, cyclone separators, Scrubbers fabric filters, ESP, wet scrubbers, control of Volatile Organic Compounds (VOC’s) Control of SO₂, NOₓ.

Others: Motor Vehicle Air Pollution Control, Global Warming, Indoor Air Pollution

Books & References

1. Air Pollution by Perkins
2. Air Pollution by Rao & Rock
3. Industrial Pollution Control by S.P.Mahajan
4. Air Pollution Control Engg. by N.D.Nevers
5. Disposal of Wastes Water by Eddy Mt Calf
6. “Environment Engg. & Science” by Sincero & Sincero
7. Introduction to Environment Engg. by – Davis and Cornwell